

Climate Masters at Work™

Participant Guide

University of Oregon Climate Leadership Initiative



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Introduction to Climate Masters at Work

This Manual

This manual is designed to serve as a starting point and reference guide for a wide array of issues to consider for reducing a business's climate impact. The various topics addressed in this manual, such as transportation, energy use, and waste, function as a system rather than as individual pieces. This manual, however, examines each component separately in order to provide a sound level of knowledge and resources for each topic. The final sections of the manual aim to stitch the subject areas back together, with the goal of sparking innovation and a shift in thinking about the processes used, the products and services produced by a business, and the overall business model.

Program Goal

The Climate Masters at Work (CMW) program was developed by the Climate Leadership Initiative, a program in the University of Oregon's Institute for a Sustainable Environment as a research project to identify effective methods of helping businesses reduce their greenhouse gas emissions and prepare for the impacts of global climate change. The CMW program is being run by the Lane Community College Business Development Center.

The program aims to educate and motivate business leaders, who will apply their knowledge at their own workplace as well as work with other businesses in emissions reductions. We hope to help these businesses reduce emissions by 5-20% as well as to document cost savings. Through presentations to the Chamber of Commerce and other groups, workshops, and outreach to suppliers and other businesses in similar sectors it is expected that these participants will multiply their impact to other businesses.

Contact: Sonja Mae, Sustainable Business Instructor and Advisor, with any questions about the Climate Masters at Work program, (541) 463-4605 or maes@lanecc.edu or visit the Business Development Center website at: LaneBDC.com/training/programs/climate

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Why Climate Masters at Work?

Global warming is the most pressing environmental issue facing the world. The largest group of scientists ever to study an issue, the Intergovernmental Panel on Climate Change (IPCC), has concluded that global temperatures are rising to dangerous levels, that humans actually are the dominant cause, that severe economic, social, and environmental impacts will result, and that those impacts will grow worse the warmer it gets. Risks include reduced water supply, increased forest fires, loss of biodiversity, rising sea levels, public health impacts, as well as natural disasters and extreme weather of increasing frequency and intensity. The latest IPCC report states that greenhouse gas (GHG) emissions must peak by 2015 to avoid dramatic temperature increases and the accompanying impacts. The IPCC states that making this shift requires action within two to three years at all levels of society and that GHG emissions must then be reduced by 60 to 80 percent by mid-century. Research conducted since the release of the latest IPCC report points to even greater and more rapid impacts than previously projected.

Global Climate Change and Businesses

We are entering a prolonged period of volatility in which weather patterns, availability of water, energy and certain natural resources cannot be relied upon in the same way they have been in the past. Transportation disruptions will likely increase as the roads that reliably transported goods may be washed out more frequently or impassible due to floods and landslides. The hydroelectricity that powers much of the Pacific Northwest will be less available in the hotter summer months with spring snowmelt taking place earlier in the year. Meanwhile, the costs of both energy and transportation are expected to increase as governments adopt policies to reduce fossil fuel use and resulting carbon dioxide emissions. International sourcing may become increasingly unreliable. Buildings that have provided adequate protection at a reasonable cost may no longer do so with the onset of more frequent and intense hot spells and storm events. Employees may need more sick days off from work as higher temperatures and greater carbon dioxide fertilization boost pollen counts and diseases such as asthma and West Nile virus rise.

A recent report from industry consultants, McKinsey and Co., states that in order to avert catastrophic climate change our society must achieve an increased “carbon efficiency” of a magnitude on par with labor productivity increases of the Industrial Revolution. Society has made this kind of shift before, but this time, we have got to make the transition in just one third of the time.¹ Businesses are perfectly poised to address this challenge. Of any institution, they are the most able to quickly meet changing needs, and can earn profits while acting as global citizens. In order to meet calls for emission cuts of 80% by 2050, business – and all sectors of society – will need to do more than retool existing systems and make modest efficiency improvements. Rather, reductions at this level will require dramatic innovation in the way businesses design products, deliver services, and operate: in short, we need whole new business models.

For those ready to meet the challenge, this new era is loaded with opportunity. Despite increasing awareness of climate change and the cost savings available through efficiency measures, many opportunities to reduce energy, material use and waste in the workplace remain untapped. By missing these options, money is being wasted and profits are being left on the table. When taken advantage of, many of these opportunities will also increase employee commitment and effectiveness, boost

public image, hedge against the risks of rising energy costs and regulations of greenhouse gases, all while reducing climate damaging greenhouse gas emissions. A 2007 market survey found that in contrast with just one year earlier, nearly all Americans display “green” attitudes and behaviors and see green brands as higher quality, meaning that increased efficiency for businesses may also lead to a growing consumer base.² Many jurisdictions and large-scale buyers either require or favor bids that include documentation of a company’s environmental actions. Another recent market study found that companies using green practices have higher employee productivity as well as higher rates of customer and employee satisfaction.³ Finally, the recent political and economic climate highly favors green jobs and providers of such employment.

The Climate Masters at Work (CMW) program will educate, train and support business leaders in thinking differently and taking steps to kick-start and sustain ongoing advances in workplace emission reductions and climate preparation. Through peer learning and co-creation, CMW seeks to spur constant learning and innovation amongst participating businesses. These steps will help place your business in the front of their fields as they respond to the rapid environmental, economic, and social transformation caused by global climate change.

What is Climate Masters at Work?

The Climate Masters at Work program is a 30 plus-hour train-the-trainer program for businesses focused on increased energy and resource efficiency and use of renewable energy in facilities, packaging, materials selection, transportation and other areas that will reduce emissions and help prepare for climate change while strengthening businesses’ economic standing. Partnerships with Lane Community College’s (LCC) Energy Management program will provide connections with trained student interns to support internal efforts at participating businesses.

Sonja Mae will advise you on how to arrange for a student intern for your business. Student interns are required to complete 30 intern hours and can perform the following tasks:

- Lighting audits
- Control system audits
- Energy analysis and energy metering
- Identify specific equipment that might be easily replaced or improved
- Identification of incentives, grants and subsidies
- Initiate energy efficiency projects

The students are not licensed tradesman, so they cannot change out light fixtures and conduct other such tasks.

Participant Commitment

Participants will “pay” for this training by investing an equal amount of time (a minimum of 25 hours) implementing the lessons learned in the training to their own workplace and/or conducting outreach to other businesses. We expect that participants will complete their payback within six months of completing the course, or by January 7, 2011.

Fulfilling the Commitment

In most cases, participants will fulfill their volunteer hours in part by facilitating the compilation of a basic greenhouse gas emissions inventory for their workplace, developing and beginning to implement a plan for cutting those emissions. External outreach efforts might include promoting the efforts of their own business and moving other businesses to action by speaking at a Chamber of Commerce or other business event, sharing successes and lessons learned in newsletters, or communicating with businesses along their supply chain to increase efficiency and reduce emissions. The volunteer outreach component will expand the program impact through peer-to-peer education while promoting participants’ own efforts.

Reporting

We require that participants record their internal and outreach efforts in writing and send us the documentation at the end of the course and at the end of the commitment period. This could be in the form of a short email or it could be a full report. We would also like to see any GHG inventories, climate action plans, and written results of the plans as they are completed.

In order to assess the effectiveness of the CMW program, we need to know what participants are doing as a result of the class. The continuation of the program relies on participants completing and reporting “payback” hours and the above mentioned materials. Please share your efforts with us and help make this program a success.

Class Information

- Classes begin promptly at **8:00 a.m.** and run until **10 a.m.**, with a five-minute break in the middle. Please be on time and plan to stay for the entire session.
- All classes will meet at Lane Community College Business Development Center at 1445 Willamette St. unless stated otherwise.
- You may bring food and drink to class.
- Please ask questions if you are unclear on a topic. We ask that you avoid using instruction time to debate issues, expound on your personal beliefs, or describe your knowledge of the subject to the class and the instructors. Other students will prefer to hear what the instructors have to share during their presentation time. We will provide opportunities online and in person for sharing your experiences and expertise.
- Participants are strongly encouraged to bring other employees at their workplace to single classes that are relevant to their work. For example, the facilities manager would be well served by attending the energy efficiency session.

The Case for a Low or No-Emissions Business

While actions to increase energy and resource efficiency at home might be an easy decision because they feel like the “right thing to do,” the same investments of time and money in the workplace often seem to require greater justification and effort. Businesses must consider and obtain a commitment for change from employees, shareholders, clients, customers, and board members. Bringing management and staff on board may require explanation of the significant benefits that can be achieved through actions to increase energy and resource efficiency. The case studies throughout this handbook and the general benefits listed below bolster the case for sustainable business practices. Meanwhile, the handbook section on organizational change will provide further insight into strategies for effectively moving your workplace towards zero emissions.

Personnel Benefits⁴

Employees are the greatest asset of any company, but also one of the greatest costs of doing business. In some cases, their level of productivity and the amount of management required to hire, train and supervise can make a significant difference to company profits. The personnel benefits associated with increasing the environmental and social responsibility of a company are:

- *Increased employee productivity and morale:* The key to getting the most out of employees is to maximize their motivation. Wages and benefits provide external motivation, but the fundamental motivation is more likely to be inspired through the purpose and meaning of their work.
- *Improved employee health:* A slew of studies have shown improved health and productivity as well as reduced absenteeism for employees working in buildings with improved air quality, temperature control, daylighting and high performance lighting, which includes the use of efficient lighting.⁵
- *Easier hiring and retention of top candidates:* Top talent are often drawn to companies with an inspiring mission, and research shows that a company’s image is most affected by its perceived level of social responsibility. Moreover, losing a talented employee can cost between \$25,000 to \$50,000, based on the costs of lost training and the intellectual property that leaves with the employee, along with the recruitment and training of a new employee. Multiple studies reveal that employees stick with a job where they feel empowered, valued, have the opportunity for advancement, and where their work is meaningful.

Leading in a Carbon Constrained Economy⁶

Rising oil prices along with increasing political and consumer focus on avoiding catastrophic climate change are leading businesses and the public towards low-carbon products and services. The providers of those goods and services, as well as those who adapt by taking advantage of climate-positive technologies, are more likely to thrive in this carbon constrained global economy. Additional benefits of providing and making use of low-carbon goods and services are:

- *Enhanced reputation, customer loyalty and market share:* Many successful businesses have reputations that rest on their “green” image – consider national chains like Whole Foods, Seventh Generation, Body Shop and Patagonia. Even those businesses that might not be seen as “green” can reap the rewards of providing more climate-positive products. Honda reported record profits of \$1.68 billion in the fiscal quarter ending in June, 2008, and is struggling to keep up with demand thanks to their focus on fuel-efficient vehicles. Meanwhile, competitors GM and Ford, whose profits once were generated by large vehicles, lost billions that year as the market moved away from less efficient vehicles.⁷
- *Reduced operational costs:* Cutting down on waste, water, and energy use, as well as selling materials for reuse and recycling can all cut cost and increase profits. For example, the New Belgium Brewing Company saves \$2,500 to \$3,000 on their monthly electric bill from their combined heat and power (CHP) or cogeneration plant. They use methane from the company’s spent yeast and wastewater to generate electricity, and then use the waste heat in their water treatment plant to maintain desired temperatures there. The payback period for the \$5 million plant was less than three years, in large part because of avoided wastewater fees.⁸
- *Reduced risk:* The risks of ignoring climate change in relation to your business are fourfold, including those of regulation, physical risk, reputation and for energy intensive companies, the risk of litigation. Specifically, regulation of greenhouse gases would increase energy and fuel costs, raising the costs of all goods, transportation and business in general. Those businesses with efficient use of resources and energy (including that used for moving materials and people), will be less affected by these price hikes. Furthermore, those who consider the impacts of global climate change on their entire supply chain will be better prepared for a less predictable future in terms of transportation and production disruptions from storm events, flooding, fires and other climate related events. Finally, while a truly “green” reputation can boost business, those companies seen as disregarding their impact on the climate may see decreased market share, and in extreme cases (typically for energy producers thus far), may face law suits for the effects of their business on the global climate.
- *Greater appeal to investors and partners:* Funders are becoming increasingly interested in supporting climate positive business activities. Bank of America announced \$20 billion in funds to support business activity that addresses climate change, while Citibank is putting \$50 billion towards investments and financing for climate change activities. There are many opportunities for state and federal tax credits for such activities, as well as utility incentives (see financing section below as well as sections on energy and transportation).
- *New business opportunities:* Through addressing issues brought up by reducing greenhouse gas emissions and other sustainability challenges, innovative products and services have and will be born.

In Lane County, OR, Euphoria Chocolate Company saves as much as \$10,000 a year through a more energy efficient heating-ventilation-air conditioning (HVAC) system in their Willamette St. store and on-demand water heater in their processing area. Market of Choice made \$126,768 in 2005 from selling their cardboard to Weyerhaeuser for recycling.

Financing and Accounting

Finances can make or break the deal when deciding whether to move towards energy and resource efficient products and practices. While many practices are essentially free, like educating truckers to drive efficiently and setting computers to sleep when not in use, some emission-savers require significant capital outlays.

The two most common forms of financial evaluation are simple payback and internal rate of return.

- *Simple payback determines the number of years needed to recover the upgrade cost.*
- *Internal rate of return considers the results of an investment versus investment in other areas.*

Here are several points to consider when completing a financial evaluation

Include all the costs and savings. Energy savings translate directly to financial savings. The cost of spending on efficiency should be calculated against the cost of purchasing power or generating that power onsite. Energy Star's website has cost calculators for many commercial products that show the net savings over the lifecycle of a product. See the end of this section for an example or visit their website to use the calculators at

http://www.energystar.gov/index.cfm?c=bulk_purchasing.bus_purchasing#off

Consider state, federal and utility tax credits and rebates. Information on specific options are provided throughout this handbook, but a good starting point for state and federal incentives can be found at the Database of State Incentives for Renewables and Efficiency (DSIRE)

<http://www.dsireusa.org/> and on the ENERGY STAR® website at

http://www.energystar.gov/index.cfm?c=sb_join.sb_financeproducts. More federal opportunities are listed at <http://www1.eere.energy.gov/financing/business.html> as they become available.

Loans and grants may be available to fund efficiency measures. The Alliance to Save Energy website has a database of energy efficiency funds and programs worldwide at

<http://www.ase.org/section/topic/financingee>, while the Small Business Administration offers grants for pollution control at <http://www.sba.gov/services/financialassistance/index.html>.

Regulation is more difficult to predict, but has potential dramatic ramifications particularly for energy intensive businesses. The EU and Northeastern states (through Regional Greenhouse Gas Initiative (RGGI)) already have a cap and trade program and the governors of seven western states, including Oregon, and four Canadian provinces plan to implement a regional cap and trade system through the Western Climate Initiative in 2012. These and other policies mean that the cost of greenhouse gas emission intensive activities will continually rise. A careful look at your supply chain might reveal your risk for these increased costs.

Costs of climate change impacts could increase the costs of certain actions through disruptions to business as usual. For example, products sourced from afar may be interrupted by extreme weather or sea level rise in the location where they are produced or assembled. Air travel may be impacted by increased storm intensity.

Broader time horizons can alter the return on investment and change the prospects for certain investments.

Remember non-financial benefits described above, like increased employee productivity, customer loyalty, etc.

It's likely that your organization uses payback period and return on investment calculations to make decisions on investments. The ones described below can be used to evaluate particular investments in increased energy or other emission reduction efforts. Also see our GHG Inventory calculator on the "Actions" tab.

Payback Periods

The payback period is the amount of time needed to break even on an investment. Payback period is calculated by dividing the cost of the investment by the annual returns.

$$\text{Payback period} = \frac{\text{Cost of project}}{\text{Annual returns}}$$

The theory behind the payback period concept is that all other things being equal, a project with a shorter payback period is a better investment. The payback period, however, does not incorporate the time value of an investment (the value to be had by making the purchase at a given point in time, or the value added by the passage of time) or the cash flows following the payback period. For example, considering only the payback period in determining whether to invest in a solar hot water system would leave out the value of the system after the system has paid for itself.

Return on Investment

A return on investment (ROI) calculation measures the efficiency of an investment or compares a number of investments. Put simply: Return on Investment = (Gain From Investment - Cost of Investment)

Cost of investment

The outcome of the calculation varies, however, based on what gains and costs are included. Some gains may be difficult to predict or measure, while altering the time horizon used could change the gains netted from the investment. Because a ROI calculation can be so easily manipulated, it is crucial to be aware of all of the inputs and make those clear to all involved in making financial decisions. In some cases, examining the way in which ROI is calculated could shed light on internal barriers to sustainable practices.

Financing Options for Energy Efficiency Upgrades⁹

Internally, one way to designate funds for reducing GHG emissions is by putting a certain percentage of savings from reduced energy or resource use towards efficiency measures that require a significant upfront outlay of capital, like solar photovoltaic panels or some of the more efficient office or manufacturing equipment.

There are typically three payment options for energy and resource efficiency upgrades: purchasing, leasing and performance contracting.

Purchasing: This is the simplest option for organizations with a strong cash reserve. All cost savings are realized by the business and the depreciation of the equipment becomes a tax deduction. However, the money spent on the purchase is no longer available for other investments.

Loans may require a forty percent down payment for efficiency projects. Payments may be structured to be equal or slightly less than the energy savings realized from the project. High performance features in new buildings may not cost more than their less efficient counterparts outside of additional architecture and engineering services. For example, purchasing the right sized HVAC system will result in energy savings but relies on equipment that must be purchased regardless.

Some banks are now providing low-interest financing for some projects through “green loan” programs. For example, Umpqua Bank, based in Portland, Oregon, recently teamed up with Energy Trust of Oregon to provide low-interest financing for energy saving home improvements and solar energy projects. This green loan program, dubbed “GreenStreet Lending”, offers special rates for small businesses and homeowners with no loan origination fees or closing costs.

Leasing: Lease payments may be slightly lower than loan payments. There are at least two different types of leases to consider. *Capital leases* are installment purchases where payment eventually ends in ownership, tax deductions can be taken for depreciation and interest payments. *Operating leases* do not transfer ownership to the lessee at the end of payment. Rather, the equipment is “rented” and tax benefits accrue to the lessor. At the end of the lease, the equipment could be purchased or the lease renegotiated.

Performance Contracting: This option, also known as “shared savings” or a “paid from savings” contract, keeps the upgrade off of your balance sheet and relies upon the performance of the upgrade. There are no upfront costs to the building owner and payments come out of energy savings. The service provider assumes the risk of the project and obtains the financing in exchange for a portion of the savings. During the contract period, the financing organization owns the equipment, with transfer of ownership occurring according to contract specifications at the end of that period.

These resources and the information above should provide a starting point for determining the feasibility of various efficiency projects, calculating the savings, and finding resources to defray the costs of your investments. Throughout the remainder of the handbook, appropriate financing options will be provided at the end of each section.

Local Financing Resources

Check in with your utility and visit the websites below to find out what incentives they offer businesses.

Business Energy Tax Credit (BETC):

<http://www.oregon.gov/ENERGY/CONS/BUS/BETC.shtml> ; or call (503) 378-4040 or email energy.in.internet@state.or.us.

Database of State Incentives for Renewables & Efficiency

<http://www.dsireusa.org/> ; use webform to email.

Eugene Water and Electric Board (EWEB):

http://www.eweb.org/business/energy/rebate_programs/index.htm ; or call (541) 484-1125 or use webform to email.

Emerald Peoples Utility District (EPUD): <http://www.epud.org/comnrg.aspx> ; contact Rob Currier at 744-7402 or email him at rob@epud.org

Springfield Utility Board (SUB): http://www.subutil.com/conservation_services/for_your_business ; or call 744-2264.

Central Lincoln PUD: <http://www.cencoast.com/>; Contact Mike Sleight at (541) 987-3414

Pacificorp and Northwest Natural use Energy Trust services: <http://www.energytrust.org/>; or call (503) 493 8888 or buildings@energytrust.org

Blachly Lane: <http://www.blachlylane.coop/> ; or call (541) 688-8711

Lane Electric: <http://www.laneelectric.com/> or call (541) 484-1151

Chapter One: Climate Change Basics

Key Learning Points

- Greenhouse effect
- Sources of carbon dioxide, methane, nitrous oxide and other greenhouse gases (GHG)
- Forcing, feedback, delays
- Climate change impacts and the role of humans
- Climate vs. weather
- Scientific proof
- Preparation and mitigation

Background

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 a forward looking business understand the general concepts involved in climate science and know where to go for more information.

The Basics

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

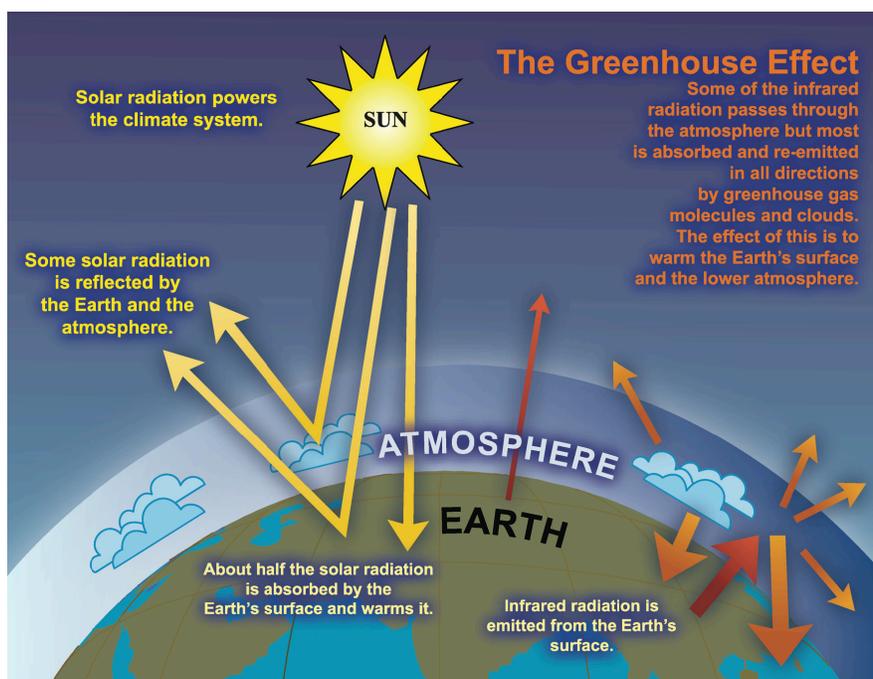


Figure 1: Greenhouse gases reflecting heat back to the earth. Source: IPCC AR4, 2007. <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter1.pdf>

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 (CO₂), nitrous oxide (N₂O) and methane (NH₄) have increased significantly (by approximately 36%, 18% and 148% respectively) in the atmosphere as a result of human activity. 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.¹⁰ Global concentrations of all three of these greenhouse gases now far exceed pre-industrial values, as determined from ice cores spanning many thousands of years. The atmospheric concentration of carbon dioxide, the most important greenhouse gas released by human activity, now exceeds by far the natural range over the last 650,000 years (the natural range being 180-300ppm and current levels reaching approximately 385).

Climate and Weather

The two words are often used interchangeably in everyday conversation with little consequence, but when discussing climate change, the difference is significant.

Stated simply, weather is what happens day by day, be it sunshine or cloudy skies, rain, sleet or snow. Climate is the average of all of this “weather” over time.

This distinction is why unseasonably cool weather in July does not debunk climate change, nor does a single short sleeve day in February provide “proof” that it is happening. Local phenomena, including regular events like El Niño, result in local effects.

Climate change, or global warming, is an average increase in global temperatures that interacts with short-term climate effects to produce weather. El Niño years will still likely be drier than others in Oregon; La Niña years wetter. But with the addition of the background warming of climate change, a La Niña year could see stronger April downpours and drier Augusts than without.

Some impacts of climate change to weather are already being seen across Northern America and the Pacific Northwest, like more frequent and intense downpours, fewer extreme cold events and more frequent extreme heat events. These downpours and temperature changes are indeed associated with human induced warming, with the heavy precipitation resulting from increased water vapors. The increase in water vapors is a consequence of higher average temperatures.

Looking into the future, models predict that weather events that once were extremely rare will become more commonplace. For example, days so hot they were only experienced every 20 years in the past are expected to occur every three years by mid-century and every other year by the end of the century.¹¹

So, while we cannot attribute any single weather event to climate change, the cumulative changes over time and across the globe do reveal troubling trends at work.

The Bottom Line¹²

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

Evidence of Warming¹³

In part we know that the climate is warming because of direct observation of increased average air and ocean temperatures, widespread melting of snow and ice, alongside rising global average sea levels. A year ago, the IPCC wrote that eleven of the last twelve years rank among the twelve warmest since 1850. Since then, 2007 tied 1998 for the second hottest year on record, with 2005 taking the lead.¹⁴ 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 observed changes 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 one 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.

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 21st century falls between 3.2°F and 7.2°F, while the full range for the century is 2°F to 11.5°F.¹⁵

According to the IPCC, global average sea levels are projected to rise between 7 and 23 inches, a narrower range than prior estimates. These estimates exclude some factors, including melt water 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.

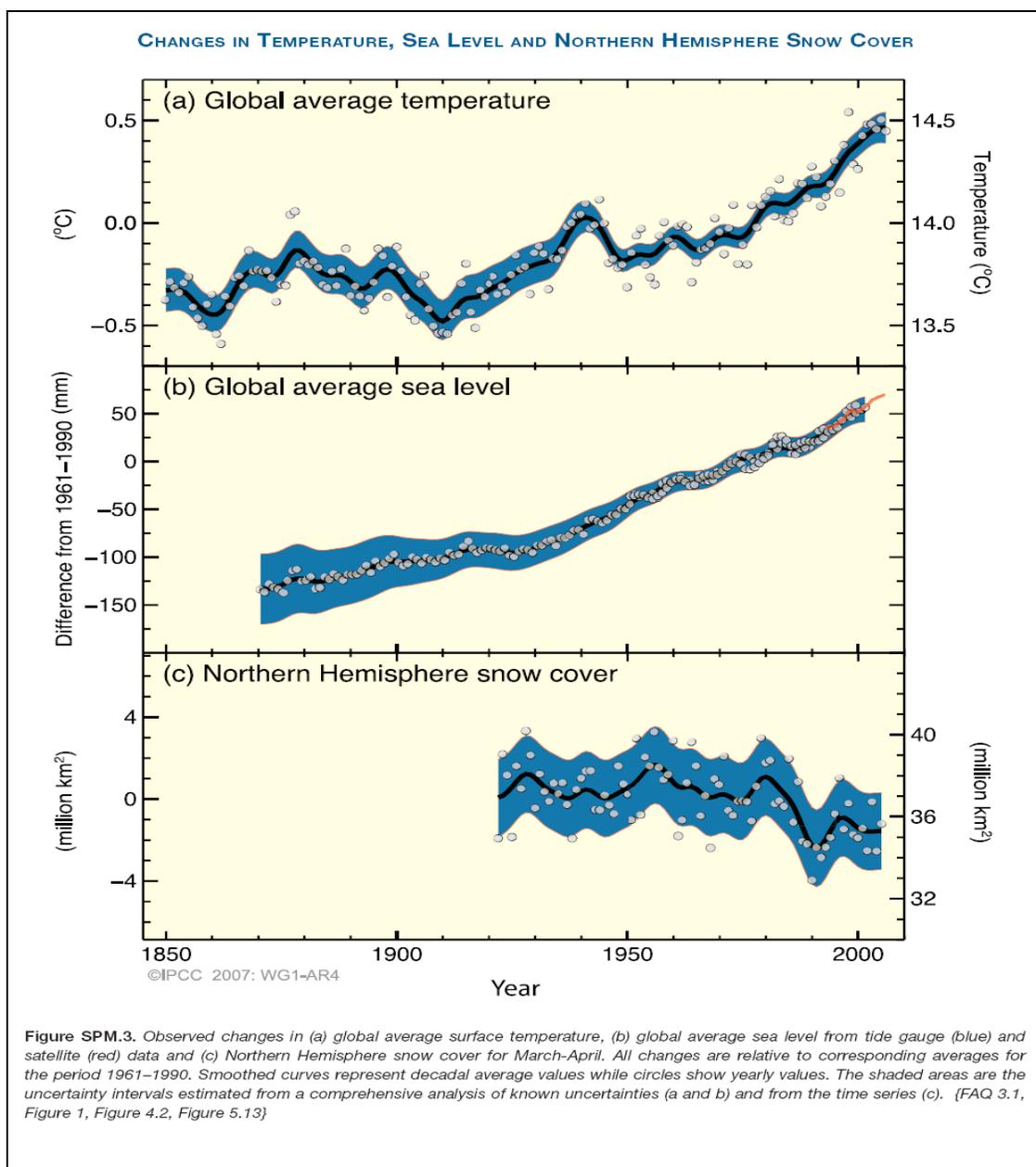


Figure 1: IPCC Report, Working Group I, “The Physical Science Basis.” <http://www.ipcc.ch/ipccreports/ar4-wg1.htm>¹⁶

IPCC Findings Specific to Western North America

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

- Ocean pH expected to decline (a phenomenon known as “acidification”).

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 expected to shrink. Effects on the Pacific Northwest, subject to regional factors including El Niño and ocean circulation phenomena, carry higher uncertainty.

*Implications for Oregon and Washington:*¹⁷

It’s getting warmer – on average - and it’s getting warmer faster. Models project a warmer climate for the Pacific Northwest during the 21st century, with temperatures increasing at a rate of 0.5°F per decade (slightly higher than the global average warming) at least through 2050, and with greater warming in summers. This rate is two and a half times faster than the warming observed in this region during the twentieth century.

In the Willamette Valley, we should expect even greater increases in the average annual temperatures. A recent downscaling of the global models to the Southern Willamette Valley projects annual average temperatures of 6°F to 8°F higher than today’s averages by 2080. Summer temperatures would have even hotter averages, with more days in the 90s and 100s.¹⁸

Changes in precipitation appear less certain than changes in temperature. Most of the scenarios project little change to the overall amount of precipitation by mid-century. However, the models do show a little less summer precipitation and a little more winter precipitation. Because of warmer winter temperatures, we are likely to see more of that precipitation fall as rain and less as snow during winter months, especially at lower elevations.

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

Climate Leadership Initiative research on forest fires estimates that compared to an “average year” during the 20th century, an average year in the 2020s could feature a 50 percent increase in the number of acres burned, and an average year in the 2040s is projected to feature a 100 percent increase in the number of acres burned.¹⁹ Fires are likely to become the destructive force in our area that hurricanes are in the southeast.

Conclusion

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

Because human emissions are the dominant cause of global warming, reducing human-produced emissions will, over time, re-stabilize the climate. However, it will take a millennium for past and future greenhouse gases to dissipate from the atmosphere, with carbon dioxide in particular taking about a century to dissipate. This means that actions taken today to reduce emissions will not affect the climate for generations. No matter how fast global emissions are reduced, many scientists therefore believe it is likely that temperatures will rise by about 3.6°F (2°C) by mid-century, which is likely to produce significant socio-economic and environmental consequences. Most scientists warn that an increase of more than 3.6°F (2°C) is likely to trigger severe and possibly irreversible climate change. No region will be immune.²⁰

Limiting warming to 3.6°F (2°C) means carbon dioxide must be limited to 350-450 parts per million (ppm). The IPCC said that global emission reductions must be between 50-85% to achieve this goal, with the upper end being much safer. At the lower end this equates to an 88% reduction in the U.S. and at the upper end it would require a 96% reduction.

Increasing evidence points to the need to achieve the upper end target, which means that the U.S. would essentially need zero net emissions by 2050.

Businesses are often seen as playing a key role in mitigation, thanks to their ability to provide low carbon services and products and due to the great opportunities for reducing their own emissions. Tactics for reducing emissions vary from business to business and organization to organization. Sources of greenhouse gases diverge between sectors based on the energy intensity of the products and services being delivered, the amount and mode of transportation needed to run the organization, the emissions associated with the energy used, and the efficiency of the entire operation.

While the details might feel overwhelming, at the heart of the matter we must decrease our burning of fossil fuels and turn agriculture and forestry into carbon sinks rather than sources. The Climate Masters at Work program is designed to provide you with tools to decrease the emissions your business is responsible for and to put you in the position to motivate, educate and inspire others to do the same.

Additional Resources on Climate Change Science and Policy:

Climate Leadership Initiative: Economic and greenhouse gas assessments, links
<http://climlead.uoregon.edu/>

Intergovernmental Panel on Climate Change (IPCC): 2007. Fourth Assessment Report
<http://www.ipcc.ch/>

Climate Crisis Coalition: Climate change news feed www.climatecrisiscoalition.org

University of Washington Climate Impacts Group: Interdisciplinary research on climate change impacts on PNW <http://www.cses.washington.edu/cig/>

Real Climate: Climate change science blog: <http://www.realclimate.org/>

Environmental Protection Agency. Glossary of Climate Change Terms.
<http://www.epa.gov/climatechange/glossary.html>

Pew Center on Global Climate Change: Publications, reports and analysis on climate change issues
<http://www.pewclimate.org/>

Addressing Climate Skeptics

- Responses to common challenges to climate science, “Setting the Record Straight” from the Climate Leadership Initiative
<http://climlead.uoregon.edu/publications/climate-education-and-communication>
- Grist article with a step-by-step set of instructions for responding to climate skeptics.
<http://www.grist.org/article/series/skeptics/>

Chapter Two: Conducting a Greenhouse Gas Emission Inventory

Key Learning Points

- Greenhouse gas emission inventories can help a business identify opportunities, set goals and track progress
- Steps include establishing organizational support, defining boundaries, collecting and reporting data, and using the information to make decisions.
- Repeating the process annually will highlight progress

What is a Greenhouse Gas Emission Inventory?

Greenhouse gas (GHG) inventories can be used to track emissions and assess progress towards emissions reduction goals. A business's greenhouse gas emission inventory tallies emissions released into (or removed from) the atmosphere over a period of time, typically one year. An inventory also identifies which activities release or remove emissions and includes the methods used for calculations.²¹

Why Conduct an Emissions Inventory?

An inventory provides a clear picture of emission sources, without which it is difficult to know which business operations cause the greatest emissions, and therefore the most significant opportunities for reduction. As such, the information provided by a GHG inventory supports development of effective policies and strategies for GHG emission reductions, leading to additional benefits like saved money and resources and an improved public image. Moreover, an inventory allows a business to measure their progress – and successes - over time.

*GHG inventories can include both **direct** and **indirect** emissions.*

***Direct emissions** are those generated by facilities/vehicles that are the property of the business, like an owned or leased fleet or power plant. **Indirect emissions** are emissions resulting from a company's business but not by created by facilities/vehicles owned and controlled by a company, like purchased electricity, employee commuting, and products produced elsewhere (the latter are also known as embodied emissions – see sidebar below).*

The following are common sources of emissions for businesses:

- *Production of energy onsite* for company use, like the burning of fossil fuels or biomass to produce energy to heat/cool the company's building.

- *Embodied emissions* in goods like computers, buildings and manufacturing equipment, as well as in those that make up the services or products sold by a business.
- *Transportation* of personnel, goods, and services. An inventory can include only vehicles owned by the business, or for greater emission reduction opportunities, can also include employee commuting, business travel and distribution or purchases.
- *Electricity* use, including that needed for heating and cooling, running equipment, heating water, manufacturing, refrigeration of goods and cooling of equipment.
- *Refrigeration and freezing* also result in the release of hydrofluorocarbons (HFCs), a potent greenhouse gas.
- *Waste* sent to landfills generates methane as it decomposes. In addition there are emissions related to transporting waste, whether it goes to a landfill or a recycling plant.

An emissions inventory can take between a few hours to twelve months to complete depending on the size of your company, the amount of staff time available to dedicate to the project, the type of inventory you wish to conduct, and availability of the required data. The remainder of this chapter walks through the process for conducting a basic GHG inventory for your workplace.

Embodied emissions, or lifecycle emissions refer to those emissions generated through every stage of an item's lifecycle. Those emissions come from processes including: harvesting, mining or drilling for raw materials; manufacturing and producing each component; transportation at every stage of the product's life; energy for using the product; and methane from decomposition in the landfill or other end of life processes.

Steps for Conducting Your GHG Inventory²²

1) Establish organizational support

Decide how much staff time and resources will be dedicated to the inventory and climate action plan. Then designate a staff member or team to initiate, track, and complete the inventory process. They will need to gather data, make calculations, track the results, and then help to develop plans to reduce emissions, as outlined below. It is important to have backing for the inventory process at senior management levels and is ideal to build support throughout the entire staff (see organizational change chapter for more on building support), so aim to have a diverse team, ideally with representatives from all departments of your organization.

The Greenhouse Gas Protocol is “the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions... it provides the accounting framework for nearly every GHG standard and program in the world.”

2) Define organizational boundaries

Decide which units of your company are going to be the focus of the inventory: which facilities, offices, in what locations, etc. Consider the percentage of operational and financial control that your business has over each unit. For partnerships in which your business has an equity share, you may choose to include a proportionate share of those emissions in your inventory.

3) Define operational boundaries

Research the ways in which your company generates emissions (transportation, electricity and energy used, embodied emissions) and decide which ones to track. Within each area, decide what to include. For example, within transportation, will you include employee commuting or just business travel? Will transportation of goods, customers or partners to your business be included in the inventory, or just distribution of your products and services?

Scopes help to define what should be reported in the inventory (see Figure 1 below). The Greenhouse Gas Protocol categorizes emissions into three broad scopes:²³

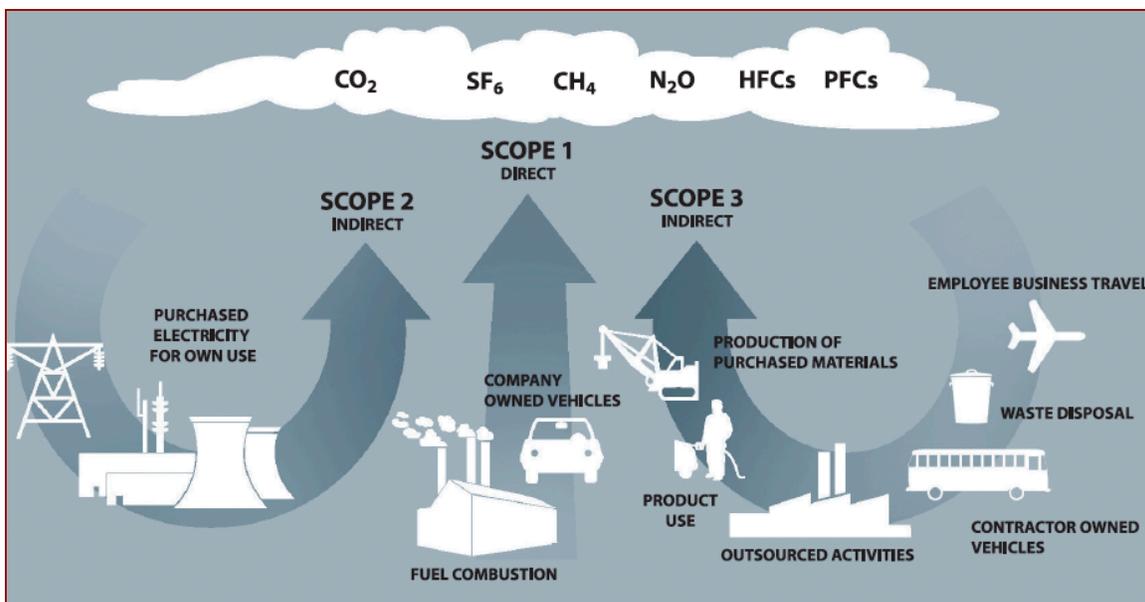


Figure 1. Scopes. Source: World Resources Institute and the World Business Council for Sustainable Development, Greenhouse Gas Protocol <http://www.ghgprotocol.org/>

- Scope 1: All direct GHG emissions. These include emissions for vehicles owned or leased by a business and for energy produced onsite. Mandatory reporters must track scope 1 emissions. If a business is tracking its GHG emissions voluntarily there are no required scopes to report.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, natural gas, or steam. These must also be tracked for mandatory reporters.
- Scope 3: Other indirect emissions related to your business activities like embodied emissions in goods such as paper and equipment, employee commuting and air travel, and outsourced activities. These do not have to be tracked, but can be helpful to fully understand the GHG generated and the potential for reducing emissions and waste.

4) Collect data

In order to collect data for the emissions inventory, businesses must identify sources and select their calculation approach prior to gathering data. Once information has been collected, calculation tools can be applied and rolled out across the entire company. Figure 2 provides an overview of the data collection process.

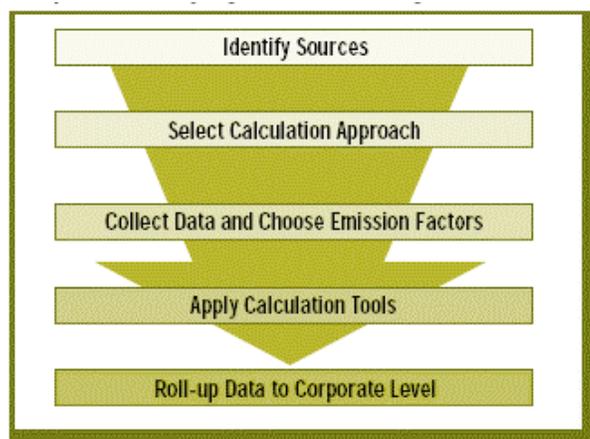


Figure 2. Steps for collecting data for a GHG emissions inventory. Source: WRI, WBCSD, 2004. "A Corporate Accounting and Reporting Standard" <http://www.ghgprotocol.org/calculation-tools/service-sector>

Two types of data are required for calculating GHG emissions—the activity data and emissions factors; together, these equal the amount of CO₂ emissions generated by the company as shown in Figure 3.

Activity Data		Emission Factor	=	GHG Emissions
Activities of the organization that directly or indirectly emit GHGs	X	Source-specific factor that converts activity data into an emission value		Contribution to GHG emissions by the organization
10,000 gallons of fuel used annually for auto travel		10,000 gallons of fuel X 8.87 kgCO ₂ /gallon		88,700 kgCO ₂ / 1000 kg/metric ton = 88.7 metric tons of CO ₂

Figure 3. Types of data required for calculating your company's GHG emissions. Source: Seattle Climate Partnership, 2007. "Curbing Your Climate Impact: A Resource Guide for Employers." http://www.seattle.gov/climate/docs/Climate_partnership_resource_guide.PDF

Activity data: This is a quantification of activities that generate emissions. To obtain activity data for travel, for example, examine how many miles are traveled and by what mode. To gather activity data for purchased energy use, collect utility bills and tally the number of kWh and therms used.

Consider tracking the following areas for your business:

- *Transportation* of goods and services; business travel; employee commuting.
- *Energy* purchased and generated on-site.
- *Materials* such as paper; equipment; those making up your product or involved in your services; and packaging.
- *Waste* including materials thrown away, recycled and composted.

The emissions inventory worksheet that accompanies this handbook includes all the transportation, energy and waste components mentioned above, and some material components (the latter being difficult to quantify for every material used).

Emissions factors: These are source specific and describe the emission-intensity of each activity. The emission factor for car travel, for example, depends on the car’s fuel type and miles per gallon. The coefficient for electricity is contingent on the utility’s energy portfolio or on the fuel source, in the case of heating oil or natural gas, for example.

An **emissions coefficient** represents the amount of emissions resulting from the burning of a given quantity of fossil fuel (coal, oil, natural gas) or the generation of a given quantity of electricity. Many inventory programs can be set with defaults for coefficients. More information on coefficients and warming potentials is available in Appendix 1

Global Warming Potential: Different greenhouse gases have varied abilities to absorb and radiate heat back to the earth. Carbon dioxide has a global warming potential of one, to which all the other gases are compared. Despite the fact that CO₂ has the lowest global warming potential, it is still the greatest contributor to climate change due to its prevalence. Although there are six primary GHG (listed below from the IPCC's Fourth Assessment Report), the emission factors convert energy into carbon dioxide equivalent (CO₂e), based on the warming potential of each gas in relation to carbon dioxide.²⁴

Greenhouse Gas	Chemical Name	Global Warming Potential (over 100 yr)
Carbon dioxide	CO ₂	1
Methane	CH ₄	25
Nitrous oxide	N ₂ O	298
Hydrofluorocarbons	HFCs	124 – 14,800
Perfluorocarbons	PFCs	7,390 – 12,200
Sulfur hexafluoride	SF ₆	22,800

The first year of your inventory will provide a baseline. If the information is available, you may want to start with a past year to see how your emissions have changed over time.

*Essential Areas to Consider in Creating an Inventory:*²⁵

- *Relevance:* Understand what elements are important for your inventory
- *Completeness:* Ensure your data—and the conclusions you draw from it—is as complete as possible.
- *Consistency:* Maintain similar standards across all areas of your inventory and from year to year.
- *Transparency:* Make sure that your methods are clear and the discoveries are open to others.
- *Accuracy:* Work to make sure your calculations and the results are as accurate as possible.

Worksheets for Conducting Your Inventory

Many local governments and nonprofit organizations have developed tools to guide businesses through the inventory process. These tools range in length and complexity, calculating both direct and indirect emissions, and some are tailored to certain industries. Businesses should review the various options, as they will want to select the tool that best helps them meet their goals. Businesses can also develop their own inventory tool following some guidelines provided in the Resources at the end of this section.

The spreadsheet that accompanies this handbook is a local adaptation of the Seattle Climate Partnership’s calculator. Contact climlead@uoregon.edu to receive the tool.

- The Greenhouse Gas Protocol Initiative (free at <http://www.ghgprotocol.org/calculation-tools/service-sector>) provides a variety of inventory guidance documents and tools that are tailored to specific sectors and account for both direct and indirect emissions. Businesses can calculate emissions for fuel use, as well as from business travel and employee commuting by using their employee surveys to gather information.
- Seattle Climate Action Plan carbon calculator (free at <http://www.seattle.gov/climate/SCPresources.htm>). A very detailed inventory spreadsheet that accounts for multiple aspects of your business.
- Various companies sell inventory software or the service of conducting inventories and assisting with climate action plan development.

5) Report Data

Once the inventory is complete, businesses should report “complete, consistent, accurate, and transparent” data to stakeholders.²⁶ For some companies, reporting GHG emissions from certain facilities may comprise confidentiality. These numbers can be made available to the inventory team and not reported publicly. However, a qualitative report should be provided to the public, including all staff, suppliers, customers and clients, and should provide information on the goals and process for the inventory, generalized findings and analysis, challenges and opportunities for emissions reduction.

6) Updating and Verification

Once the inventory process is in place, inventories should be repeated every year. Your business may want to have the inventory verified by an objective assessor. A verifier could help fine tune the inventory process, provide more credibility and transparency to the results, and reduce staff-time spent conducting the inventory. That being said, internal involvement in the inventory process can be a great learning experience and provide an opportunity for employees to identify areas for emissions reduction.

7) Emissions Reduction and Offsets

The results of the inventory help the company identify where and how emissions are generated. The process also provides a platform for setting emission reduction goals that can save your business money and resources. The following sections will provide opportunities for areas where emissions can be reduced, while the Emissions Free and Offsets sections will help your business set and reach the ultimate goal of eliminating or offsetting all emissions.

Additional Resources on Greenhouse Gas Emission Inventories

U.S. Environmental Protection Agency Climate Leaders Inventory Guidance

Detailed and comprehensive summary of how to conduct an inventory.

www.epa.gov/climateleaders/resources/inventory-guidance.html

An Overview of Greenhouse Gas Emissions Inventory Issues

Provides step-by-step explanation for conducting an inventory.

<http://www.pewclimate.org/docUploads/greenhouse.pdf>

Department of Energy

A comprehensive guide to conducting an inventory.

<http://www.pi.energy.gov/documents/CDStratCompleteReport11609.pdf>

Power Engineering

Details and tips for conducting an inventory.

<http://www.powergenworldwide.com/index/display/articledisplay/313217/articles/power-engineering/volume-111/issue-11/features/conducting-a-greenhouse-gas-emission-inventory.html>

World Resources Institute Greenhouse Gas Protocol

An accounting tool to quantify greenhouse gas emissions.

<http://www.ghgprotocol.org/>

Chapter Three: Energy

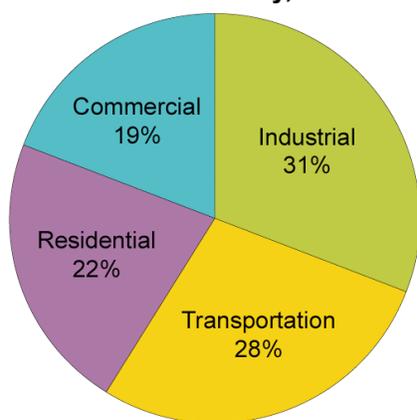
Key Learning Points

- Make a commitment to reduce your facility’s energy consumption- set goals and track progress.
- An audit highlights key opportunities
- Reduce greenhouse gas emissions by curbing energy use and moving to renewables

Introduction

This chapter explores sources of energy demand in the workplace and efforts businesses can take to reduce and offset energy consumption. As shown in Figure 1, industrial and commercial related energy demands make up 50% of total U.S. energy demand.²⁷

Share of Energy Consumed by Major Sectors of the Economy, 2008



Source: Energy Information Administration, *Annual Energy Review 2008*.

Figure 1
http://tonto.eia.doe.gov/energyexplained/index.cfm?page=us_energy_use

Local Profile

According to the City of Eugene’s 2005 Greenhouse Gas Emission Inventory, the commercial sector accounted for 17% of the city’s emissions, and industry accounted for 10%. Together, this amounts to approximately 245,000 short tons (a short ton is 2,000 pounds; a long ton is 2,240 pounds) of carbon dioxide equivalent.¹ This percentage only accounts for electricity and natural gas use, and does not account for the emissions embodied by food or material goods, or for transportation. The other sectors the city considered are transportation (51 percent), residential (22%), and waste (0%, because of methane capture at the landfill). The city inventory does not account, however, for emissions related to goods we consume that are manufactured and transported outside the city.

¹ Because all the greenhouse gases have different warming potentials, the gases are often translated into carbon dioxide equivalents, or CO₂e. To arrive at this number, methane emissions would be multiplied by twenty-three, and so forth.

Eugene Community Greenhouse Gas Emissions Inventory Report (July 2007)

<http://www.oregon.gov/ENERGY/GBLWRM/docs/Eugene.pdf>

Emissions from energy are dependent on the local energy portfolio and the source of electricity or fuel used to generate energy. For example, parts of the country where coal makes up the majority of the electrical mix will see a greater percentage of their business emissions coming from their electrical load.

A fully inclusive quantification of energy consumption and resulting greenhouse gas (GHG) emissions for businesses would incorporate energy used in building construction and materials, energy and emissions embodied in equipment used within the building, and so on. These life cycle, or embodied emissions will be considered in other portions of the handbook.

While factories and manufacturing companies have obvious large energy draws, every office demands energy to keep the building operational and comfortable for the employees, through lighting, heating and cooling, and equipment like computers and copiers. Even the necessities that keep employees going through their day, like the coffee pot and vending machine, need energy to operate.

According to the US Department of Energy (DOE), with 18% of the total energy consumption, commercial buildings are responsible for 38% of US and 9% of global CO₂ emissions.²⁸ Approximately 78% of commercial building energy comes from electricity, while the remainder derives from fuels burned or produced on site.²⁹

As mentioned above, the actual amount of emissions generated per unit of energy depends on the source and efficiency of generation. For instance, hydropower produces about 0.1 pounds of CO₂ per kilowatt hour (kWh), while coal and natural gas provide around 1 to 1.5 pounds of CO₂ per kWh.³⁰ Therefore, buildings in the Northwest of the United States tend to contribute less greenhouse gas emissions than those in other states, because a lot of power comes from low emitting sources such as hydro, biomass and nuclear. Energy use by sector is described in Figure 2.

According to a DOE report, energy demand from commercial buildings doubled between 1980 and 2000 due to an increase in construction, size, and addition of more equipment, such as computers.³¹ As new buildings continue to be constructed faster than old buildings are retired, energy demand will increase until buildings can be designed as zero-energy or zero-emissions buildings.

The DOE estimates that a typical office space uses 80,000 British Thermal Units (BTUs) per square foot per year. According to the Portland Office of Sustainable Development in Oregon, office energy use per square foot is more than the average school, retail space, and church, averaging \$1.59 per square foot per year to

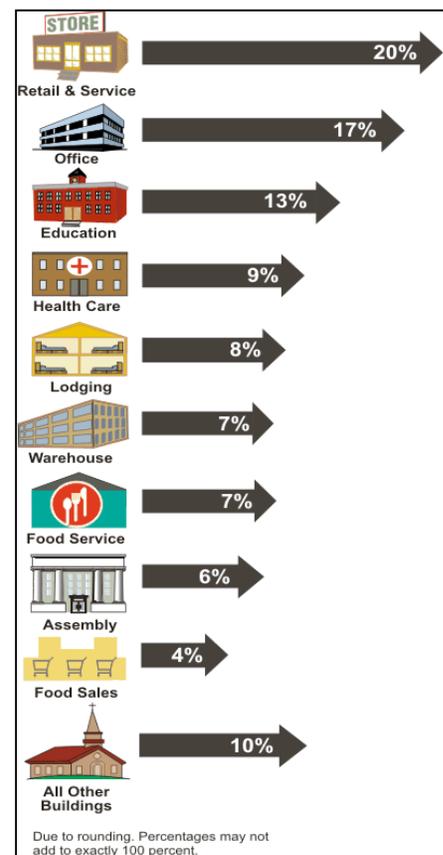


Figure 2. Energy Use by Type of Building. Source: EIA, 2006.

power the office. Each use of energy presented in Figure 3, however, provides an opportunity for energy reduction and costs savings: more money that can be put back into a business. With no-cost or low-cost changes that increase energy efficiency, businesses have reported savings of 25%, or \$4,000 annually for a 10,000 square foot office.³²

Efficiency improvements for each of these energy uses will be presented in more detail throughout this section. Before energy efficiency can be improved, however, it is important to understand a workplace's energy demands by conducting an energy audit.

Conducting an Energy Audit

The simplest strategy for auditing your energy use is to work with your utility or a contractor. If you will be conducting the audit on your own, begin with collecting monthly utility bills, or contacting the local utility company for an annual energy summary. Total your bills, subtracting out non-energy charges such as sewage and water. Then estimate a 5-15% savings that can be made from low- or no-cost measures and set a target for reducing energy consumption (tips for a more thorough audit can be found in the EMISSIONS INVENTORY section, and suggestions for setting targets can be found in the EMISSIONS FREE section).

Understanding Electricity

Electricity is measured in units of power called watts. The amount of electricity we use over a period of time is measured in kilowatt-hours (kWh). A kWh is the energy of 1000 watts acting for one hour. For example, if you use a 100-watt light bulb for ten hours, you use 1000 watt-hours of energy, or 1 kilowatt-hour. Likewise, if you use ten 100-watt light bulbs for one hour, you use 1 kilowatt-hour.

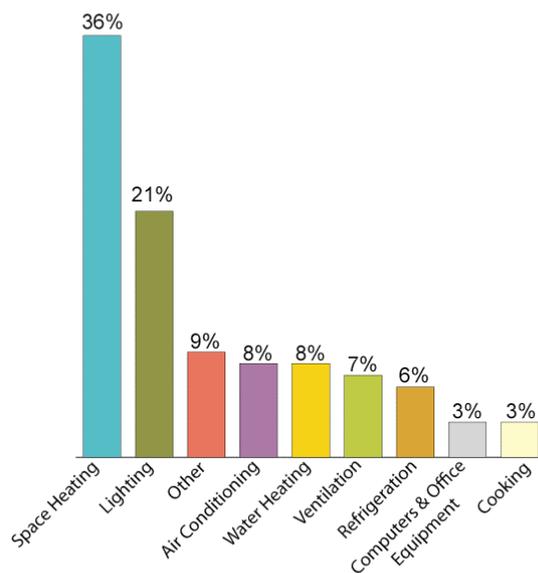
Watt (W): A watt is a derived unit of power in the International System of Units (SI). It measures the rate of energy conversion whereby one unit of power is equal to 1 joule per second.

Kilowatt: The kilowatt is equal to 1,000 watts.

Megawatt: The megawatt is equal to one million watts.

For small buildings, identify a team of employees that can survey equipment that draws energy. While the specifics of the audit will vary depending on your type of business, items to consider may include the number of lighting fixtures and the watts per fixture, the number of computers, printers, faxes, and copiers. Also look for items such as fans or space heaters, vending machines, refrigerators, coffee makers, televisions, stoves, freezers, manufacturing equipment or other items that draw energy.

Energy Use in Commercial Buildings, 2003



Source: U.S. Energy Information Administration, 2003
Commercial Building Energy Consumption Survey, Table E1A
(September 2008).

Figure 1 http://tonto.eia.doe.gov/kids/energy.cfm?page=us_energy_commercial-basics-k.cfm#USED

For an office building, calculate the number of employees per piece of equipment and see if some can be eliminated (e.g. one printer per every ten or more employees may be sufficient). Depending on the business, consider calculating the number of guests served or products made per piece of equipment that draws energy. If you find items that can be eliminated, sell or donate them to a nonprofit charity, or dispose of them through an electronics recycling agency (see the WASTE section of this handbook for resources on office equipment recyclers). Items to consider for your audit are provided in Table 1.

After determining your current energy use, decide where you want to be and how you can get there. Appendix one provides a form to help your business set goals and take transition steps to move to greater energy efficiency. For large buildings or to receive a more detailed energy audit, contact your local utility company for an assessment (see the Resources section below). They can look at heating and cooling units as well as the building shell and provide recommendations for improving insulation and weatherization to increase your energy savings.

Table 1. Sample form to complete when conducting an audit.

<i>Audit Question</i>	<i>Response</i>
What kind of power system does the facility depend on?	Type
How much of our energy use is electric, natural gas, oil, propane, other?	Type %
From what is our electricity derived (hydro, coal, nuclear?)	Type
What is our current energy expense?	Amount
Have our employees been trained on energy-saving techniques?	Yes/No How
What are our greenhouse gas emissions?	Amount
How many hours per day is the building occupied?	Number
How hot or cold is the building?	Estimate
Where are the cold spots? Hot spots?	Estimate
Is the A/C system zoned?	Yes/No Where
Is the building well insulated and/or weatherized?	Yes/No Where
Are the windows energy efficient (newer, double paned) or do they have storm windows?	Yes/No Where
How hot is the water?	Temperature
How well is the tank insulated?	Describe
Are electronics plugged into power strips?	Yes/No Where
Which electronics / appliances are phantom power users? (still use power when turned off)	Type Number
Do we turn off the power strips when electronics are not in use?	Yes/No
How many lights are in use for more than 2 hours each day?	Number Where
Of these lights, how many are fluorescent? How many are low wattage?	Number Where
Are there regulations for powering down computers, printers, and other equipment at night?	Yes/No Type How communicated?
Are there dimmer switches or occupancy sensors anywhere in the building?	Yes/No Number Where
Are there motion sensing lights outside?	Yes/No Number Where
Are there goals for reducing consumption and emissions?	Yes/No Goals Where written?

Strategies for Reducing Energy Use

Space Heating and Cooling

Heating, cooling and ventilation (HVAC) are the largest energy consumers in most buildings, accounting for over 40% of the energy use in most offices as shown previously in Figure 3.³³

The HVAC system provides heating, cooling, humidity control, filtration, fresh air makeup, building pressure control, and comfort control. In mild climates like the Northwest, small offices typically have larger heating than cooling demands. On the other hand, larger offices generally have stronger cooling demands because of the heat generated by people, equipment and lighting inside the building. The HVAC system ensures that your employees are comfortable. Increasing efficiency of the system doesn't mean sacrificing comfort, but rather a properly designed, installed and maintained system can increase employee productivity, inhibit growth of mold and fungi, and save money on your energy bill. Ideas for no- and low- cost changes that can be made to your system are provided below.

Temperature- Avoid thermostat wars and ensure proper maintenance. Studies have found that the majority of individuals are comfortable at levels of 69-71° F for heating and 75-77° F for cooling.³⁴

- Communicate with your building manager to pick a temperature and set it. For every degree the temperature is raised in the summer, or lowered in the winter, you'll see a savings of 2-3% and prevent over 500 pounds of CO2 from entering the atmosphere. 35
- Conduct a temperature trial with your employees to find levels at which most people are comfortable working.
- Consider using locking covers on thermostats so staff cannot change the setting.
- Allow and encourage people to bring extra clothes or dress for the season so they are comfortable. If necessary, individuals can use a low wattage (100-200 watts) panel heater or footrest for a little extra heat in their office during the coldest months.
- Reduce heating and cooling in areas that are not occupied consistently, such as corridors, lobbies, basements or storerooms. Consider turning off all heating and cooling for areas without sensitive equipment.
- Like lighting, time clocks can be set on thermostats so that the temperature is automatically adjusted during the day or on weekends when staff are not in the office.
- For unoccupied periods, set heating at 55° F and cooling at 80° F.
- If your building has older, dial thermostats, contact your local utility company to see if there are rebates for programmable thermostat replacements. And, measure the temperature with an external thermometer to ensure that you are heating and cooling to the desired temperatures.
- Keep doors and windows closed when it is above 75° F or below 55° F outside. Otherwise, the heating and cooling system will be overloaded.
- Encourage employees to arrange their offices so they can avoid sitting next to the window when it is cold outside and to use blinds during cold, cloudy days and at night to keep the heat in.

- Make sure your HVAC system is properly maintained, appropriately sized for your building, and has an Energy Star® rating.

Ventilation. Natural ventilation can be achieved through using convective forces, which transfer heat in a fluid or gas such as in air. Natural ventilation uses wind and temperature differences to create airflows in and through buildings.

- Natural ventilation should be used in conjunction with economizers (see below).
- For mechanical ventilation, ensure that equipment is properly maintained and cleaned.
- Consider turning off ventilation thirty minutes or so before the end of the work day if the office empties out at a consistent time.

Outside air (OSA) dampers and economizers. OSA systems bring in outside air when it's cooler than the air inside the building. They help cut down on cooling systems and bring in fresh air to circulate the building.

- OSA dampers should be closed during unoccupied hours.
- Airflow at OSA intakes should be measured to ensure that it matches the occupant load.
- Economizers should be checked to ensure that they are functioning properly and that there is minimum ventilation during extreme weather. If your building does not have an economizer, consider purchasing one: the system will pay for itself in energy cost reductions in two to five years. In large buildings that don't cool down well at night, economizers can be used to provide fresh, cool outside air during the early morning (called "precooling") to ensure that the building is comfortable and not stuffy when employees arrive. Precooling may also prevent the need to run the air conditioner for most of the day and can cut cooling demand by up to 30% or \$50/1000 square foot of building space annually.³⁶ Energy recovery ventilators (ERVs) are best used in conjunction with economizers.

Reduce solar heat gain. While blinds will help reduce solar heat in small offices, additional techniques can be used if your building is located in an area of the country that heats up in the summer. By reducing solar heat gain, you'll cut back on air conditioning use.

- Painting a roof white reflects the sun's light back into the atmosphere and is especially effective in sunny climates. A reflective roof can reduce solar gain by up to 40%.³⁷
- Most of the building's heat transfer occurs through windows. Installing awnings, solar shade screens, or tinted window film will prevent too much sun from coming through the windows and heating offices.

The "Urban Heat Island" or the "Urban Heat Effect" depicts the thermal gradient differences between developed and undeveloped areas. Urban areas can be 3-6°F warmer than nearby rural areas and rainfall can also be affected due to lack of vegetation, absorption and reflection of heat by buildings, blocking of wind ventilation by structures, and "waste" heat generated by cars and industries. The Heat Island Group estimates that the heat island effect costs ratepayers in Los Angeles about \$100 million per year in energy expenditures. More information is available from the Heat Island Group:
<http://eetd.lbl.gov/HeatIsland/EnergyUse/>

- Plant trees! Shading vegetation has many added benefits: tree shaded neighborhoods can offset the city ‘heat island effect’ by reducing temperatures by 3-6°F and improves appearances.³⁸ Deciduous trees lose their leaves in the winter when more sunlight is desired. Native species typically require less watering.
- Consider an eco-roof, a technique that involves using vegetation for the actual roof surface. Eco-roofs reduce solar gain through the roof and stormwater runoff, while also providing a perfect lunchtime escape for your employees.

Water Heating and Cooling

- Equipment can be shut down when not needed and there is no threat of freeze.
- Insulation on hot or cold water piping should be maintained and replaced when damaged.
- Use the smallest and most efficient chiller available for your load.
- Ensure that operating staff are trained to maintain equipment, shut down equipment when not needed, and using the most efficient technology and technique for chilling water.
- Chilled water temperatures can be changed depending on the season and automatic reset controls can be set.
- Water heating in an office can account for 9-15% of the energy load.³⁹ Water heater thermostats should be reduced from the manufacturer set 140° F down to 120° F and have proper insulation to reduce heat loss. Reducing the heat setting by 20° F will result in an 18% savings and will prevent the likelihood of severe hot water burns.⁴⁰ Also, ensure that you have a heater appropriate for your building size.
- Incentives, rebates, or tax credits are likely available from your utility company or the state for installing solar water heating. Solar collectors are relatively inexpensive compared to photovoltaic (PV) paneling that generates electricity, and can cut your energy use for water heating in half. Solar water heaters usually pay for themselves in energy savings within five years.
- Talk to your building operator and local utility company about maximizing the efficiency of your chillers, heaters, and boilers.
- Install low-flow water fixtures. For office kitchens, bathrooms, and showers, low flow fixtures can help cut your water usage and energy savings significantly.
- Forty-five percent of all fuel burned by U.S. manufacturers is consumed to produce steam.⁴¹ If your facility uses a steam-boiler system, ensure that the building manager is trained in maximizing boiler efficiency.

Lighting

According to the EIA, lighting accounts for 23% of the total energy expenditures for a commercial building. Simple changes in lighting can greatly reduce these costs and your building’s emissions. For example, implementing daylighting strategies can save 50-80% off your lighting energy bill.⁴²

No cost changes

- Have staff turn off lights when they leave a room, and build awareness among employees that the last person to leave their floor should ensure that all lights are off. Meet with the building manager to ensure that the cleaning crew is instructed to turn off lights when they leave the building for the night.
- Rearrange offices to take advantage of natural lighting. Remove shelving from window areas, use paints that brighten an office, and arrange desks near windows. If remodeling, install skylights to increase the amount of daylight that enters the office. In addition to saving on energy bills, studies have found that employee productivity increases with exposure to natural light.
- Use task lighting by focusing lights on areas of the room where employees are working instead of lighting the entire space.
- Educate and remind your staff to turn off lights with notices and stickers placed around the office (see Figure 4)



Figure 4. Use friendly stickers to remind your employees to turn off lights. These were developed by the City of Eugene Facilities Management and Reprographics Department. Your local utility company may have stickers available free of charge. Courtesy of Hart (EWEB) 2002

Small investments that improve lighting efficiency

- Use blinds and shades to control solar gain and heat loss. If your office building has a lot of windows, you may want to install blinds to reduce solar gain, and to keep the heat in during the winter. Blinds can be drawn when giving presentations or showing videos.
- Replace incandescent lights with compact fluorescents lights (CFLs). CFLs are much more energy efficient than older incandescent lamps. A 25-watt CFL has the same light output as a 100-watt incandescent, so you reduce the energy use for each lamp by almost 75% by replacing the bulb. In addition, CFLs last almost ten times as long as older bulbs, so less money is spent on replacement bulbs and maintenance. CFLs usually pay for themselves in energy savings within two years.⁴³ You can also upgrade fluorescent tubes as well as lamps with magnetic ballasts and electronic ballast (see Appendix Two).
- Install automatic shutoffs or occupancy sensors. Employees and cleaning crews can forget to turn off the lights sometimes. By installing occupancy sensors, which detect the

presence of people in the rooms, lights will automatically shut off when no one is around. This technology works especially well in break rooms, conference rooms, storage areas, as well as in every office space. Occupancy sensors are fairly inexpensive and simple to install. Some utility companies may offer incentives or rebates for purchasing sensors. Savings from occupancy sensors can add up to a couple hundred dollars per year depending on where they are placed and the size of the building.⁴⁴ Automatic shutoffs can be installed and set to turn off and on at a certain time, e.g. 9pm and 6am, and can be set to change the times seasonally.

- Control switches. Use dimmers and switches that allow you to reduce the amount of light used during the daytime or to light portions of a room when the entire area isn't in use. Dimmers are especially efficient when used with natural lighting.
- Replace incandescent lights in exit signs. Exit signs may be small, but they are illuminated 24 hours a day and can be a huge drain on energy if inefficient bulbs are used. Ensure exit signs use CFLs, light emitting diodes (LEDs), neon lighting, or electroluminescent lighting technology. These forms of light also last longer, so your maintenance costs will be reduced.

Tip: Labeling of all switches is an inexpensive way to build awareness among employees and ensure that different lighting controls are used in the most efficient way possible.

Exterior lighting. Alterations can also be made to your building's exterior lighting.

- If safety allows, have parking lot lights turned off or dimmed down during certain periods of the night.
- Controls can be set to automatically turn lights on and off at specified times, or occupancy sensors can be used so the area is lit only when in use.
- Outdoor lights can be switched from a mercury vapor fixture (typically used) to high pressure sodium or fluorescent lighting, cutting energy consumption and costs in half.

Electronics and office equipment

Switching equipment off at night and having it sleep when not actively in use during the day can reduce energy consumption by 80%.⁴⁵ Many office buildings leave equipment on overnight and during the weekends or holidays, which has led to a doubling of energy consumption during unoccupied building times in the last twenty years.⁴⁶ Simple no- or low-cost steps, like turning off equipment, have a large impact on reducing your energy consumption.

- Turn off items that aren't in use. Unplug items like coffee makers, TVs, or projectors that do not need to be left on all day – much equipment that is in the “off” position draws power. The last person to leave the office should ensure that printers, scanners, fax machines, copiers, and other equipment are turned off. Using a **smart plug strip** can help save energy and make it easier to remember to turn off all equipment at the end of the day.
- You can purchase seven day time clocks that automatically shut down printers and copiers after hours. Post a sign next to the equipment letting staff know the shut-off times and how to manually override the program should they wish to use equipment after hours.

- Wait to turn equipment on in the morning until it is needed.
- Use ‘reduced power’ or ‘energy saving’ modes which are available on most printers and copiers. Note that some equipment may have a short ‘warm up’ period when reactivated.
- Encourage staff to only print or copy when absolutely necessary. Email meeting agendas and minutes, project documents on a screen during presentations, and encourage staff not to print drafts. Not only will you see energy savings, but you’ll reduce paper use as well!
- Power down computers. Set all computer monitors to go into sleep mode after 5-10 minutes of inactivity, and the hard drive to sleep after 20 minutes using a program, your IT staff, or by educating all employees to do so. Discourage staff from using screen savers as they do not help save energy. Encourage staff to turn off computers at the end of the day (rebooting in the morning is good for the computer’s memory).⁴⁷ If the computer must be accessed remotely or requires nighttime updates, ensure that the monitor is turned off. If your business does not have IT staff, there are companies that can be hired to manage your computer energy use. Computers are shut down at night, but awakened to run virus scans as well as free services that allow for centralized management. Activating sleep settings on 4000 computers in one study saved \$45,000 per year (the equivalent of energy use for 600 homes and planting 200 acres of trees).⁴⁸ On average, you can save \$50 per computer per year.⁴⁹ *EZ GPO* software (a centralized power management system which puts computers to sleep after idle time) is available free from the EPA – see the Resources section below.
- Encourage staff to use the stairs instead of elevators. It’s better for their health and the planet!
- When purchasing new equipment like computer monitors or printers, buy those with “Energy Star®” labels and use EPEAT® to determine which are least environmentally damaging. The Energy Star® label is a United States government rating for energy efficient equipment. LCD (liquid crystal display) monitors, inkjet printers, duplex copiers, printers and faxes, can be more expensive, but if you’re looking for new equipment, the energy savings from these purchases add up.⁵⁰ Don’t throw out the old equipment- it can be recycled in your community with nonprofit electronic recycling organizations or with the manufacturing. Resources for recycling are available in the WASTE section.
- Vending machines may keep your employees energized, but they also draw a lot of energy, costing your company money and emitting greenhouse gases. Vending machine suppliers can remove or turn off the advertising lights in the machine. Inexpensive occupancy sensors (such as VendingMi\$er™) can also be installed that power down the machines when not in use, while still keeping drinks cold. According to VendingMi\$er™, \$50 per year per machine can be saved by reducing vending machine energy consumption.
- Replace refrigerators or air conditioners that use CFCs (Chlorofluorocarbons) with low-leakage HFCs (hydrofluorocarbons). While HFCs do not cause ozone depletion, they are still powerful greenhouse gases. However, they are more energy efficient, safer, and cheaper than CFCs and efforts are underway to make them cleaner.⁵¹

Motivate and educate employees to save energy by sending out monthly reminder tips and updates on savings. An example adapted from the Eugene Water and Electric Board:

Way To Go! . . . Keep Saving!

Our staff have saved almost ___% energy. This effort is a combination of building staff and facilities effort. Good progress has been made, beating the ___ kWh daytime target and saving ___ kWh on average during the day. Nighttime savings have been ___ kWh, compared with a ___ kWh target.

More can be done with those “invisible” energy users that keep running after hours: computers, monitors, copiers, and printers. Continued savings at this rate will equal annual savings of \$_____ off our energy bills. We will all need to continue those saving habits to reach our goal. Thank you all for your continued effort. To recap the suggestions made over the past two months:

- Lights out when no one is there! Leave an area . . . turn the lights off.*
- Switch off computers at night. Everyday, log off and shut off computer and monitor.*
- Reduce work area lighting. Use targeted lighting and pull back the blinds to take advantage of sunny days.*
- Monitor the monitor. When away from the computer turn off that 100-watt monitor.*

Source: Hart (EWEB) 2002

Building envelope

Air can leak in and out of the building, making it uncomfortably hot in the summer or cold in the winter and causing your energy bill to skyrocket. Several actions can be taken to increase comfort and reduce costs.

- Keep doors closed. Ensure automatic doors are functioning properly to prevent drafts and keep loading doors closed when not actively in use. Slit panel curtains can help regulate building temperature when used in doorways of high activity.
- Seal up your building. 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 save as much as 10% on your heating and cooling bill by reducing the air leaks in your building.
- Replace windows. Use plastic storm windows or encourage the building owner to invest in double- or triple-paned glass or permanent storm windows. They can cut your heat loss in half.
- Prevent solar glare. Using blinds or shades on windows can prevent direct solar gain.

Organizational Change Mechanisms for Energy Efficiency

Depending on your type of business, your greatest energy demand may come from a variety of other areas. For instance, restaurants and kitchens draw huge amounts of energy because of coolers and freezers, stoves and exhaust fans, and long operating hours, while manufacturing production floors draw energy to operate machinery. Whether you have a food production company or manufacture electronics, tips that can be applied across all types of businesses include:

- Secure management support for reducing energy consumption;
- Form a staff team to build awareness and educate employees;
- Regularly service and maintain equipment, and purchase energy efficient replacements when appropriate;
- Train staff on proper use of equipment, whether a printer, stove or heavy machinery;
- Implement the tips from the manual that are applicable to your business; and
- Contact your local utility company for an energy audit.

Large Businesses

A “management-centered” approach to improve energy efficiency often works well with existing practices in large businesses. This approach starts with an assessment of energy management practices. To begin the assessment, answer the following questions:

- What are the processes for monitoring and documenting energy use?
- How does energy play into capital expenditure decisions, equipment purchases, and maintenance procedures? Is there demonstrated corporate commitment to making improvements in energy consumption?
- Has management set energy-use targets?
- Who is accountable for energy use?
- Has there been energy-use training?

Next, management creates a strategic energy plan that communicates corporate commitment, energy goals and objectives, and sets in place a process for making progress. Good energy plans state objectives and goals. For example:

- In the first 12 months, we aim to reduce electricity use by XX% and natural gas use by XX%.
- To support our energy improvement plan, we aim to reduce consumption by XX BTU’s per unit of product distributed over the next year.

Finally, management supervises the execution of the energy plan, including the regular measurement of energy management practices, revising the plan, and rewarding success.

Small Businesses

Smaller businesses typically take a more tactical approach to continuous energy improvement. In this approach:

- One person or team becomes the champion of the energy efficiency improvement effort. This person or team is accountable for improvements, monitoring and reporting on progress, and training themselves and others.
- Given limited resources, a small business may want to identify a few key performance indicators to begin to track its energy use (e.g., electric bills).
- Prioritize energy improvements within large critical systems (e.g., coolers that run 24 hours per day).
- Because of its size, a small business may be able to train all employees in the basics of improving energy efficiency in everyday operations.
- A small business can also evaluate its energy vendors. Are they providing the right kind of service needed? Does the utility have representatives that can help in the effort to reduce energy loads?

Additional tips for any size business:

- Set aside a small fund (e.g. \$10 for every new piece of equipment purchased) that can be invested in energy conservation.
- Sign up with the EPA to become an Energy Star® business. Doing so is free, and provides you access to a variety of resources while allowing you to promote your business. See the Reference section below for more information.
- Hire or appoint a staff member or team to be an energy conservation manager.
- Commit to doing everything possible to reduce your businesses energy consumption, improve efficiency of your operations and the products you buy and sell.
- Don't stop with an audit- continue to monitor your changes and savings!

Renewable Energy

After all steps have been made to reduce energy consumption, you can look to renewable energies to ensure that your power source is “green”. Many utility companies offer their customers the option to purchase solar, biomass, geothermal, wind or other “green” energies at low cost. Green energies emit little or no carbon emissions during production. While energy conservation should be the priority for your office, you will likely still need energy to operate on a daily basis. Having businesses buy into green energies increases demand for this type of power and demonstrates your support to stakeholders. More information on generating your own renewable energy is provided in the GREEN BUILDING section.

Energy Efficiency Resources

*Many of the descriptions below are courtesy of the City of Portland Green Office Guide.

Oregon: General Reference

Business Energy Tax Credit (BETC)

The Oregon Office of Energy (OOE) offers a 35 percent business energy tax credit (BETC) to businesses that purchase energy-saving equipment. Oregon is one of only a small number of states offering this kind of incentive. www.energy.state.or.us/bus/tax/taxcdt.htm

Energy Trust of Oregon: Business Energy Solutions

Information on improving existing buildings and new buildings as well as production lines. Also provides information on incentives for businesses. Energy Trust provides audits for Pacificorps and Northwest Natural customers, as well as energy saving and renewable energy information for all types of businesses. <http://energytrust.org/business/>

Small Scale Energy Loan Program (SELP)

Another program offered by ODE is the Small Scale Energy Loan Program (SELP). Through SELP, a business with a strong credit history can obtain long-term, fixed-rate loans to finance energy improvements. The interest rates are often better than what a bank would offer a small business. www.energy.state.or.us/loan/selphme.htm

Lane County Resource Efficiency Tool Kit

A comprehensive from improving energy efficiency and reducing the environmental footprint of businesses.

<http://www.lanecounty.org/Departments/PW/WMD/Recycle/Documents/ResourceEfficiencyTOOLKIT.pdf>

Oregon Department of Energy, Conservation Division

Energy saving tips, information on incentives and renewables for businesses. www.oregon.gov/energy/cons

Oregon: Utilities

Emerald People's Utility District

Provides audits, resources and tips for businesses to cut energy consumption.

www.epud.org/comnrg.aspx Renewable energy purchases: www.epud.org/renewnrg.aspx

Eugene Water and Electric Board

Audits, low or no-cost energy saving tips for businesses. <http://eweb.org/saveenergy/business>
Renewable energy purchases: <http://www.eweb.org/renewable>

Springfield Utility Board

SUB offers audits, tips and incentives for businesses to cut back on energy consumption. www.subutil.com/conservation_services/for_your_business Renewable energy purchases: www.subutil.com/conservation_services/ecochoice

Oregon Utilities

Links to websites for utility companies in Oregon. www.oregon.gov/ENERGY/Power.shtml/shtml

Northwest/National

Energy Efficiency and Renewable Energy Network

The Energy Efficiency and Renewable Energy Network (EREN) is a program managed by the US Department of Energy (DOE). The EREN website addresses technologies such as lighting, water heating, and office equipment. It has information on energy audits, building codes, and landscaping for energy efficiency. <http://www.eere.energy.gov/>

Energy Experts

Energyexperts.org includes a selection of objective and timely information on energy efficiency in all building types for building owners, operators and occupants. This site also delivers information on technologies and best practices for programs and businesses that work to design or retrofit buildings. <http://energyexperts.org/>

ENERGY STAR® for Small Businesses

This site contains the EPA’s “10 Quick Tip\$,” an energy calculator, and ENERGY STAR® success stories. It also offers the opportunity to subscribe to EPA’s E-Update and to sign firms up as ENERGY STAR® partners. EPA also maintains sites for larger businesses, home-based businesses, along with additional resource information.

http://www.energystar.gov/index.cfm?c=small_business.sb_index

Portfolio Manager Overview

Portfolio Manager is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment. www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

DSIRE: Database of State Incentives for Renewables & Efficiency

A comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency. www.dsireusa.org/

Energy Information Administration

Energy statistics for the United States. www.eia.doe.gov

EZ GPO

Allows for programming of computers to go into “sleep” mode and other management settings. Information and free download

www.energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_ez_gpo

Tax Incentives Assistance Project (TIAP)

Gives consumers and businesses information they need to make use of the federal income tax incentives for energy efficient products and technologies passed by Congress as part of the Energy Policy Act of 2005. www.energytaxincentives.org

US DOE Energy Efficiency and Renewable Energy Solar Energies Technologies Program

Information on renewable energies and energy efficiency tips. www.eere.energy.gov

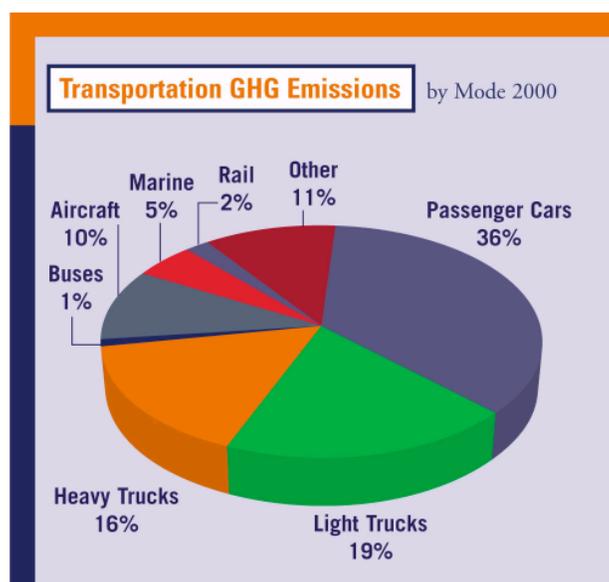
Chapter Four: Transportation

Key Learning Points

- Conducting a business transportation profile can build awareness of emissions generated through employee commuting, product distribution, and business-related travel.
- Transportation often provides a great opportunity for emissions reduction.
- Strategies for reducing commuting emissions include telecommuting options, flexible schedules, and incentive programs.
- Driver training and proper vehicle maintenance will reduce emissions generated by company fleets.

Introduction

Per capita energy use for transportation is highest in North America compared to other regions of the world, and is expected to grow by almost 4% per year through 2020.⁵² Transportation makes up more than one quarter of greenhouse gas emissions in the United States and is the fastest growing sector of greenhouse gas emissions in the US.⁵³ Figure 1 presents a breakdown of emissions contributions by various transportation sectors. That figure would be even greater if it accounted for “lifecycle” emissions from vehicle manufacturing, road construction and maintenance, and the extraction and refining of fuel.



Source: U.S. EPA, (2002), Table 1.14.

Figure 1 Source: Pew Center on Global Climate Change: http://www.pewclimate.org/docUploads/images/transp_fig2.jpg

Workplace transportation emissions derive from employee transportation to and from work, distribution of products, and work-related travel. Some of these emissions can be reduced through infrastructure changes, and others through behavior changes.

In the United States, the average vehicle emits about one pound of CO₂ per mile. Here's why: burning a gallon of gasoline results in the release of nearly 20 lbs of carbon dioxide into the atmosphere. The average mileage in the U.S. is 20.3 mile per gallon, when combining cars and light trucks.⁵⁴ So a car getting about 20 miles a gallon, with a gallon of gasoline emitting about 20 pounds of carbon dioxide, results in the release of a pound of CO₂ for each mile driven. Every day, Americans on average commute 22 miles one way: over the course of a year, we drive an average 11,000 miles for our commute, thereby each emitting almost 11,000 pounds of CO₂.

Heavy duty diesel truck fleets are major contributors to GHG emissions. Diesel burning (whether while the truck is in motion or during idling) results in 22.2 pounds of CO₂/gallon.⁵⁵ With the average truck traveling 120,000 miles at 6 mpg annually, there are many opportunities to green up fleets to reduce emissions and increase savings.⁵⁶

Conducting a Business Transportation Profile

To better understand where your company should implement changes, conduct a transportation profile for your business. A sample worksheet for doing so is below. The worksheet can be completed at a staff meeting, through an online survey, by email, or by examining reimbursement logs. Once you have a better understanding of your company's transportation behavior, set your "desired future" by completing a document such as the example provided in Appendix Four.

Business Transportation Audit or Profile: Sample Worksheet

Audit Question	Response
How many employees drive to work on their own?	Number
How many employees carpool to work?	Number
How many employees take public transportation to work?	Number
How many employees bike to work?	Number
How many employees walk to work?	Number
Does your facility include bike racks? Showers? Preferred parking for carpool/vanpool?	Yes/No What
Does your business provide incentives for employees to use alternative transportation for commuting?	Yes/No What?
Create a map of where your employees live- how many miles on average do employees travel?	Av. number miles
What driving or travel training is currently provided to employees? Does it include 'smart' driving or fuel saving tips?	
How does your company choose which vehicles they purchase?	
What vehicles does your company own? How many MPG does each get?	Type MPG
How many miles, on average, does each fleet car travel per week?	MPG
How are fleet routes selected?	
Are trips combined and/or minimized to the absolute minimum?	Yes/No
Is your business offsetting the carbon dioxide emissions of the supply chain or for other travel?	Yes/No How
Are you substituting less polluting transport methods (e.g. air freight with boat)?	Yes/No What methods
How many trips are taken by plane on average per employee per year?	Number
What is the average distance of each trip?	Miles
How many employees telecommute?	Number
Does the business plan include opportunities for telecommuting?	Yes/No What opportunities
Does your facility include equipment for teleconferencing?	Yes/No What equipment
Do you have a program in place to reduce the miles driven by employees commuting?	Yes/No What type of program

Reducing Emissions from Employee Commuting

The average commuter travels 44 miles each day, using 1.4 gallons of gasoline and creating upwards of 50 pounds of CO₂ emissions.^{57,58} The cost to the individual, including gas, wear and tear, and parking is around \$650 per month. (See the Resource section for calculating personal driving expenditures.) Businesses can reduce the need for parking spaces by locating offices near, and encouraging use of, public transportation, bike and walking paths, and carpool and vanpool networks. With the addition of improved telecommuting technology, businesses can save money and reduce emissions created by commuting.

Alternative Transportation

Both employees and employers save by using alternative transportation, while employers can use the open parking spaces for more productive uses or for additional customer parking. Many communities offer subsidized transit passes for businesses and in some cases, state tax credits may also be available to workplaces that provide employees with transit passes.

Bus. A full bus is the equivalent of taking 40-70 cars off the road, yet it only takes up the space of 2-3 cars. Even a transit bus with as few as seven passengers uses less fuel per passenger mile than a single car.⁵⁹ Many buses now offer free wireless to riders so employees can clean up their email inbox on their way to work.

Rail. Trains, monorail and lightrail not only take cars off the road, but also reduce the need for constructing additional highways and lanes that cause homeowners to vacate their property and disrupt wildlife habitat. Encouraging and subsidizing employees to use rail can save them over \$500 per month. As an added bonus, rail riders typically have access to outlets and internet. Many rail transit systems offer business incentives and discounted prices for employee passes.

Bike. Biking is not only better for the environment than driving, but better for employee health. While employees may worry about biking in traffic or in bad weather, many biking or outdoor stores offer courses on bike safety and tips on dressing for the weather. Biking sometimes takes longer, but in areas with bad traffic, it may actually cut down on commute time. To encourage bike commuting, offer “bike to work day” celebrations, install bike racks that are secure and covered, and consider building a shower and changing room if your building isn’t already equipped with one (or offset employee membership fees at a nearby gym that has showers). You may also want to offer incentives: Paul’s Bicycle Way of Life in Eugene, Oregon, pays employees that bike to work an additional 50 cents an hour.⁶⁰ Bike routes are available for most cities and transit websites typically have tips to educate employees on loading their bike on the bus.

In Lane County, Oregon, Point2Point/LTD offers a Group Bus Pass program for employers as an annual contractual agreement between LTD and the employer. The Group Pass Program is a reduced-price transportation benefit provided to all employees similar to medical or dental plans. Companies with a minimum of ten employees can receive a state Business Energy Tax credit if they help pay for at least 50% of the monthly cost of the bus passes.

Ride sharing, vanpooling and carpooling. For those for whom transit or biking isn’t an option or of interest, encourage ride sharing. Increasing occupancy from one to two people in US rush hour traffic

would save 40 million gallons of gas per day or 15% of US gas consumption.⁶¹ Whether carpooling with colleagues or with people that work in a similar vicinity, everyone saves on gas, parking, emissions, stress, and (where there are High Occupancy Vehicle -HOV- lanes) commute time. In some areas, vanpools are also an option: vanpools typically travel longer distances and take more people than carpools. Companies that promote vanpools or carpools may also qualify for a tax credit in some states. Many transit departments provide online carpool registration for work or events, and there are also national carpooling databases available in the Resources section. To encourage employee carpooling, consider offering carpool/vanpool preferred parking passes if your business has a parking lot.

Reducing Employee Commuting

Flexible work schedules. A flexible work schedule allows employees to better balance their home life and work life, often boosting productivity and increasing employee morale. Consider allowing flextime for employees, so that they can commute during times with less traffic or telecommute part of the week. A study in Los Angeles found an 18% increase in productivity among employees that were able to choose their own work schedule.⁶² Reducing the number of days that employees need to come into the office will reduce time spent commuting. Four ten-hour work days can cut commute time, emissions, and costs by up to 20%. If the office needs to be up and running five or more days a week, consider staggering ‘weekends’ for employees (some work Monday through Thursday, others Tuesday through Friday).

Telecommuting. Telecommuting saves money for the company and employees, while also allowing employees greater control over their work environment. When companies allow employees to telecommute, they can cut down on office space costs. This can be an especially good option for small businesses with limited building space. A 2007 study by the Consumer Electronics Association found that the 3.9 million American telecommuters save 9 to 14 billion kilowatt-hours of electricity per year — the same amount of energy used by roughly 1 million U.S. households every year, reduce gasoline consumption by about 840 million gallons, and curb CO₂ emissions by nearly 14 million tons (equivalent to removing 2 million vehicles from American roads every year).⁶³ See the end of this section for a variety of resources that allow employees to get as much work done at home as they would in the office, including participating in meetings. Many states such as Oregon, Illinois, Arizona, and Washington, provide businesses with tax credits and other incentives for purchasing equipment for employee telecommuting.⁶⁴

Reducing Business Travel.

Americans make more than 405 million long-distance business trips per year, the majority of which are within 250 miles from home and mostly traveled to in their personal vehicle.⁶⁵ Despite a slowing economy, business travel is expected to continue growing.⁶⁶ Air travel accounts for 16% of business trips with an average trip being 816 miles.⁶⁷ Because the majority of fuel is used during takeoff and landing, these shorter distance trips use more fuel, and therefore create more emissions. Air travel is not only becoming more expensive with rising fuel prices, but also generates more emissions than other forms of travel, resulting in about 1.26 lbs of carbon dioxide equivalent (CO₂e) per passenger mile, or more than 2.5 tons of CO₂e for a roundtrip flight from coast to coast.⁶⁸ Compare this to the approximately 1 lb per mile in the average U.S. vehicle (no matter how many people you pack in),

0.42 lbs per passenger mile on a bus and 0.35 lbs per passenger mile for travel by train (depending on the efficiency of the actual train or bus and the number of passengers). Short haul flights result in greater emissions per mile than long haul flights, due to the extra energy needed for takeoff and landing.

- Carefully consider every flight and every trip- could a phone or videoconference replace travel?
- Try to make the most of each journey by visiting multiple sites and cut out those that are not top priority. You'll save money, reduce employee stress or time spent dealing with delayed or cancelled flights, and avoid tons of greenhouse gas emissions.
- As much as possible, have employees book direct routes with few landings and takeoffs.
- When possible, travel by bus, train, or a fuel-efficient car full of people.
- Work with a travel agency that understands your goals at reducing employee air travel and will look for the most efficient means of travel.

Teleconferencing

Teleconferencing is a cost effective, efficient way to bring together multiple people into a “virtual” meeting. Technology for teleconference has improved significantly, given demand from large companies opening multiple offices around the world and individuals electing to work from home. In addition to having conference calls, a ‘face to face’ meeting is possible by bringing participants in by video. Videoconferencing saves employee travel time, costs, and emissions. Face2Face Meetings, a video conferencing company, estimates that a single business trip requires three employees to travel and costs an estimated \$3000 in travel cost and loss of work time.⁶⁹ Technology has advanced to the point where videoconferencing services are relatively inexpensive (and even free in some cases) and can feel like the individual is truly in the room participating in the meeting. In addition to saving money on flights or gas, employees are less likely to feel exhausted or stressed from the travel and can use their time more productively. While high-end videoconferencing equipment can cost \$5000-\$10,000, the payback time would be relatively short with savings generated from only a couple of business trips.

Company Fleets

Your business doesn't have to purchase a hybrid or flex-fuel vehicle to reduce your carbon emissions and save money- however, these changes can carry weight with consumers- smart driving and maintenance of traditional vehicles can lower your company's bills and impact on the environment.

Choosing Your Company Cars

- **Traditional vehicles.** Look for those with high miles per gallon (MPG) and low emissions – you'll cut down on fuel costs as well as carbon emissions. Ensure your employees keep to the recommended maintenance check ups. Diesel vehicles give off fewer CO₂ emissions, but the exhaust emissions are bad for urban air quality. And today, the cost of diesel is much higher than gasoline. As a general rule, the higher MPG for diesel vehicles means that they are better for long distance fleets, whereas cars running on gasoline are more efficient for urban travel.
- **Hybrid vehicles.** Today's models are very affordable, especially considering the savings in fuel purchases. Many states offer tax credits or incentives for purchasing a hybrid vehicle. In

New York, the company Laro Service Systems switched the company's 27-car fleet to hybrids, which will result in an estimated fuel savings of \$6000 per month. Bank of America, Timberland and Google have also jumped on the bandwagon by offering cash payments of up to \$5000 for employees that purchase hybrids.⁷⁰

- **Alternative fuel vehicles.** Biodiesel and bioethanol, which combine plant-based fuels with traditional gasoline or diesel fuel, result in less CO₂ emissions and draw on renewable fuels. Although the exact emissions from biofuels depends on the feedstock and the refining process, typically, using 99% biodiesel results in 75% fewer greenhouse gas emissions than diesel. Using 85% ethanol (corn based) generally results in 18% fewer greenhouse gas emissions than gasoline. The use of biofuels is controversial as they are linked to increased food prices and destruction of carbon-storing rainforest. Research is underway to develop plant based fuels, such as cellulose, that would not replace food with fuel. In some places, biofuels are available that are made from waste products. If your business is using biofuels, ask the retailer about the feedstock and the sustainability of the product.
- **Liquefied Natural Gas.** Natural gas is a mixture of hydrocarbons—mainly methane (CH₄)—and is produced either from gas wells or in conjunction with crude oil production. Natural gas is domestically produced and is readily available to end-users through the utility infrastructure delivered through the pipeline system that also contains hydrocarbons such as ethane and propane. Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous state (CNG) or in a liquefied state (LNG). The interest in natural gas from a sustainability perspective is because of its cleaner burning qualities, increased efficiency as compared to gasoline, its availability through the domestic resource base, and its commercial availability to end users. However, considering long-term sustainability it should be noted that natural gas is a non-renewable resource and is still a fossil fuel. Commercially available medium- and heavy-duty natural gas engines have demonstrated over 90 % reductions of carbon monoxide (CO) and particulate matter and more than 50 % reduction in nitrogen oxides (NO_x) relative to commercial diesel engines. In addition, smog-producing gases, such as carbon monoxide and nitrogen oxides, are reduced by more than 90 % and 60 %, respectively and carbon dioxide is reduced by 30 % to 40 %.⁷¹
- **Hydrogen** powered vehicles release only water and harmless vapor and are an eco-friendly alternative to other fuel powered vehicles when the source of hydrogen is renewable. However, the technology for allowing hydrogen powered cars to enter the mainstream is still at least a few years away and often the process for extracting hydrogen relies on natural gas or other fossil fuels.
- **Electric vehicles.** Electric vehicles generate no CO₂ emissions nor exhaust emissions. While great advancement has been made in electric vehicle technology, their range is still limited. And don't forget that when charging up the vehicle, if electricity generation that powers the vehicle is produced by a non-green source, emissions are being created.
- **Fleet sharing.** WeCar™, a car sharing program developed by Enterprise Rent-A-Car® and Zipcar®, provides businesses with access to fleets of hybrids located around cities, electronically accessible, and available to workers 24 hours a day, 7 days a week. These programs, which exist in limited locations as provided by WeCar™, are “designed to reduce pollution, ease traffic congestion, and make car rental convenient for downtown dwellers and workers”.⁷²

Additional Tips

- Teach smart driving.** Teach your employees environmentally and fiscally responsible driving behavior and save \$200-500 per vehicle per year.⁷³ Smart driving includes smooth, non-aggressive driving, reduced braking, and not leaving the vehicle idling. Offering driver training can save on fuel consumption and improve driver safety.
- Car maintenance.** Employees need to be trained on general car maintenance and to undertake routine check-ups. According to the Energy Savings Trust, “fuel consumption can increase by as much as: 10 per cent with an out-of-tune engine, 10 per cent with a clogged air filter, 6 per cent with misaligned wheels, and up to 10 per cent with under/over inflated tires.”⁷⁴ Savings from proper vehicle maintenance can be over \$350 per vehicle per year.⁷⁵
- Educate your employees.** Make sure your employees know the impact of business transport on the environment. Provide them with a list of car selection and driving dos and don'ts, and make sure that the most efficient routes are selected. Create a page on your company's intranet that lists travel tips and links to websites that can generate maps of the shortest routes.
- Plan for trips.** Taking fewer trips by combining trips, videoconferencing, or allowing telecommuting means reduced CO₂ emissions and less driving hours.
- Install navigation systems.** Using Geographical Positioning System navigational equipment in your vehicles can provide the employees the quickest routes to their destination and cut down on travel time. GPS units can also assist in auditing company fleet mileage.

Product Distribution

Idle Reduction. An idling truck burns nearly one gallon of diesel fuel per hour. Trucks idle an average of 1,900 hours per year. Reducing unnecessary idling could save nearly \$4,750 in fuel costs, cut air pollutants, and cut 19 metric tons of carbon dioxide annually per vehicle.⁷⁶ There are several ways to reduce idling including: driver education, setting truck parameters for automatic engine shut down, installing auxiliary power units, installing direct fired heaters, and participating in truck stop electrification programs. Technological solutions typically have a payback of 2-3 years. Cascade Sierra Solutions provides a library of resources on different technological available for trucks (see Resources).

Improved Aerodynamics. Improving the aerodynamics of a typical line-haul truck by 15 percent could cut annual fuel use more than 2,000 gallons, save over \$6,000 in fuel costs, and eliminate 20 metric tons of carbon dioxide.⁷⁷ There are numerous strategies for reducing drag such as gap enclosure to reduce drag in the gap between the tractor and trailer, side skirts/ belly fairings to reduce airflow under the trailer in crosswinds, boat tail plates and cab extenders that taper the back of trailers to minimize wake airflow, side mirror design by reconfiguring shape and support systems to reduce drag, and pneumatic aerodynamic technology that works by blowing compressed air from slots located at the rear of the trailer.

Improved Freight Logistics. Improved logistics can reduce the miles that a truck drives empty. Eliminating 15 percent of a line-haul truck's empty miles could save \$3,000 in fuel and reduce 24 metric tons of CO₂ annually.⁷⁸ There are several strategies to improve freight logistics such as delivery cost analysis, utilizing routing optimization and scheduling software, vehicle GPS tracking and wireless software.

Automatic Tire Inflation Systems. When not properly inflated, tires flex more under load, producing heat and increasing rolling resistance, which wastes fuel. Automatic tire inflation (ATI) systems monitor and continually adjust the level of pressurized air in tires, maintaining proper tire inflation automatically, even while the truck is moving. Some ATI systems use the vehicle's own air-brake compressor to supply air to all the tires. Other systems use self-contained compressors mounted on each hub that are powered by the rolling motion of the wheels. Once an ATI system is installed, it should not require any special attention from the driver. Retrofitting a line-haul truck with an automatic tire inflation system could save 100 gallons of fuel annually and reduce tire wear and maintenance, while eliminating one metric ton of CO₂.⁷⁹ Arvin Meritor is the main manufacturer of ATIs (www.arvinmeritor.com).*

Single Wide-base Tires. Replacing standard thinner tires per wheel with single wide-base tires improves the fuel efficiency of heavy-duty tractor-trailer trucks and allows them to be made to run with more stability, according to studies by Oak Ridge National Laboratory. Interstate tests by the National Transportation Research Center show gas mileage increased nearly 3 percent with use of wider singlewide tires. The change can also allow for widening the trailer frame thereby providing for a more stable configuration. The tires improve fuel efficiency by decreasing weight and rolling resistance. Specifying single wide-base tires on a new combination truck could save \$1,000 immediately and reap annual fuel savings of one to three percent or more while cutting CO₂ emissions by more than four metric tons. Payback is dependent on whether doing a retrofit or purchasing tires for new fleets. Bridgestone and Michelin both produce single wide-base tires.^{80*}

Driver Training. Even highly experienced drivers can boost their skills with training aimed at raising fuel economy by five percent or more, which would save \$1,200 in annual fuel costs and cut eight metric tons of carbon dioxide. Driver training can focus on topics such as idle reduction, reducing highway speed, monitoring the engines revolutions per minute (RPMs), and more.

Low-Viscosity Lubricants. When used in a line-haul truck, synthetic engine and drive train lubricants can improve fuel economy by three percent, saving nearly 500 gallons of fuel and cutting five metric tons of CO₂ annually.⁸¹

Reducing Highway Speed. A line-haul truck with 90 percent highway miles that reduces its top speed from 70 to 65 miles per hour could cut its annual fuel bill nearly \$1,500 while eliminating almost 10 metric tons of CO₂.⁸²

Weight Reduction. Reducing 3,000 pounds from a line-haul truck by using lighter-weight components could save up to 500 gallons of fuel annually and eliminate up to five metric tons of CO₂.⁸³

Fleet Modernization. Purchasing a truck manufactured in 2007 can reduce diesel particulate emissions by 85 percent and Nitrogen Oxide (NOx) by 25 percent. Trucks manufactured before 1994 can emit 100 times the amount of particulate matter and NOx that a new truck does.⁸⁴

Case Study: Safeway

Safeway Inc. is a Fortune 100 company and one of the largest food and drug retailers in North America, based on sales. The company operates 1,738 stores in the United States and western Canada and had annual sales of \$40.2 billion in 2006. As one of the nation's leading retailers, Safeway is also embracing environmentally friendly initiatives throughout its business operations, and in January 2008 announced it has converted its entire California and U.S. truck fleet to cleaner-burning biodiesel fuel.

The biodiesel initiative makes Safeway one of the first major retailers in the United States to convert its entire fleet of more than 1,000 trucks to cleaner-burning biodiesel fuel. The decision by Safeway will help reduce carbon dioxide emissions by 75 million pounds annually, the equivalent of taking nearly 7,500 passenger vehicles off the road each year.

"Safeway is proud to lead by example to help protect the environment," said Chairman, President and CEO Steve Burd. "Using biodiesel to power our transportation fleet will prevent millions of pounds of carbon emissions from being released into the environment. Our biodiesel program is just one of many initiatives underway that will make a positive impact on the environment."

To help educate the public about environmental awareness, every Safeway truck will have special decals indicating the vehicle is operated with cleaner-burning biodiesel.

In addition, the company is participating in the U.S. Environmental Protection Agency's SmartWay Transportation Partnership, which commits Safeway to establishing a baseline fuel efficiency of its fleet and implementing a plan to decrease carbon emissions. Those efficiencies, which include purchasing trailers with large capacity, have saved more than 6.5 million gallons of diesel fuel and decreased carbon emissions by 73,000 tons annually. Safeway also is part of the EPA's Grow & Go Partners, which promotes the benefits of renewable fuels.

Source: http://greenfleetsbc.com/index.php?option=com_content&task=view&id=63&Itemid=1

Case Study: evo

evo is a ski, snowboard, wakeboard, skate and lifestyle apparel store and online retailer in Seattle, Washington. They offer a \$200 credit to employees towards a bike purchase for those who bike commute at least 3 days a week during the summer and 2 days a week in the winter. To further encourage bike commuting, evo occasionally enters into employee bike commute competitions against other Seattle organizations. Prizes and bragging rights go to the winner. A \$500 cash incentive is offered to employees that purchase a hybrid or alternative fuel vehicle. Other green transportation initiatives include company-paid bus passes, networking among employees to assist new staff to find housing within walking distance to work, and carpooling up to the ski mountain. Additionally, evo offers each employee 40 hours of paid time off specifically for volunteer work, which many employees choose to put towards green projects.⁸⁵

Source: <http://evogear.com>

Transportation Resources

General Resources

The U.S. Department of Energy Alternative Fuels Data Center

This database captures state and federal laws and incentives related to alternative fuels and vehicles, air quality, fuel efficiency, and other transportation-related topics. State-level information is updated annually after each state's legislative session ends. Federal information is updated after enacted legislation is signed into law. http://www.afdc.energy.gov/afdc/laws/incen_laws.html

Calculate your commute costs at:

<http://www.commuterpage.com/Userweb/CostCommuting/CostCommuting.htm>

Clean Air

Information on the benefits of telecommuting. Tips on green commuting and resources for analyzing what it takes to set up your business for telecommuting. www.cleanair.org

Rideshare Resources

National database and registration for ride sharing <http://www.rideshare-directory.com/>

Rideshare for the Eugene Springfield area <http://www.ltd.org/cs/csindex.html>

Vanpool Opportunities along the 1-5 corridor www.valleyvanpool.info

Local General Resources

Point2Point Solutions

Commuter Solutions provides employer programs, Smart Ways to School, car & vanpools, along with other local transportation options. <http://www.ltd.org/cs/csindex.html>

Business Energy Tax Credits

Information on transportation-related tax credits for Oregon businesses.

<http://www.oregon.gov/ENERGY/TRANS/transhm.shtml>

Cascade Sierra Solutions

CSS is a non-profit organization dedicated to saving fuel and reducing emissions from heavy-duty diesel engines. CSS operates in the States of Washington, Oregon and California with a primary focus on the I-5 corridor. www.cascadesierrasolutions.org Library (including information on idle reduction technology): https://secure.cascadesierrasolutions.org/CSS_library/

Lane Council of Government

This site is user friendly and contains regional information about the transportation planning process, current projects, and information about transportation options. The Lane Council of Governments maintains the site. www.keepusmoving.info

National Vehicle Resources:

Fuel Economy.gov

Information on driving efficiently, mileage for different vehicles, biofuels and hybrids.

www.fueleconomy.gov

US EPA Green Vehicle Guide

Statistics on the latest fuel-efficient vehicles. <http://www.epa.gov/greenvehicles/>

Vehicles Shares:

WeCar® www.wecar.com and Zipcar <http://www.zipcar.com/>

Oregon Bicycle Resources:

City of Eugene

Bike maps and resources for biking in Eugene. [http://www.eugene-](http://www.eugene-or.gov/portal/server.pt?open=512&objID=744&PageID=3998&cached=true&mode=2&userID=2)

[or.gov/portal/server.pt?open=512&objID=744&PageID=3998&cached=true&mode=2&userID=2](http://www.eugene-or.gov/portal/server.pt?open=512&objID=744&PageID=3998&cached=true&mode=2&userID=2)

Center for Appropriate Transportation (CAT)

A nonprofit organization that provides Pedalers Express delivery service, education and youth programs, Oregon Cycling magazine, and more. www.catoregon.org

Oregon Department of Transportation (ODOT)

Links to the Oregon Bicycle Manual and information on laws and regulations and a list of bike travel web resources. <http://www.oregon.gov/ODOT/HWY/BIKEPED/>

Telecommuting and Teleconferencing Resources

Many resources exist for telecommuting and teleconferencing, which can be easily found through an internet search.

Chapter Five: Supply Chain & Product and Service Design

Key Learning Points

- Reducing climate impact along the supply chain can reduce overall business costs
- A life cycle or “cradle to grave” analysis can identify areas where you can reduce emissions in product/service development
- Models such as biomimicry, Cradle-to-Cradle or Design for the Environment can support improved design of products
- Reducing emissions in product design can reduce the cost of production and improve sales

Introduction

Most businesses do not operate as islands; product or service development depends on other companies that provide raw materials, finished products and services. While your organization can control emissions generated from your own work, the behaviors of your suppliers and that with which they provide you may counteract your efforts to reduce emissions. This can include emissions released during feedstock extraction, transportation, production, use, and disposal of products.

According to the United Nations System-Wide Earthwatch initiative, industrialized countries account for only 20% of the world population, but consume 86% of aluminum, 81% of paper, 80% of iron and steel, and 76% of timber produced globally.⁸⁶ This consumption results in significant greenhouse gas emissions from resource extraction, processing and manufacturing, transportation, use and disposal. The pie chart below shows that 42% of US greenhouse gas emissions result from the provision of materials and food.

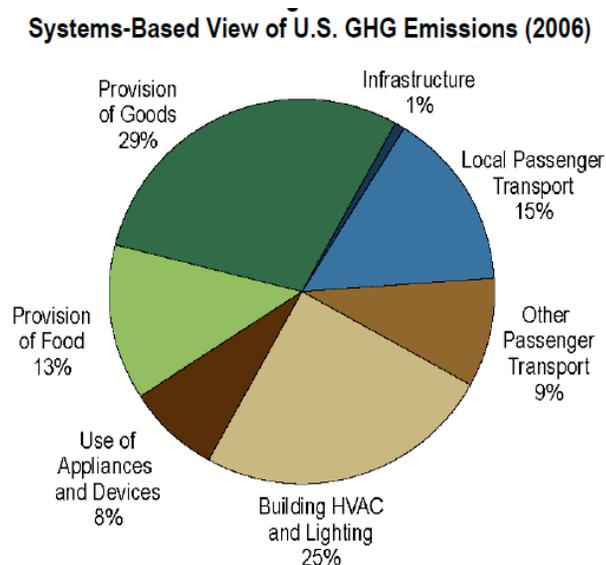


Figure 1: The extraction of natural resources, manufacture, transportation and disposal of goods makes up 29% of total US GHG emissions. Source: EPA, “GHG Land and Materials Management” 2009. http://www.epa.gov/oswer/docs/ghg_land_and_materials_management.pdf.

Preventing waste throughout the product life cycle, reducing our use of virgin materials, increasing product lifespan, supporting, and when applicable, producing carbon-neutral, carbon reducing products are important emission reduction strategies.

The prospect of changing how we manufacture and deliver products and services to achieve a sustainable society may be daunting, yet the evidence increasingly shows growing profits for companies that lead in making resource and energy efficient, or “eco-efficient,” products.⁸⁷ Products and services that meet these environmental criteria have increased marketability and viability.⁸⁸ Customers and clients have begun to demand products and services that conform to a more sustainable ethic.⁸⁹ A Goldman Sachs report found that companies leading in environmental, social, and good governance policies have outperformed the MSCI world index of stocks by 25 percent since 2005. Seventy-two percent of the companies on the list outperformed their industry peers.⁹⁰ As product and service design are a creative endeavor with no prescribed rules for best practices, this chapter outlines a basic framework for assessing the sustainability of your current products and services and aims to provide inspiration and tools for decreasing the associated emissions.

Supply Chain Management

To reduce emissions along the supply chain, businesses should review their supply chain management. Green Supply Chain Management (or Green SCM) was developed in recognition of the disproportionate impact processes along the supply chain can have on an organization’s environmental footprint. It recognizes that by integrating environmental and supply chain management, costs can be reduced and efficiency and flexibility in production can be increased.⁹¹



Figure 2. The green supply chain is a cyclical process, as described in the Cradle-to-Cradle approach (see PRODUCT section).

Suppliers, producers and distributors are involved in the process to ensure that the product has as few emissions as possible.

Graphic from: <http://www.mhia.org/news/green>

Start by breaking your supply chain assessment into steps. As with other organizational change processes, envision the ideal future for your organization’s suppliers and work backwards from there. Based on your ideal, set goals for where you want to be in the near future, identify where your organization is today, and begin to make a transition towards those goals. (See the Desired Futures chart in Appendix Nine for a template to identify your organization’s goals and identify strategies.) This chapter provides tips that can support you as you move through the process.^{92,93}

Internal Visioning and Goal Setting

In contemplating your supply chain, look beyond the materials that make up your products or services to those that keep your business in operation, such as paper and office equipment, product delivery and distribution, as well as all other services used by your organization. The following ideas for reducing emissions in products and services are intended to spark your visioning process.

Your ideal could include all of the following elements, depending on the product:

- Raw materials sourced from widely available recycled or remanufactured elements (post-consumer or post-industrial wastes), or rapidly renewable and organically raised plant-based raw materials (e.g. agricultural residues, sustainably harvested wood or bamboo, etc.);
- Manufacturing using 100 percent renewable energy;
- No waste in production;
- No toxic materials used in production or generated during product use (including GHGs);
- Quality and durability appropriate for intended use;
- Designed for re-use and/or easy recycling or composting; and
- Minimal transportation energy impacts.

Assessment

Next, work with your finance staff to identify the vendors whom you work with and what you spend the most money on. What are the potential environmental and climate impacts of the products or services these vendors provide to your business? Are they supplying “clean” materials or do they have highly polluting products? You might find this information and any steps towards improvement they’re taking in environmental reports. Develop a system for rating your suppliers on their environmental record, which answer the following questions:

- Is information provided on emissions and other impacts of your products and if so, is it credible (e.g. provided by an outside evaluator)?
- Are the products made from a sustainable resource?
- Are climate change implications considered in the manufacturing process?
- Does the supplier consider durability, recyclability and reusability of the product?
- Does the supplier have a take-back program?⁹⁴

Transitioning Towards Your Ideal

Once you have completed your assessment, prioritize the opportunities identified and determine a set of action items to implement the top opportunities based on:

- "Biggest bang for the buck";
- Products or processes that generate the most pollution or waste;
- 1-2 supplier(s) known to provide quality products and service, exhibit some environmental initiatives and interest, or with whom you have a longstanding business relationship.

If applicable, establish terms and agreements for a partnership with your supplier, involving your supplier early in the process and identifying opportunities for them to produce the same products or services using less resources, waste, and pollution. This can save both parties money and improve profitability. For example, Anheuser-Busch Companies, Inc., worked with aluminum can manufacturers to decrease thickness of the can wall and lid diameter, achieving a 30% weight reduction in aluminum cans, saving 20 million pounds of aluminum annually and changing beverage can design industry-wide.⁹⁵

If your supplier isn’t immediately receptive to working with your company to reduce emissions in their products or services, you may want to give them a few months to make adjustments by educating them on environmental and economic benefits of making changes. If your supplier still isn’t willing to work with the emission reduction standards that you set, consider switching to a new supplier that already delivers lower emissions products and services. Identify suppliers that go beyond simply providing a product or basic service and which are willing to help their customers meet environmental goals. Choose a new supplier that has environmental management systems, products and services that come from sustainable sources and that encourage take-back, re-use and recycling of their products rather than landfilling or disposing. You might increase your leverage by working across your trade association to identify “climate-positive” suppliers or to put pressure on

current suppliers to improve their environmental performance and offer reduced emission products or services.

Benefits of partnering with your supplier include:

- The supplier is the expert on their products and services and can maximize efficiencies and minimize associated wastes;
- Two or more perspectives (or expertise areas) are better than one when it comes to designing greener products and processes;
- Working together strengthens the customer-supplier relationship; and
- Shared savings and mutual benefits make collaborative efforts even more worthwhile.

A few examples of ways to partner with a supplier include:⁹⁶

- Collaborating on green design and manufacturing projects;
- Sharing tools used for environmental improvement;
- Researching alternative materials, products, equipment, and processes that have lower life cycle impacts;
- Managing of inventories by the supplier (e.g., chemicals, cleaning supplies, lab supplies, office supplies, etc.);
- Devising ways to take back and recycle or refurbish end-of-life items and packaging.⁹⁷
- Using smaller, lighter products to decrease greenhouse gas emissions and transportation impacts and costs. Material weight has a significant impact and can be a relevant, shorthand way to compare general environmental benefits, even across materials. Reducing material weight could be more important than increasing recycled content alone.⁹⁸
- Improving packaging designs in order to increase the number of products per pallet. Packaging alone makes up 32% of trash by weight and is comprised of a variety of materials.
- Transporting products by sea as opposed to air, and by train instead of truck, which allows for more efficient shipments with lower environmental impact.⁹⁹

Keep in mind that when making changes in your products and packaging, there may be some upfront costs for investment in time and new materials, a resistance to change from manufacturers and staff, and consumer indifference if it is a new product or significantly more expensive than the non-green product.¹⁰⁰ However, another way to spread your influence up and down the supply chain is by educating customers on ways to reduce their emissions and waste. Not only will this discourage waste that results from your products and services, but it will also signal to customers that environmental performance is an important issue to your organization.

Life Cycle Analysis

To round out your awareness of your product- and service- related emissions you must understand not just what goes into the design and development stages of your products and services, but also what happens when they leave your business. By looking across all of these stages, a life cycle analysis (LCA) (also known as “life cycle assessment” or “cradle-to-grave analysis”) is a comprehensive assessment of the environmental performance of a product that encompasses the following: the identification and quantification of energy, materials and emissions across all stages of the life cycle; the impact of these energy and material uses and emissions; and the opportunities for environmental improvement.¹⁰¹ The Carnegie-Mellon University Green Design Institute, describes the steps of a life cycle analysis as follows:

- First, raw materials are extracted from the earth. Some examples are ore, water and oil.
- Second, raw materials are processed into finished materials. For example, bauxite ore is processed into aluminum and oil is processed into plastics.
- Third, the materials are manufactured or assembled into a final product.
- Fourth, the consumer purchases and takes control of the product.
- Fifth, the consumer no longer has use for the product. (This is the waste management stage or end-of-life stage when the product is broken down into component materials for remanufacturing or recycling, or is discarded.)
- A sixth stage is sometimes included, which involves distribution as the materials and product are transported between stages.¹⁰²

Initially your business can conduct a simple product inventory to review how your products are made, where they come from, and begin to identify areas where improvements can be made. Below are some questions to consider:

What products do we sell?

- Can they be produced with non-toxic, organic, and sustainably extracted materials?
- Can they be produced using recycled or previously used materials?
- Can the materials be locally sourced and constructed?

Comparison of life cycle analysis and supply chain accounting for a manufacturer

In the case of a company manufacturing automobiles, supply chain GHG accounting would include the emissions associated with the upstream production of raw materials used to manufacture automobiles; the upstream manufacturing of all the various components that the automaker will assemble to manufacture the final automobile; the transportation of those materials and components to the automaker; and the final production of the automobile by the automaker. If the automaker assesses the greenhouse gases emitted per car, the assessment is at the product level. If the automakers assesses the supply chain emissions of all its products and all its facilities and aggregates all such emissions, the analysis is at the corporate level.

In contrast to supply chain accounting, life cycle accounting would take into account not only the upstream emissions and manufacturing emissions of the car, but also the product use and disposal phases of the car, such that the emissions associated with driving the car and ultimately disposing/recycling of the materials are included in the analysis. The life cycle assessment can either be at the product level (life cycle emissions per car) or at the corporate level (the aggregation of the life cycle emissions of all the cars the company manufactures and sells).

From WRI/WBCSD 2007

- Can the amount of materials needed to make the product be reduced?
- Is it technically feasible to compost or recycle the byproducts and end product?
- Does a recycling or composting infrastructure exist for the byproducts and end product?
- What product comes out of the recycled material or compost, and what is the quality and value of that product?
- Can extraneous packaging materials be eliminated?
- Do we have a take-back strategy for the product and its materials?
- Can dissimilar materials be easily separated?
- Can common or readily available disassembly tools be used?
- Can the material type be identified through markings, magnets, etc.?
- How long do the products last? (i.e. durability of product)
- How many parts do the products have?

Where do our products come from?

- Can we cut transportation costs and impacts by sourcing locally?
- Can distribution be streamlined?
- Are we using the most efficient mode of transportation?
- Can we use fossil fuel free or low carbon sources of transportation?

What services do we provide and use?

- Do we use low-emission options? (e.g. for packaging, transportation, distribution, food service, architecture/construction, landscaping, IT, media, etc.)
- Do we provide our customers with low-emission options? (e.g. for food service, architecture/construction, health care, landscaping, travel, lodging, IT, media)
- Do we educate and/or support our customers on reducing their carbon emissions?
- Have we done everything possible to set an example for our customers by investing in efforts to reduce our businesses emissions?
- Do we provide support for our products that increases their durability and lifespan?

After conducting an assessment of products and services, consider developing a Desired Futures chart to identify goals for reducing emissions in your products and transitional steps to reach your goals. A sample chart is available in Appendix Eight. You can then move beyond your own operations and approach emissions reduction throughout the entire supply chain.

Undertaking a life cycle assessment is not an easy task: aside from the technical challenges involved in quantifying impacts throughout a product's life, subjective assumptions must be made about boundaries.¹⁰³ For example, if a product includes recycled materials, should the impacts associated with the original raw materials be included? While challenging, a LCA will enable your business to: 1) differentiate the impacts of comparable products; 2) assess design options for the same product; and 3) identify where in the life cycle an impact should be targeted for reduction.

Simpler steps can be taken to evaluate emissions associated with products you use. One option for evaluating the impacts of some of your most commonly used goods and materials is the Economic Input-Output Life Cycle Assessment (EIO-LCA) tool at www.eiolca.net/, which provides the GHG emissions associated with a certain dollar amount of a product (see sidebar).¹⁰⁴

Economic Input-Output Life Cycle Assessment (EIO-LCA)

The Economic Input-Output Life Cycle Assessment (EIO-LCA) is an online calculator that estimates the materials, energy resources, and emissions required for and resulting from activities in our economy. It is one technique for performing a life cycle analysis. The method uses information about industry transactions - purchases of materials by one industry from other industries, and the information about direct environmental emissions of industries, to estimate the total emissions throughout the supply chain.

From: Economic Input-Output Life Cycle Assessment, Green Design Institute
http://www.eiolca.net/Method/LCA_Primer.html
and <http://www.eiolca.net/Method/index.html>

Approaches to Product and Service Design

Below are several ways of thinking about product and service design intended to spark new ideas about your existing products and services. The descriptions below are brief. Please see the resources section of this chapter for links to further information on these approaches.

The Cradle-to-Cradle Approach¹⁰⁵

Within a Cradle-to-Cradle (C2C)¹⁰⁶ framework every material is designed to be renewable: after a long and useful product life, materials are designed to replenish the earth or to supply high quality resources for the next generation of products through a closed-loop cycle. This framework exemplifies the “borrow-use-replenish” way of thinking; after being used for a single purpose, materials do not end up in the “grave” (i.e. landfill or any other receptacle of waste), but rather serve as the “cradle” for a new good or service. Products must have a defined end-of-use strategy and be designed for disassembly so that recovery of materials is possible. Ideal design or redesign selects materials with the most positive human and environmental health characteristics and highest value recovery potential. The goal of the C2C model is to optimize the product and all the materials used in the product or services to produce a healthy, prosperous, cradle-to-cradle life cycle.

One example is the Ecoberm® erosion control product produced by Rexius Sustainable Solutions. The product eliminates the need for plastic silt fencing and is made of all recycled organic materials. Unlike other similar products, the Ecoberm® uses no non-biodegradable reinforcements. Once the erosion control project is completed, the compost/mulch blend can be used as an earth friendly soil amendment.¹⁰⁷

Biomimicry

In the simplest of terms, biomimicry involves looking to nature for inspiration to increase the efficiency of products. A variety of manufacturers have been applying biomimicry principles to product design and development including car and clothing manufacturers, fan makers, computer and cell phone designers, wind energy producers, and plastic and cement makers. The United Nations Environment Programme has teamed with a number of nongovernmental organizations to identify “Natures 100 Best Innovations.” As discussed in the case study at the end of this section, Interface carpets used biomimicry to redesign their products to make them more efficient and to reduce waste.

The core idea is that nature, imaginative by necessity, has already solved many of the problems we are grappling with. Animals, plants, and microbes ... have found what works, what is appropriate, and most important, what lasts here on Earth...after 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival.

— Janine M. Benyus, author
Biomimicry: Innovation Inspired by Nature

Design for Environment (DfE)

Design for Environment is a partnership program with the US EPA that allows manufacturers to put the DfE label on household and commercial products such as cleaners and detergents that meet stringent criteria for human and environmental health.¹⁰⁸ DfE is “based upon consideration of the entire lifecycle of a product ‘upfront’ during design [which] reveals new windows of opportunity for

optimizing designs to simultaneously improve product function and appeal along with efficient use of materials and energy.”¹⁰⁹ According to the Minnesota Pollution Control Agency, advantages of DfE include:

- Innovative, optimized product design
- Reduced costs (efficient use of materials, energy)
- Reduced manufacturing cycle times
- Improved sales and marketing position
- Reduced regulatory concerns¹¹⁰

DfE can result in significant savings, especially when used in the earliest stages of design and working with suppliers and manufacturers.

Policies and Regulations

There are currently minimal regulations on product greenhouse gas emissions at the state or national level, but regulation concepts are being considered in other countries or implemented by individual businesses in the United States. This section aims to provide a basic overview of these concepts. As recognized by some researchers, some risks are associated with product-related policies. For example, if different measures are applied to different products, there may be unevenness in the market. However, there could also be benefits if a policy is applied consistently in a region by which it increases innovation and enhances competitiveness.¹¹¹

Integrated Product Policy (IPP)¹¹²

The European Commissions as well as many governments in the EU and in other countries are considering the implementation of an Integrated Product Policy approach to environmental policy making. IPP seeks to reduce the environmental impact of a product system by looking at the entire life cycle of a product, and hence avoiding the “shift” of environmental problems between different stages of the products life cycle. IPP has been implemented through “ecolabeling” and take-back schemes as well as by using tax measures as an incentive to use less impacting products. However, IPP has not been consistently applied and therefore its success at this stage is still being tested. The core building blocks of IPP include identification of products that have measures aimed at:

- reducing and managing resources and wastes;
- the innovation of more environmentally-sound products;
- the creation and support of markets for more environmentally-sound products;
- transmitting information up and down the product chain;
- allocating responsibility for managing the environmental burdens of product systems.

EPA Mandatory Greenhouse Gas Reporting

As of early 2010, the EPA had proposed a rule that would require suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions to submit annual reports to EPA. The gases covered by the proposed rule are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O),

hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF₆), and other fluorinated gases including nitrogen trifluoride (NF₃) and hydrofluorinated ethers (HFE).¹¹³

Oregon Greenhouse Gas Reporting Requirements^{114,115,116}

In October of 2008 Oregon approved requirements for mandatory greenhouse gas reporting. Starting in 2010, all facilities with operations in Oregon that emit more than 2,500 metric tons of CO₂ equivalent (or CO₂e) annually will be required to report total emissions to the Department of Environmental Quality. It is estimated that this will affect 481 small businesses, 126 large businesses and more than 100 local and state government agencies including hospitals, prisons, and landfills. The mandatory reporting rules are part of the statewide greenhouse gas emissions reduction strategy of lowering emissions to 10% below 1990 levels by 2020 and to 75% below 1990 levels by 2050.

Extended Product Responsibility (EPR)¹¹⁷

Extended Product Responsibility is a pollution prevention policy that focuses on product systems. The three key principles of EPR include:

- Extending responsibility to the producer for stages where responsibility does not currently exist or is not defined, such as the disposal or use stages;
- A product systems approach, focusing on creating feedback to product designers to improve products;
- Sharing and clear definition of responsibility for products' life cycle environmental impacts.

To extend environmental responsibility along the product chain, incentives are often employed either by the company or by the government (e.g. bottle refund bills). There are typically five different types of responsibility that are assigned to the product manufacturer. These may include:

- Liability – the producer is responsible for environmental damage caused by the product in question.
- Economic responsibility – the producer covers all or part of costs for collection, recycling or final disposal of products they manufacture.
- Physical responsibility – the manufacturer is involved in physical management of the products or of the effect of the products. This can range from merely developing the necessary technology to managing the total "take back" system for collecting or disposing of products they manufacture.
- Ownership – the producers assumes both physical and economic responsibility.
- Informative responsibility – the producer is responsible for providing information on the product or its effects at various stages of its life cycle.¹¹⁸

Some companies manage product responsibility using the following instruments. Those companies taking the lead in eco-efficiency will find that many of these instruments work in their favor, as they are ahead of their competitors by the time regulation comes into play:

- Regulatory Instruments: take-back systems; minimum recycled content standards; secondary materials utilization rate requirements; recovery rates/time and energy-efficiency standards; disposal, material, and product bans and restrictions materials bans and restrictions.

- Economic Instruments: advance disposal fees; virgin materials levies; removal of subsidies for virgin materials; deposit/refund systems; and environmentally preferable products procurement procedures.
- Informative Instruments: identification and use seal-of-approval types of environmental labeling (Energy Star™, Eco-Seal™), environmental information labeling (energy efficiency, CFC content, recycled content), product hazard warnings, and product durability labeling.

Conclusion

The thought of having to look beyond emissions reductions within internal operations to consider your entire supply chain may seem overwhelming. However, as outlined in this chapter, the investment you put into your own emissions reduction may be insignificant in the face of the emissions associated with your supplied products and services. Working along the supply chain with your suppliers will build relationships, improve efficiency, provide savings, and allow your business to develop cleaner products and services to your customers.

Keep in mind that rethinking your product or service design is a major step your company can take in reducing emissions, saving money and inspiring creativity. The innovation that comes out of product and service assessment could even lead to more highly desired end products for your customers and further appeal to the growing market of eco-consumers. The process takes time, and support for innovation must be integrated into your organization's culture, as every successful step forward will surely be preceded by several false starts.

Case Study #1: Interface Carpets and Biomimicry

Interface is a worldwide leader in carpet and fabric manufacturing and sales. For the first 21 years of operation, Interface never gave serious thought to what it was taking from or doing to the Earth, except to be sure it obeyed all laws and regulations, and realized profit growth. But in 1994, CEO Ray Anderson had an epiphany. He provided his global team with a mission to convert Interface to a restorative enterprise; first by reaching sustainability in business practices, and then becoming truly restorative—a company returning more than it takes—by helping others to achieve sustainability.

Interface began its journey toward sustainability by focusing on the elimination of waste. Carpets were designed to reflect nature: no two tiles were the same, yet all were similar, reflecting the “pleasant orderliness in the chaos of nature”. The product, Entropy, is made with recycled content in a climate-neutral factory; and quickly became a best seller now representing 52% of Interface’s sales. Using principles like waste minimization and biomimicry has enabled Interface to bring the company’s CO₂ emissions to roughly 10% of their 1996 levels. The cumulative avoided costs from waste elimination activities since 1995 are calculated to be over \$372 million. Total waste sent to landfills from Interface’s carpet manufacturing facilities has decreased by 66% since 1996.

Interface has instituted a product reclamation program, ReEntry, to reduce industrial materials that end up in landfills. The process begins in the product design phase, creating a holistic approach to reclamation before a product ever reaches the sales floor. By evaluating product type and condition, as well as location (to mitigate transportation factors), ReEntry plans for optimal product reprocessing through recycling, creating new products and materials, or facilitating product reuse. The ReEntry program diverted 133 million pounds of material from landfill between 1995 and 2007.

From: <http://www.interfaceinc.com>

L. Hunter Lovins 2008 State of the World http://www.worldwatch.org/files/pdf/SOW08_chapter_3.pdf

Case Study 2: Hewlett Packard

The computer manufacturer has taken multiple steps to reduce emissions generated in product design and production. HP took the following steps to cut down on emissions:

Made products more easily recyclable. HP uses common fasteners and snap-in features, and avoids the use of glues, adhesives and welds where feasible. This makes it easier to dismantle products and to separate and identify different plastics. HP also uses LED technology, eliminating mercury fluorescent tubes and making the display screens easier to manage at end-of-life. Overall, HP notebook PC products are now more than 90 percent recyclable or recoverable by weight. Printing and imaging products are also 70-85% recyclable, and all materials used in packaging are required to be recyclable.¹¹⁹

Durable materials. HP implemented efficient product design, longer battery life and enhanced power management to decrease energy consumption and reduce climate impact.

Recycled materials. HP used more than 5 million pounds of recycled plastic in its original HP inkjet cartridges in 2007.

“Eco Highlights” labeling. In 2008, HP introduced this special labeling to describe the environmental features of select products, including information about materials use and recycling. The products with this label “meet stringent environmental standards such as energy-savings and innovative material use.” The labels show information on key environmental attributes including energy efficiency, packaging and recycling information.¹²⁰

Supply Chain Resources

Third-party certification programs for sustainable products

- Energy Star (www.energystar.gov) -- Energy-efficient technology products, where standards constantly evolve to meet advances in technology.
- Forest Stewardship Council (www.fscus.org) -- Certifies wood and paper products come from responsibly managed forests.
- Cradle to Cradle certification (www.c2ccertified.com) --Integrates many aspects of life cycle assessment into its evaluation, as well as a rigorous evaluation of use of potentially harmful substances.
- Green Seal (www.green seal.org) -- Certifies a number of cleaning products and paper items.
- GreenGuard (www.greenguard.org) and SCS Indoor Advantage certifications -- Ensure that products use materials that minimize impacts on indoor air quality from volatile organic compounds (VOCs) and other air contaminants.
- Electronic Product Environmental Assessment Tool (www.epeat.net) -- More than 1500 computer desktops, notebooks, monitors and integrated products certified to date under three tiers, from bronze to gold.

Free Lifecycle Assessment Tools

- Economic Input-Output Lifecycle Analysis model (EIO/LCA) (<http://www.eiolca.net/>) – discussed above.
- Building for Environmental and Economic Sustainability (BEES) (www.wbdg.org/tools/bees.php) -- a useful and interesting tool even though it needs to be populated with more products.
- The Athena Institute (<http://www.athenasmi.org/tools/ecoCalculator/>) offers a LCA calculator to impartially compare building designs.

National Product and Service Design Resources

Center for Clean Products

Pioneers of the concept of extended product responsibility and conducts research on green production processes and products. The center has produced reports based on research on automobile, printing, and computer display design and life cycle assessments. <http://isse.utk.edu/ccp/>

Center for Sustainable Design

Provides training and practical applications in green design through conferences, seminars, workshops, and consulting programs. CfSD publishes training manuals, guidelines, reports, and the "Journal of Sustainable Product Design." <http://www.cfsd.org.uk/>

O2 Global Network

An international ecodesign association fostering green design through workshops, ecodesign tips, and other strategies. <http://www.o2.org/index.php>

2.2010 – DRAFT: Contact Climate Leadership Initiative to reproduce

EPA's Recycled Content (ReCon) Tool

EPA created the Recycled Content (ReCon) Tool to help companies and individuals estimate life cycle greenhouse gas (GHG) emissions and energy impacts from purchasing and/or manufacturing materials with varying degrees of post-consumer recycled content.

http://www.epa.gov/climatechange/wycd/waste/calculators/ReCon_home.html

Cradle to Cradle

Description of the Cradle-to-Cradle concept and steps for incorporating into your business.

http://www.mcdonough.com/cradle_to_cradle.htm

Green Design

News and updates on businesses incorporating green packaging and product design.

<http://www.greenerdesign.com/browse/design-innovation>

Biomimicry

Inspiration from nature to develop more efficient products. <http://www.biomimicry.net/>

Design for Environment (DfE)

EPA's DfE program and product labeling: <http://www.epa.gov/dfe/>

Zero Waste Alliance

Non-profit partnership supporting organizations in developing and applying Zero Waste strategies.

<http://www.zerowaste.org/>

Assignments

1. Use the following to guide evaluation of your products or services (copy as needed for multiple products)

1. Name of product:					
2. Estimated life expectancy of product: ___ (days/mos/yrs)					
3. Describe packaging of product:					
4. Is the packaging made from recycled or reused materials?					
5. Can the packaging be recycled, reused or composted?					
6. Is there a take-back strategy for the product?					
7. Can the product be easily disassembled for reuse or recycling of materials?					
8a. List the materials that make up the product	8b. List the origin of materials (if known)	8c. Identify means of transportation for manufacturing	8d. Identify any organic, recycled, or reused components	8e. Identify materials that could be reduced, purchased organically, recycled or reused	8f. Identify any materials that can be composted, recycled or reused at the end life of the product
1.					
2.					
3.					
4.					
5.					

2. How can your company incorporate enhanced product or service design into your business? What are the benefits of doing so? What are the challenges of doing so?

Chapter Six: Waste

Key Learning Points

- You can achieve zero waste!
- Upstream emissions are the most significant emissions source
- Reduce potential waste at the source
- Purchase materials made with post-consumer waste content
- Design products for easy reuse and recycling
- Reuse material, or find new byproduct users
- Recycle as necessary
- Compost when applicable
- Properly dispose of toxics and hazardous materials
- Innovative ways for reducing waste can create income streams

Introduction

Although industrialized nations are recycling more waste than ever before, more than half our waste is still sent to the landfill and we are also creating more waste per capita each year.^{121,122}

Unfortunately, material disposal has only increased with widespread availability and production of single use items (from 120,000 tons/year in 1960 to 12,720,000 tons/year today).¹²³ Waste decomposing in landfills results in emissions of the potent greenhouse gas, methane, yet it is the emissions embodied in the production of new materials that has the greatest impact on the climate. It is therefore most significant for the climate that a new product replaces nearly everything we send to the landfill; the result is the emission-intensive extraction of more raw materials.¹²⁴ As such, the best strategy for reducing greenhouse gas emissions related to materials lies in decreasing consumption and material use, as opposed to focusing on end of life strategies like recycling and composting. By minimizing waste, a firm can reduce purchasing and waste disposal costs, minimize greenhouse gas production, reduce the emission-intensive extraction of raw materials and improve their reputation by being an industry and civic leader in emerging field of waste reduction.¹²⁵

Greenhouse gas emissions embodied in materials come specifically from the following sources:

- *Energy used in manufacturing and natural resource extraction.* This includes direct combustion of fossil fuels (for example, natural-gas fired boilers at paper mills), electricity generated by fossil fuels for use by industry, and extraction and production of cement, which, according to the Energy Information Agency, accounts for approximately 1% of the US greenhouse gas production.¹²⁶

- *Other emissions from industrial processes (non energy).* For example: carbon dioxide (CO₂) is emitted when converting limestone to lime (used in the production of steel and aluminum); and manufacturing plastic products results in methane emissions from natural gas processing (methane has 21 to 25 times the warming potential of CO₂).¹²⁷
- *Transportation-related emissions* are generated at every step of a product's life. This includes transporting raw materials to industry, manufactured products to customers, and discards to recovery and waste disposal facilities. Transportation by plane is the least efficient, followed by truck, then train. Barging goods is the most efficient, meaning that in some cases, goods shipped from far away use less energy and result in fewer emissions related to transportation than those trucked from closer by.
- *Methane emissions from landfills.* In the oxygen-poor landfill environment, a portion of carbon in waste is converted to methane as it decomposes anaerobically. There is a current movement to capture the methane from landfills and use the gas as an energy source for electrical generation or heat. According to the EPA methane collection efficiencies range from 60 to 85%, which is then converted to the less potent greenhouse gas, CO₂.¹²⁸
- *Emissions from incineration of wastes.* These include the potent greenhouse gas nitrous oxide as well as CO₂ from the combustion of fossil carbon-derived materials such as tires, plastics, and synthetic textiles.
- Decreased carbon storage in forests as timber is removed. Carbon continues to be stored in wood until it decomposes or burns. This means that carbon is actually stored in wood products and even in landfills until the wood degrades. However, as mentioned above, when resources are sent to landfills this typically results in replacement with raw materials. Fortunately, increasing reuse and recycling of paper and wood products are projected to decrease the demand for timber, thereby increasing carbon storage in forests.

Reducing Versus Recycling

Waste prevention is an upstream activity that involves reducing waste through changes in the design, purchase, and use of materials. Waste prevention is very different from recycling. Recycling is a process for redirecting discards away from disposal and back into the flow of commerce, where they are transformed and used as feedstocks to make new products. In contrast, waste prevention is about not making waste in the first place – through changing what we use and how we use it.

In its simplest form, waste prevention means using less stuff. Waste prevention has the potential for large environmental benefits because it typically reduces environmental impacts over all stages of the life cycle of materials: resource extraction, manufacturing, transportation and end-of-life management (such as recycling or disposal). For households and businesses alike, waste prevention can also typically save much more money than recycling or composting.

From: Oregon Department of Environmental Quality Solid Waste Program <http://www.deq.state.or.us/lq/sw/wasteprevention/index.htm>

Waste Composition in Lane County

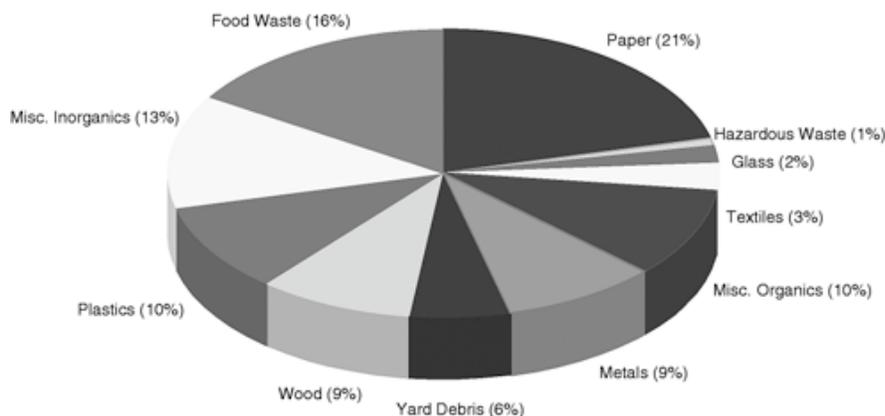


Figure 3. Lane County Recycler Handbook: “What is in Our Landfill?”
http://www.lanecounty.org/Departments/PW/WMD/Recycle/Documents/LC_Recyclers_Handbook_09WEB.pdf

Thinking Big with Zero Waste

In order to make a significant move towards reducing waste and saving money, businesses might consider aiming for “zero waste” in their facilities, setting and making good on product “take back” commitments through redesigning products for easy disassembly and reuse of parts and rethinking packaging for improved transportation and disposal. (See Appendix Six for Zero Waste principles.)

Whatever your goals are, start out with an assessment to understand your current consumption and disposal practices, and then identify the ‘desired future’ for where your company wants to go. Follow-up by setting intermediary goals to help you reach that ideal future. (See Appendix Five for a sample Desired Futures chart.)

To conduct your waste assessment you may choose to bring in an expert or find a team of staff to look at current waste problems, janitorial issues, internal and external recycling systems and all other relevant factors involving your company's waste stream. Appendix Seven provides a sample “Discard Assessment” worksheet.

Analyze the costs associated with disposing your company's waste and, if possible, determine specific tonnages of materials disposed.

In Lane County, the Master Recycler BEST program will conduct waste audits for businesses. Contact Kelly Bell at (541) 682-2059 or kelly.bell@co.lane.or.us to schedule an audit.

*BRING Recycling's Re:Think program also assists businesses with waste reduction.
www.bringrecycling.org*

Additional resources can be found at Eugene's Materials Exchange Center for Community Arts, BRING Recycling, or NextStep.

In many cases, working towards zero waste leads to savings in materials and fuel, as well as new revenue streams from turning byproducts and waste into profits. Waste is a symptom of inefficient processes, and by reducing waste your businesses may increase your reputation in the eyes of customers, the public, and employees, perhaps even motivating other businesses to follow your lead. Not least importantly, waste reduction can save your businesses a significant amount of money (e.g. Hewlett Packard has been able to reduce waste by as much as 93% and save \$1.25 million per year in disposal fees) and reduce your impact on the environment.¹²⁹

Reduce

Recycling alone cannot resolve waste related climate issues. While recycling saves energy and natural resources, it should

be looked at as an option after reducing and reusing items have been considered. One of the simplest and most effective ways for a business to eliminate waste and the associated upstream and downstream emissions is to curb consumption, ensure that the products it does use or develop are as long lasting and easily reused or recycled as possible. With smart, environmentally friendly product design techniques, the emissions from products throughout their lifecycle is mitigated and minimized. (More information on reducing emissions in your products is provided in the PRODUCT AND SERVICE DESIGN Section.) Specific actions that your business can take to reduce waste follow.

Reduce packaging waste by:

- Ordering items in bulk;
- Requesting no - or reduced/reusable - packaging from manufacturers (so long as it does not damage the goods being transported);
- Reusing packaging or finding someone who will;
- Replacing cardboard boxes with durable, reusable boxes for shipments to your branch offices, stores, and warehouses.

Reduce office supply, equipment and material waste by:

- Investing in equipment that helps reduce waste, such as:
 - High quality, durable, repairable equipment

Oregon Law

Oregon statute includes a waste management hierarchy, which states that the preferred order for managing wastes are prevention, followed by reuse, followed by recycling, then composting, then energy recovery, and finally landfilling as the least preferred option. Also contained in law are the following waste generation goals and waste recovery goals for Oregon:

- In 2009 and subsequent years, no increase in total waste generation.
- In 2009, a waste recovery goal of 50 percent.

<http://www.deq.state.or.us/lq/pubs/docs/sw/Number09Materials.pdf>

Working Towards Zero Waste

(see Appendix Six for principles)

Planning and Preparation

- Study the waste stream and associated costs
- Develop a waste reduction proposal and gain the support of management
- Assess employees' interest and encourage their support

Laying the Foundation

- Select a waste reduction coordinator
- Set goals
- Decide on waste reduction measures, procurement policies, and what will be reduced/recycled/reused
- Locate markets for waste materials, or select a recycling service
- Identify sources of recycled products
- Design a waste collection and storage system

Getting the Program On-Line

- Educate your staff
- Promote and implement the program
- Establish monitoring and evaluation procedures

- Copiers that make two-sided copies
 - Rechargeable batteries
 - Repairable merchandise
- Using reusable rather than disposable products, including within your break room (e.g. dishes, mugs, water glasses) or when hosting events or meetings.

Reduce paper waste by:

- Using electronic mail rather than printing hard copies (e.g. a hospital in Portland, OR saves \$9,200 and 175,000 pages of paper a year by not printing and sending daily financial reports to departments that don't read them);¹³⁰
- Pruning mailing lists - both incoming and outgoing;
- Minimizing misprints by posting a diagram on how to load special paper like letterhead so it will be printed correctly;
- Using or creating a central filing system instead of maintaining duplicate personal files;
- Promoting recycling to all employees - make a poster or label that lists or even shows what can and can't be recycled.

Reuse

Reusing products, whether in the same form or as a new product, lowers purchasing costs, waste, and emissions associated with the generation of new products. Many byproducts that would normally be considered waste, such as industrial grade chemicals, office paper and packaging cardboard, can be utilized within your own business or by others, often in completely different industries. Some legwork is often required to match byproduct output with potential input users, but resources do exist to facilitate this process, such as nation-wide programs like the Industrial Materials Exchange, and community organizations. These organizations act as conduits, and often are established to be resource or industry specific. For your business, consider the following:

- What byproducts exist within your business?
- Are they being reused?
- If not, what are potential markets for those materials?

Balers

Loose or non-baled materials require a tremendous amount of space in comparison to baled waste. For companies that do not yet have a recycling program in place, balers can lower waste hauling requirements considerably, since even a small quantity of baled recyclables will usually be picked up at no charge by a recycler.¹ Balers are most commonly used for cardboard, paper, and plastic. A baler is not the same thing as a trash compactor. A compactor compresses materials into a receiving container that is either dumped onsite or hauled to a trash receiving station. Instead, a baler takes loose, recyclable products (or trash) and compresses it into a bundle that is bound for handling. A variety of baler designs exist, which can be selected based on industry type and waste production. Most balers produce bales that are manually bound, but there are balers that bind automatically.² Baler companies often provide services for destruction of sensitive documents before they are sent for recycling.

¹ Waste Care <http://www.wastecare.com/Products-Services/Balers/aboutbalers.htm>

² Lee Zion. April 3, 2000. San Diego Business Journal. Companies Using Balers to Tighten Recycling Load. <http://www.thefreelibrary.com/Companies+Using+Balers+to+Tighten+Recycling+Load.-a062027782>

When your business is looking to buy, consider refurbished items to reduce the need for manufacturing new items. Example items that can be reused and refurbished include:

- Rechargeable laser printer cartridges
- Re-treaded tires support
- Office furniture or machinery

Recycle

Recycling has gained widespread recognition and prevalence in the last two decades, and it continues to grow. However, many communities still lack recycling programs. If this is the case in your location, contact your city or local government about recycling programs that may be expanded to your community or lobby for the adoption of a local program.

The most important step in establishing an effective recycling program at your business is identifying materials that are commonly discarded, and developing a time efficient system to separate what might otherwise be waste.

To boost recycling at your business, consider taking the following steps:

- Assess what is already being recycled in your facilities.
- If some of your byproducts are not recyclable, seek out a reusable or recyclable alternative.
- For materials not being recycled, contact your waste hauler to see which items can be added to your service for recycling (see Resources at end of section for numbers).
- Make it inconvenient to throw items away by reducing the number and size of garbage cans.
- Make it easier to recycle by setting recycling and composting (if available in your area) bins next to garbage containers and in additional locations.
- Educate staff on what items can be recycled and composted and post notices next to bins.
- Purchase items that can be recycled or returned to the manufacturer.
- Consider purchasing products with recycled content in order to close the loop by providing a market for recycled products. For example, a ton of 100% recycled paper saves the equivalent of 4,100 kWh of energy, 7,000 gallons of water, 60 pounds of air emissions, and three cubic yards of landfill space.¹³¹
- Recycle and purchase remanufactured toner and printer cartridges at local printing stores or nation-wide stores that offer these services and products.
- Recycle electronics that are no longer in use. See the References section for further information on where electronics can be recycled.
- Businesses in the food service industry can often partner with local food banks to have food repackaged and delivered to food pantries and meal sites, saving food waste from going to the landfill. (Businesses avoid liability under a Good Samaritan law and can even gain tax credits through food donation.)
- Know what can be recycled in your area.

WHAT CAN BE RECYCLED IN LANE COUNTY?		
MATERIALS RECYCLED FOR FREE		MATERIALS RECYCLED FOR FEE*
Aluminum Antifreeze Corrugated cardboard Glass bottles and jars Building materials including doors, windows, sinks, toilets, bookcases, lumber, siding, cabinets, etc. ^ Motor oil & filters Hazardous waste High-grade paper Household batteries Lead-acid batteries Newspaper Low-grade paper Magazines Sharps (needles, scalpels, & other sharp instrument)	Paint Plastic film Tin & steel cans Plastic bottles, tubs, jars #1-5 & 7 Steel, brass, copper, & other scrap including metal toasters, tables, bed frames, microwaves, etc. Plastic milk jugs Plastic plant pots and trays Reusable items Office equipment (some fees apply) and furniture, ink cartridges, cell phones, CD cases, software, stereo equipment, black foam, etc. ^	Appliances: Refrigerators, air conditioners, freezers, washers, dryers, dishwashers, heat pumps, trash compactors Concrete Electronic waste: TV sets, computers & computer related equipment, Fax machines, copiers, VCRs, DVD players, stereos, & telephones Mattresses & box springs Propane tanks Tires Lumber, rotten wood, shakes, pressboard, pegboard, plywood, lath, pallets, panels. Yard debris
All items listed can be recycled at Lane County Disposal sites except items noted with ^. These can be recycled at other venues in Lane County including BRING Recycling and Next Step Recycling *For fee information visit http://www.lanecounty.org/Departments/PW/WMD/Recycle/Pages/recycle.aspx and http://www.nextsteprecycling.org/accept_business.php#business Information from Lane County, BRING and Next Step		

Oregon Businesses Reducing Waste¹³²

The following Oregon based businesses have taken steps to reduce their waste, which has also resulted in large economic benefits:

McKenzie-Willamette Medical Center estimates that they have saved between \$10,000 and \$50,000 over the past five years by selling their used cardboard to Weyerhaeuser.

Euphoria Chocolate Company saves \$3,000 a year by reusing their shipping boxes 20-30 times each.

GloryBee Foods reuses totes and drums for their honeys and sweeteners, which they sell to community members when no longer at food grade quality. They sell many of their plastics to Weyerhaeuser for recycling.

Market of Choice made \$126,768 in 2005 from selling their cardboard to Weyerhaeuser for recycling

Legacy Health Systems in Oregon replaced disposable mattresses with reusable mattresses, resulting in a savings of \$81,527 and 16,350 pounds of waste per year.

Corvallis Hardware/True Value purchases the large majority of its products from Cotter & Company. Deliveries from the Portland distribution center are shipped in reusable plastic totes.

Empty totes from the previous week are picked up for reuse when new merchandise is dropped off.

Toxics and Hazardous Materials

Synthetic and toxic chemicals and materials are used prevalently to produce plastics, paints, electronic appliances and parts, batteries, and even some foods (in small amounts), as well as a wealth of other products. Often, these toxics are already taken into account at recycling centers and facilities, so individual businesses need not worry about many toxics in commonly recyclable materials.

Some materials however, such as paints, motor oils and cleaning or other chemicals, have special treatment and disposal protocols, often regulated by law. If your business utilizes materials with toxic properties, please contact your local waste disposal service provider about methods to properly recycle such materials.

Lane County businesses, agencies and organizations that generate small quantities of hazardous waste are called “Conditionally Exempt Generators” (CEGs) and may be eligible to participate in Lane County’s CEG collection program. Participating businesses must pre-register and pay disposal fees for their waste. Call (541) 682-4120 for an information packet. A CEG is a business or non-residential organization that generates:

- Less than 220 pounds of hazardous waste per month (this is approximately equal to 25-27 gallons of liquid with a weight comparable to water) AND
- Less than 2.2 pounds per month of "acutely hazardous" materials.
- In addition, no more than 2200 pounds of hazardous waste may be stored at your facility at any one time during the calendar year. Call for more information about determining your status.

Lane County does not accept radioactive materials, explosives, certain very reactive materials, and acutely hazardous¹ wastes. Information on services, pricing and application forms are available in the References section.

Case Study #1: Mountain Rose Herbs

Instead of seeing garbage, waste, and landfills as an acceptable and excusable part of business, Mountain Rose Herbs has come to employ and embody the practice of “Zero Waste.” The Zero Waste paradigm utilizes waste as a resource, commodity and a local source of revenue, where all potential waste is evaluated for full retrieval, recycling and reclamation. If a material can be recycled, re-directed, composted, salvaged or re-introduced into the production cycle then it must, with no exceptions.

When Mountain Rose Herbs adopted a Zero Waste policy, it went from producing about 1,400 gallons of waste per month (a normal amount for a processor of their size) to about 80 gallons per month, equal to what most 4 person households generate.

Here is a brief list of what Mountain Rose Herbs does with its waste:

All office paper, pressboard and scrap paper is recycled

All metal and plastic drums are steam cleaned for re-use or are recycled

All cardboard and pressboard is recycled (and yes.... that includes toilet paper rolls)

All tin, steel and aluminum is sorted for collection

All scrap plastic including bottles, cords, straps, lids, pourers, etc are reclaimed by a local facility to be melted down into saleable material

All scrap metal, steel and iron is collected for melting

All wood and pallets are sent to be chipped for landscaping materials

Waste oil from bulk vegetable and carrier oils is collected for bio-diesel salvage

Botanical refuse material is collected for composting at local nurseries

Electronic and computer components are taken to a local facility for proper salvage and disposal, (preventing several known heavy metal sources from being land-filled)

All Styrofoam is sent to a re-claimer for re-use in shipping computers

All break room and staff waste is composted

All waste essential oil is collected for natural pest control products and for use in natural weed killers

Adapted from <http://www.mountainroseherbs.com/about/zerowaste.html>

Waste Reduction Resources

National

U.S. Environmental Protection Agency

Information on waste reduction, resource conservation, and disposal of hazardous wastes.

<http://www.epa.gov/osw/>

Industrial Materials Exchange

Like classified advertisements for business industrial waste, IMEX matches waste generators with waste users. <http://www.govlink.org/hazwaste/business/imex/>

California Integrated Waste Management Board

Sector specific information and resources on waste reduction.

<http://www.ciwmb.ca.gov/BizWaste/FactSheets/>

Reduce Your Waste

Identifies a waste profile based on industry type. Allows for users to enter specific details on their waste. Provides resources and guidelines for reducing waste.

<http://reduceyourwaste.org/StepOne.asp>

The Green Plan for the Food Service Industry

Fact sheets on reducing waste for the food service industry, including managing food materials, waste reduction, and donation of food. <http://www.p2pays.org/food/main/food.htm>

Oregon

Oregon Department of Environmental Quality (DEQ)

<http://www.deq.state.or.us/lq/sw/>.

Oregon Governor's Advisory Group on Global Warming

Briefing paper on the connection between global warming and materials/waste. Available at:

<http://www.deq.state.or.us/lq/pubs/docs/sw/Number09Materials.pdf>

Lane County

City of Eugene, Solid Waste and Recycling

Regulates garbage and recycling collection. Solid Waste and Recycling staff also provides educational opportunities and public outreach on waste prevention, recycling and composting.

Website: www.eugenerecycles.org

Lane County Waste Management.

Provides waste management services through disposal sites and the Short Mountain Landfill, emphasizing waste reduction and recycling programs. Special and Hazardous Waste programs offered.

Website: <http://www.lanecounty.org/Departments/PW/WMD/Disposal/Pages/sites.aspx>

Information on the “Less is Best” program for businesses available at:

<http://www.lanecounty.org/Departments/PW/WMD/Recycle/Pages/lessisbest.aspx>

CEG Program:

http://www.lanecounty.org/Departments/PW/WMD/HazWaste/Documents/CEGpacket_2006.pdf

NextStep Recycling.

Recycles computer hardware and other electronics, and provides educational outreach.

Website: <http://www.nextsteprecycling.org/>.

Eugene Free Recycle.

Uses e-mail to facilitate material reuse.

Website: <http://groups.yahoo.com/group/EugeneFreeRecycle/>.

Materials Exchange Center for Community Arts.

Material reuse hub, focusing on educational and artistic outlets.

Website: <http://www.materials-exchange.org/>.

BRING Recycling

Non-profit recycling center that provides conservation education and programming. They take electronic waste (computers, televisions, copiers, etc) mostly for free (charges for some items occur due to the handling hazards). Donations are tax deductible.

Website: <http://www.bringrecycling.org/>.

Food for Lane County: Food Rescue Express

The Food Rescue Express (FREX) Program repackages rescued food for distribution to food pantries and meal sites, contributing thousands of pounds of food to the emergency food system and preventing food from entering landfills.

Website: http://www.foodforlanecounty.org/index.php/programs/food_rescue_express/

Weyerhaeuser Recycling: 541-744-4119

ASW Disposal 541-485-4474

Lane Garbage/Apex Disposal: 541-479-5335 or <http://www.laneapex.com/>

Royal Refuse: 541-688-5622 or <http://www.royalrefuseservice.com/>

Sanipac: 541-736-3600 or <http://www.sanipac.com/>

Chapter Seven: Green Building

Key Learning Points

- Building operations account for a substantial proportion of energy use in the United States.
- The greatest source of GHG emissions from buildings comes from operation.
- “Green” buildings can result in energy savings and improve employee productivity.
- While some “greening” expenditures for new construction or renovation come with a cost, many pay for themselves in terms of energy and cost-savings in a short amount of time.

Introduction

Design, construction, and operation of buildings account for over 20% of the United States economy and over 40% of energy use and CO₂ emissions.¹³³ In addition, the United States Green Building Council (USGBC) found that buildings in the United States account for:

- 70% of electricity consumption;
- 40% of raw materials use;
- 30% of waste output (136 million tons annually); and
- 12% of potable water consumption.¹³⁴

Greenhouse gas (GHG) emissions derive primarily from energy used throughout the life of the building, but also from those embodied within building materials. (Embodied emissions may not be reflected in the greenhouse gas emission numbers above.) Thus the emissions come from the entire life cycle of a building—including raw materials extraction, product manufacturing, construction or renovation, operation and maintenance, and decommissioning.

According to the USGBC, green buildings are “designed, constructed, and operated to boost environmental, economic, health and productivity performance over that of conventional building.”¹³⁵ Reducing building emissions isn’t only good for the environment, but for business: research studies have shown that greener buildings improve worker productivity and health.^{136,137} For the United States, these productivity gains are estimated to accumulate savings close to \$200 billion.¹³⁸

Whether constructing a new office building or renovating an existing building, opportunities exist for implementing changes that reduce emissions, improve energy efficiency, and increase worker productivity. Green building may come with a 2% increase in costs, but typically pay for themselves in terms of energy and cost-savings in a short amount of time.¹³⁹

A pamphlet developed by the USGBC, Urban Land Institute and The Real Estate Roundtable argues that the top reasons for businesses to build green are:¹⁴⁰

- Lower operating costs

- Better employee productivity
- Enhanced health and well-being
- Reduced liability
- Reduced tenant costs
- Increased property value
- Access to financial incentive programs
- Recognition by communities (and customers)

Barriers to green building include a lack of life-cycle cost analysis and use, real and perceived higher upfront costs, insufficient research and funding for research on new technologies and benefits of green buildings, and lack of awareness.

Building Design

Before construction on a new building or remodeling begins, a team should identify clear targets for sustainability and low emissions. Of all the building generated emissions, the greatest portion

Going Green

The Jean Vollum Natural Capital Center in Portland, Oregon, is a 70,000ft² space of mixed office and retail tenants including Ecotrust, Progressive Investment Management, ShoreBank Pacific, the Certified Forest Products Council, the Portland Office of Sustainable Development, Hot Lips Pizza, World Cup Coffee, and Patagonia. The building is a renovated 1895 warehouse, which gained a LEED rating of Gold. Landscaping includes native species that don't require irrigation. The warehouse is located near bus and trolley lines, includes ample bike parking and few car spaces. Two Flexcars are on site and tenants can use showers and changing rooms in the building. The renovations included improving heating, cooling and lighting efficiency, recycling of building debris, salvaging or structural materials, use of sustainably grown certified lumber, and several water-saving features.

generally comes from operation and maintenance. Therefore, design buildings for energy efficiency, maximizing passive solar heating and cooling as well as daylighting (see the ENERGY section for more information).

If enhanced energy efficiency is possible, renovation of existing buildings can be the most sustainable approach, due to reductions in embodied energy and emissions of materials. Tips for improving the energy efficiency of an existing building are provided throughout this section along with tips for starting from scratch with the building design.

Another key consideration is ensuring the building will be long lasting and adaptable, so it can outlive the current occupants. Make sure it can be adapted to other uses and that materials used in its construction can be deconstructed, recycled and reused.

The *Whole Building* design (see Figure 1) consists of an integrated design approach and team process, which draws from all stakeholders' knowledge across the life cycle of the project, from determining the purpose of the building, through planning, design, construction, and operations."¹⁴¹

This approach relies on collaborations between stakeholders to leverage design strategies that will achieve multiple benefits, with the intention of producing a much more energy efficient and cost-effective building than could otherwise be produced. Discussed below are specific tips for consideration in the design, construction and maintenance phase of buildings.



Figure 1. From Whole Building Design Guide http://www.wbdg.org/wbdg_approach.php

Site Selection Considerations

According to an article in Environmental Building News, “For an average office building in the United States, 30% of energy is expended by workers getting to and from the building than the building itself uses.”¹⁴² This demonstrates the importance of consideration for the transportation energy intensity

Transportation energy intensity. The amount of energy required to get employees, vendors, and customers to or from a building.

of a building: location and design of the structure should aim to encourage employee use of alternative transportation. If your business is constructing a new office building, site selection is likely one of the first considerations. The building location has a great impact on design, construction, emissions generation, and worker productivity. For instance, an energy efficient building constructed from recycled materials, but located 20 miles outside of town, may produce fewer direct emissions from the building itself, but will increase employee commuting emissions. The following topics are considerations for your planning team to evaluate for their costs and benefits.

Commuting. As discussed in the transportation section, employee commuting contributes significantly to carbon emissions and can also cost your company in lost productivity. The optimal workplace for encouraging the use of alternative transportation will:

- Locate within a ½ to ¼ mile of existing, planned or funded commuter rail, light rail, bus lines or subway;
- Provide bike storage, showers and changing rooms, if facilities allow;
- Offer preferred parking for low emitting, fuel efficient vehicles or carpools;
- Consider allowing for flexible schedules and/or telecommuting for employees to reduce commuting time and its associated emissions;

- Raise the costs and reduce the convenience of parking.

Impact on Surrounding Habitat. Buildings convert wildlife habitat and have large impacts on the surrounding ecosystem, which in some cases leads to greenhouse gas emissions through release of carbon stored in disturbed soils or removal of carbon absorbing trees. Replacing native vegetation or trees with plants or turf with high water dependency also contributes to emissions (see the discussion on water below). Design, construction and maintenance of buildings can reduce their impact on habitat, lower water use, and reduce the urban heat island effect (for more on the heat island effect see the ENERGY Section). The following tips can be implemented for new or existing buildings.

- Reduce the amount of ground space the building occupies;
- Construct vegetated or open space adjacent to the building that is equal in size to the building ‘footprint’ and that provides shading to reduce the heat effect and cooling demand;
- Plant native or drought-tolerant plant species to reduce water use;
- Plant coniferous trees to the north to act as winter windbreaks, reducing heating demands;
- Plant deciduous trees to the south and west to provide shading and reduce cooling;
- Protect existing plants, trees and topsoil during construction;
- Use recycled water (greywater) or harvested rainwater for irrigation or use landscaping that does not require irrigation to reduce need for water filtration and pumping;
- Use a storm water design that reduces impervious cover and increases on-site infiltration to decrease the need for pumping and filtering water.
- Use light colors for the roof and sidewalks and add shade elements to reduce the heat island effect and the building’s need for air conditioning.

Construction Waste

Costs for construction waste management vary depending on building location, but are typically low for urban projects. Before beginning construction, ensure that you select a construction manager that is well versed in using recycled materials and dealing with waste from the project.

Choosing Building Materials

Recycled materials

Recycled and recyclable materials can typically be purchased at low cost, and along with salvaging material from other construction projects may actually result in material cost savings. Materials with recycled content include steel (manufacturers often have as much as 50% reclaimed steel)¹⁴³, some gypsum board products, some cellulose insulation, tile made from ground glass, and recycled plastic lumber.

Certified materials

Choosing products that have gained third-party certification for their sustainable attributes can be (although are not necessarily) better for the climate. For example, wood products can be certified as sustainably grown by a third party such as the Forest Stewardship Council (FSC). Forests, which absorb and store carbon dioxide, contribute to climate change when logged due to the carbon dioxide released to the atmosphere from decaying vegetation, disturbed soil, and burning trees. (Wood products do store carbon until they decompose.) Wood grown in a sustainable manner can be less depleting of carbon sinks (where carbon dioxide is stored) than wood harvested unsustainably, because the land is required to be reforested instead of potentially being converted to other uses.^{144,145} Certified wood can be more expensive than non-certified wood and difficult to find.

Local materials

Turn to local manufacturers for your recycled, renewable and certified products first. If recycled, renewable or certified products aren't available, look for locally made materials to reduce transportation emissions.

Salvaged materials

Salvaging materials from demolition sites can save you money and prevent materials from going to the landfill. However, when using salvaged materials such as lumber, millwork, plumbing fixtures, windows, toilets, or hardware, for example, make sure the materials are safe and that they don't compromise energy or water efficiency, as most of the energy used in buildings comes from operation rather than construction and the energy embodied in materials.

Low lifecycle emission materials

Ask about the lifecycle emissions of the materials you use and seek out those with low-embodied emissions and low toxicity. Concrete has very high amounts of greenhouse gas emissions associated with its production. "Rapidly renewable" materials such as cork, straw, and bamboo quickly convert carbon dioxide into biomass. These materials regenerate in less than ten years. On the other hand, bamboo and cork are often grown in other countries and must be imported, increasing transportation-related emissions.

Durable materials

Save money in the long run and decrease embodied emissions by avoiding frequent replacement and waste: a product that lasts longer or requires less maintenance usually saves energy. For example, if re-roofing with asphalt composite, consider a forty-year roof instead of the standard twenty-year roof.

Don't dump construction waste

For new construction, remodeling, or "spring cleaning" in the office, ensures that waste disposal is avoided as much as possible by identifying a site for collecting recyclable equipment and materials. More ideas for waste diversion can be found in the WASTE section.

Renovations

When renovating existing buildings, maintain materials that can be reused, including structure, building envelope and elements. This will save on embodied emissions (and costs) associated with

new materials. Remove elements that may be hazardous and upgrade to improve energy and water efficiency.

Additional Considerations for New and Renovated Buildings

Size Matters

Bigger buildings require more materials, more space to be heated or cooled, and allow for more room to fill with products, some high in embodied emissions. Optimize your building space so that minimal materials are used in construction and operation. Building small can free up costs for higher quality materials. Small can be beautiful and results in more interactions between employees!

Building Energy Efficiency

Lighting, heating and cooling are huge draws of energy, as noted in the Energy Section.

- Maximize daylighting and insulation.
- Select high efficiency lighting, heating and cooling equipment.
- Ensure that a new building's HVAC system does not use CFC-based refrigerants; for existing buildings, develop a plan for switching these out.
- Consider passive solar heating and cooling. Passive solar heating/cooling refers to the design of structures or components to absorb, reflect, or otherwise channel the sun in more efficient ways. This in turn reduces the need for mechanical applications, further decreasing energy consumption. Overhangs on the south facing portion of the roof allow winter sun to enter, while in the summer months, when heat is typically unwanted, the sun is blocked. Furthermore, various types of heat absorbing materials can be employed to more efficiently capture the sun's heat. These materials are typically dense and include common mediums such as concrete and stone. Walls and floors filled with water or other heat retaining liquids are also utilized.

Water

Water use requires energy for pumping and filtration. In California, for example, “water-related energy use consumes 19 percent of the state’s electricity, 30 percent of its natural gas, and 88 billion gallons of diesel fuel every year.”¹⁴⁶ This much energy is not used to deliver potable water in every state, but regardless of the energy intensity of your water use, by reducing your facility’s water consumption, you’ll save on utility bills and reduce whatever emissions are generated through the distribution and treatment of water. Moreover, reductions in electric or gas-heated hot water use will save energy and money used for heating that water.

- Install low flow toilets, faucets and showers and consider waterless urinals.
- Educate staff about reducing water consumption in the bathrooms and kitchens.
- Install grey water reuse or rainwater catchments systems for toilet flushing and irrigation.
- Plant native or low-water consuming plants and limit irrigation to early morning or late evenings, if at all. Consider water-efficient systems such as drip irrigation.

- Consider installing solar water heaters, for which incentives can usually be obtained from your utility provider. These systems can be installed on almost any type of building. Because water usage is fairly low for office buildings, solar water heaters are typically used on commercial apartment buildings that heat swimming pools or for Laundromats.

Onsite Renewable Energy

On-site generation of renewable energy, typically through the installation of photovoltaic panels, can have high upfront costs. However, many of these systems come with strong local and state incentives and can pay for themselves in as few as 5 years, depending on the size of the system and the incentives available. After this point, all energy produced is “free” and if net metered can be sold to the utility, in some cases resulting in profit. If onsite construction of renewable energy is not feasible, renewable energy can typically be purchased off-site for a reasonable price as part of the building’s operating costs.

Education

Use the building design and construction to educate your staff, customers and suppliers on the environmental impacts of buildings and how to minimize these impacts.

Case Study: Pepsi-Cola's PV Paneling:

In 2007, the Pepsi-Cola Bottling Company in Eugene, Oregon, installed a 252 kW solar electric system. Each year, the system generates 281,900 kWh of energy. Over its lifetime, the system will save the equivalent of 760,000 gallons of gasoline. Between January and July of 2008, the system prevented 232,030 in CO₂ emissions, equivalent to generating power for over 3,700 homes in a day and the emissions from the average car driven for over 8,400 days. The Eugene plant has also been using biodiesel for their delivery trucks, and is working with their utility, EWEB, to install energy-efficient lighting control systems.

In 2004, the Pepsi company also installed a 3 part 172 kw system in Klamath Falls, making them the first commercial net zero energy business buildings in Oregon. The company was attracted to solar installation through a combination of tax credits, financial incentives, and low-interest loans, as well as the ability to eliminate their electric bills. According to Energy Trust of Oregon, "The package of incentives and tax credits that closed the deal for the Bocchi family included \$210,000 in financial incentives from Energy Trust of Oregon, Inc., \$444,412 in Business Energy Tax Credits from the Oregon Department of Energy, an accelerated state and federal tax depreciation schedule and a financing package from the Oregon Energy Loan Program."¹⁴⁷ With tax incentives, utility incentives, and energy production a PV system in Oregon can pay for itself in 5-6 years. According to solar installers, Advanced Energy Systems, beyond the initial payback period, the energy generation far outweighs the maintenance cost.¹⁴⁸

Case Study: Southcenter Double Tree Inn Material Salvaging

Built in the late 1960s, the two-story, 200-room Double-Tree Inn was located next to Westfield Southcenter (formerly Southcenter Mall) in Tukwila, WA. Westfield Corporation acquired the property and contracted with PDG, Inc., to conduct asbestos abatement and then demolish the hotel and meeting facility. Before granting the demolition contractor access to the building, Westfield permitted American Development Company to conduct some non-structural deconstruction and salvage activities at the hotel.

Nearly 34 tons of cedar lumber and other materials were salvaged from an extensive trellis that was removed from the exterior of the hotel.

An additional six tons of cedar siding and other lumber was recovered from the building's exterior.

Interior woodwork, including paneling, beams, poles, and trim, yielded an additional 18 tons of salvaged materials.

Reusable items were gathered from hotel rooms included mirrors, sinks, faucets, and countertops - totaling nearly seven tons.

More than a ton of miscellaneous material was also salvaged, including door hinges, stair treads, grab bars, cabinets, lights, and two large skylights.

In all, more than 66 tons of used building materials were salvaged from the hotel, including over 36,000 board feet of lumber representing an estimated value of more than \$10,000, in addition to the savings on disposal fees.

From "Deconstruction Case Study" King County Department of Natural Resources and Parks
http://www.metrokc.gov/DNRP/swd/greenbuilding/documents/decon_southcenter.pdf

Green Building Resources*

*CLI does not endorse any of the businesses listed below, but provides them for resources

National Green Building Resources

EPA: eeBuildings

Resources for improving energy efficiency in buildings.

http://www.epa.gov/eebuildings/energy_savings/detail/index.html

Green-e

Green Incentives and Certified Renewable Energy Distributors for Buildings

www.green-e.org

Buildinggreen.com

Variety of resources on design, construction, LEED, and project examples.

Website: www.buildinggreen.com

“Understanding carbon footprints of buildings”

Website: <http://www.buildinggreen.com/auth/article.cfm/2008/6/27/Counting-Carbon-Understanding-Carbon-Footprints-of-Buildings/>

“Checklist for green construction”

Website: http://www.buildinggreen.com/ebn/sample/EBN_Checklist.pdf

United States Green Building Council

Links to government and state incentives

Website: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1779>

Construction Carbon Calculators

Build Carbon Neutral

Combines on-site energy use with data on the CO₂ emissions in the materials drawn from the Athena Institute’s Impact Estimator for Buildings and from estimates of carbon released from soils during construction.

Website: www.buildcarbonneutral.org

The Athena Impact Estimator for Buildings

A software package that provides life-cycle data on materials with an option to enter operating energy use to calculate an integrated, whole-building total for greenhouse gases and other environmental impacts. Pricing runs from \$230 to \$600.

Website: www.athenasmi.ca

The Whole Building Design Guide

Provides references for building design, relevant building codes and standards, resources for products and tools, links to relevant federal publications and agencies, and publications on green building.

Website: <http://www.wbdg.org/design/sustainable.php>

Oregon Green Building Resources

Solar Power Provider Directory

Website: <http://www.solaroregon.org/find-a-professional/solar-contractor>
<http://www.solarpowerdirectory.com/city/EugeneSolarPower.html>

Oregon Green Building and Solar Energy Resources

Website: <http://www.oregon.gov/ENERGY/RENEW/Solar/Tour/docs/G-SMag87.pdf>
http://www.oregon.gov/OHCS/DO_GreenBuilding.shtml

The City of Eugene

Information on green-building basics, permits, and local demonstration projects. www.eugene-or.gov/greenbuilding

The City of Portland's Green Building Program

Oregon and Portland resources, including a green building database. Green-building guides for housing, workspaces, and low-income housing. www.portlandonline.com/osd/index.cfm?c=ebeib
www.portlandonline.com/osd/index.cfm?c=42168

Energy Trust

Incentives and Opportunities for Businesses in Oregon
<http://energytrust.org/business/>

City of Portland

Resource for salvaged building materials.
<http://www.portlandonline.com/osd/index.cfm?c=41965&a=113177>

Cascadia Green Building Council

Fact sheets, links and case studies on green building <http://www.cascadiagbc.org/>

Chapter Eight: Becoming Emissions Free

Key Learning Points

- Benefits from emissions reductions include cost savings, improved brand image, and enhanced relations.
- Teamwork and innovation will progress efforts in reducing emissions.
- Set big goals, but start with small changes.
- Complete organizational change strategy may be needed.

Introduction

Developing a change strategy that includes a clear vision, goals and methods will increase your chances for a successful transition to an emissions-free or “zero emissions” business model. A well-executed change strategy will bring new energy to your business while enabling you to achieve your goals. Without a strong organizational change strategy, your energy and resource efficiency projects may experience some success, but are more likely to be short-lived or cast to the wayside. This section integrates some key components of organizational change into the framework of developing a climate action plan. While the tools described below can be used for any type of sustainability planning, we focus specifically on reducing greenhouse gas emissions. For more on organizational change, please see the titles listed in the Resources section of this chapter.

Tool 1: Commit to Change

Participants in the Climate Masters at Work program belong to organizations that have already committed to some level of sustainable practices by virtue of committing staff time to reducing greenhouse gas emissions. Likely, this is one of many steps your organization has taken towards a mental model that recognizes the boundaries of our natural systems and aims to act within them.

However, if your business’s commitment to sustainability does not reach much further than complying with regulations or industry standard, it could be difficult to make the shift needed for significant progress towards real emission reductions. In its strongest form, a commitment should include management and other leaders as well as staff at every level. This could be initiated by a single leading figure bringing up the topic with management, it could originate from the top and be conveyed with consistent communication to the rest of the organization, or it could be in response to a crisis like bad publicity.

Without this commitment and a move away from business-as-usual thinking, it is unlikely that much progress will be made on a climate action plan or any sustainability effort. The most successful efforts will take place within an organizational culture that has embraced sustainable thinking.

Tool 2: Organize a Team or Teams

Identifying a diverse team of individuals to provide oversight and guidance to the process of emission reduction planning and action will strengthen the effort by broadening the number of staff and departments closely involved, by putting more person-power into the effort, and by publicizing that your business takes this effort seriously.

Who should be involved? The most effective transition teams to craft the foundation of a whole different business model will include staff at all levels and representing a variety of departments.

Bringing in new people onto the planning team will lead to the airing of different ideas and perspectives and potentially will assist you in tackling problems that the old decision makers or planners might not have seen. A team that is small, yet representative of your entire company is usually most effective. Consider including employees that hold positions such as senior staff, management, administrative, warehouse, and tech. You may also want to include a representative of the board, shareholders or customers/clients. As new initiatives develop, new teams or subcommittees can be formed to tackle those topics.



It is crucial that teams be clear on their goals, people's role on the team, and the guidelines they are operating within to achieve their mission.

Tool 3: Set Ambitious Visions and Targets

Sustainability efforts often fail when businesses drain all of their energy, time and money capturing the low-hanging fruit, like changing out light bulbs, without a bigger vision to work towards, such as “achieve net zero emissions in ten years.” Many organizations use “ends planning” or “backcasting” to successfully achieve sustainable development. This technique involves first crafting an inspiring vision of an ideal future, followed by designing the processes to reach those future conditions. One example of a tool for goal setting is called Appreciative Inquiry (AI). AI and similar processes draws people away from problem solving based on the current situation, which can close off the path to innovation and the big picture thinking needed to draw close to an ambitious target like net zero GHG emissions. Instead, AI focuses on bringing about new ideas and desires. (A link to more information on AI can be found in the Resources portion of this section.)

To form an exciting vision, brainstorm what your organization would look like and how it might operate if it were completely sustainable. Consider the qualities of the products or services you would provide and the way in which your business would operate if it were to, for example, have no net greenhouse gas emissions. Try to align your emission reductions goals with your business strategy and identify goals that will provide new opportunities for your business. Sustainability author, Bob Doppelt, writes, “Compelling visions are felt in the heart and understood in the mind.”

Once you have laid out your vision for 10 or so years into the future, begin working backwards from there. If your products and services are to have no emissions in the next decade, what is the closest approximation to the ideal that you can achieve in three or four years? What can you do today towards reaching that goal? See the Desired Futures chart in Appendix Ten for an example of how your company may implement ends planning.

Tool 4: Develop New Strategies, Tactics and Plans

Now that you know what you are working towards, you'll need new strategies, tactics and plans to move you towards that ideal vision. While the visioning process laid out the big picture of where you want to be, this step involves setting our specific goals for the next few years.

Embracing Change

From Bob Doppelt, "Overcoming the Seven Sustainability Blunders."

In the early 1990s, the Xerox Corporation adopted the vision of becoming "Waste Free." The vision catalyzed profound changes in operations all the way back to the initial designs of major product lines. The strategies required decentralized decision-making, which helped to dramatically increase employee morale and commitment. By the end of 2001, the initiative had led to the reuse or recycling of the equivalent of 1.8 million printers and copiers. It also resulted in several billion dollars of cost savings, as well as dramatic improvements in all environmental areas.

- Assess your starting point.* Your initial audit, or assessment, should consider direct and indirect emissions from your business- what is created, where are the sources, and how much is being produced. See the section on CONDUCTING A GHG INVENTORY for more information on that process. You may also want to consider other factors, such as the ways in which your organization communicates around initiatives such as this one as well as other social and environmental impacts of your organization.
- Set ambitious goals with set timelines.* Your goals will require innovative thinking and strong management, but they should also stretch the organization while being within the realm of reason. You could start with establishing an initial reduction goal for the entire company, or focusing on a particular sector of your business. For instance, Sony set a goal of reducing CO₂ emissions by 7% between 2000 and 2010, and by 2008 had already achieved a 9% reduction.¹⁴⁹ Johnson & Johnson focused on reducing emissions from their fleet, bringing on over 1000 hybrid vehicles, which reduced emissions by 30%.¹⁵⁰ Also, be sure to set *both* short- and long-term goals: becoming emissions free means changing human behavior and thinking, both of which can take time.
- Form change strategies to move you towards your goals.* It may require changing your form of governance to integrate sustainability across your entire organization. See "Embracing Change" on this page for an example.
- Choose evaluation methods.* You will want to assess and communicate your successes and learn from your failures. In order to do so, you will need a means for evaluating your progress. You can use the GHG inventory developed for the CMW program, or you may choose to use another form for tracking your GHGs and other sustainability indicators.

Tool 5: Communicate relentlessly



The transition to an emissions-free business model will require substantial changes in thinking and operations, both of which are dependent on commitment from the masses. For success, you will need the commitment and support from employees, board members, customers, suppliers, distributors, and shareholders. Your program will be stronger if representatives from all of these stakeholder groups are included on an ongoing, consistent basis. Once they are established, talk about the vision, goals and strategies at every staff meeting, in every

memo, every lunchtime brownbag, until everyone involved with the organization internalizes them and feels a personal connection to the vision and progress towards that vision.

Branch out and share your goals with others. Like someone trying to cut down on food consumption, it helps to share your goals for reducing your energy consumption with others in order to help you stay on track. Report on your successes and failures, and evaluate what is working and where changes are needed. By reporting to other companies, you can share strategies for achieving your goals faster and cheaper. Reporting to shareholders or customers will increase transparency about your goals and achievements and help hold you accountable for ensuring these goals are met. By telling the world your goals and achievements, you'll receive the support and feedback you need to get there. Set up an "emissions reduction" section on your website, send emails to customers, describe your efforts in your annual report, and promote your efforts in your mailings and other advertisements.

Tool 6: Continue to Learn and Recognize Achievements

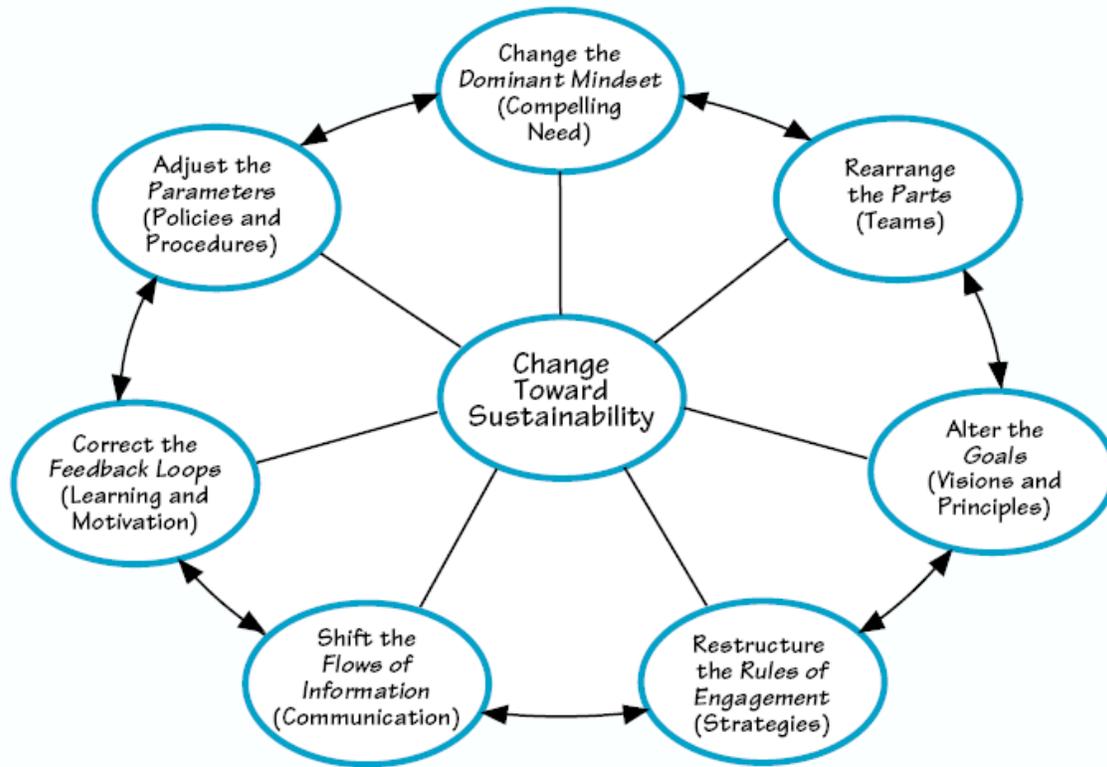
Reward learning and accept mistakes. New technologies and ideas are always coming down the line. Try things out to see how your employees, customers, and shareholders react. Give new ideas time, but if they don't work, try something new. Provide incentives for employees, and even customers and board members, to continuously learn and to develop their own ideas on how to become emissions free at work and in their own life. Some ideas won't work and some goals may not be reached, but don't let little frustrations prevent your company from moving forward. Use reports and ongoing evaluations to guide your business in a new direction.

Tool 7: Embed New Thinking in Standard Operating Procedures

As the organization moves towards new ways of thinking and acting, the systems and structures will need to incorporate these shifts. For example, new hires and promotions might be based in part on the ways in which employees have integrated sustainable thinking into their actions. Guiding principles for selecting suppliers and distributors may be needed.

This part of the process, and others, will be continual, rather than a task with a set beginning and end. As the organization moves forward, there will be constant reassessment, learning, innovation and visioning. Figure 1 below provides a visual rendering of the tools described in this section, highlighting the fact that this process is not linear, but rather the tools will need to be revisited time and time again during your organization's journey towards a more sustainable future.

THE WHEEL OF CHANGE TOWARD SUSTAINABILITY



The “Wheel of Change Toward Sustainability” shows how the seven interventions interact to form a continuous reinforcing process of transformation toward sustainability.

Figure 1: Bob Doppelt, “Overcoming the Seven Sustainability Blunders.” *The Systems Thinker*, Vol 14(5) <http://www.greenleaf-publishing.com/content/pdfs/systhink.pdf>

Climate Action Planning Resources

General References

ClimateBiz.com

Offers information about the economic benefits of reducing GHG emissions.

Website: <http://www.climatebiz.com/research/report/2005/12/05/no-reason-wait-benefits-greenhouse-gas-reduction>

Pew Center on Global Climate Change

Information on the Business Environmental Leadership Council, which seeks to engage businesses in finding solutions for the climate crisis.

Website: http://www.pewclimate.org/companies_leading_the_way_belc/ghg_strategies/

The Climate Group

A nonprofit dedicated to advancing business and government leadership on climate change.

Website: <http://www.theclimategroup.org>

EPA Climate Leaders

The Climate Leaders is an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies. Partner companies commit to reducing their impact on the global environment by completing a corporate-wide inventory of their greenhouse gas emissions based on a quality management system, setting aggressive reduction goals, and annually reporting their progress to EPA. Through program participation, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders.

Website: <http://www.epa.gov/climateleaders/>

Organizational Change

Appreciative Inquiry

Information on a technique for developing emission reduction goals.

Website: <http://www.new-paradigm.co.uk/Appreciative.htm>

Books

Doppelt, Bob. *Leading Change Toward Sustainability: A Change-Management Guide for Business, Government and Civil Society*. Greenleaf Publishing, 2003.

Beer, Michael and Norhia, Nitin *Breaking the Code of Change*. Boston: Harvard Business School Press, 2000

Appendix One. Conducting an Energy Audit, Setting Goals and Transitioning to Reduce Energy Emissions and Expenditures

**For a detailed energy assessment, please visit the Lane County Resource Efficiency Took Kit at: http://www.lanecounty.org/PW_WMD_Recycle%5Cdocuments%5CResourceEfficiencyTOOLKIT.pdf (pgs. 28-35). This resource breaks up the assessment by lighting, HVAC, etc. Opportunities for improving efficiency in your facility are also provided.*

Current Practices	Desired Future (10-20 year goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What kind of power systems does my operation need/depend on? How much of my energy use is electric, natural gas, oil, propane, other? • What are my biggest sources of energy consumption? (e.g., refrigeration, lighting, heating) • What design features do I have in my facility to improve energy conservation? • Are my appliances energy efficient? • Who is accountable for energy use? • Do I have established targets? • Have my workers been trained in energy-saving operating techniques? • What are my green house gas emissions? 	<p>Describe your ideal future.</p> <ul style="list-style-type: none"> • Eliminate dependency on diminishing non-renewable sources and/or polluting sources, including fossil fuels (i.e., oil, coal). • Create ‘closed loops’ such as production of regional renewable energy to mitigate risk of supply disruption. • Use only high efficiency processes and equipment. • Facility designed to maximize energy conservation (i.e., insulation, timers, variable frequency devices) • Employees engaged in energy conservation and committed to achieving targets. • Become carbon neutral (zero net greenhouse gas emissions). 	<p>The following are transition options that can support your work toward the ideal future:</p> <ul style="list-style-type: none"> • Seek energy-efficient facilities in future purchases/leases • Sign up for renewable energy credits with your local utility • Utilize local, state, and federal government incentives for improving efficiency and switching to renewable power. • Ask your local utility to perform an audit of energy practices at your facility. Make recommended improvements. • Assign a team or employee to champion energy improvement efforts. • Conduct employee training on efficient energy use. • Set targets and measure energy use • Measure your greenhouse gas emissions. Purchase carbon credits to offset emissions while transitioning to other power sources.

Appendix Two. Fluorescent tubes and ballasts.

Technical improvements in fluorescent tubes and electronic ballasts have dramatically boosted the energy efficiency of linear fluorescent lighting systems. Fluorescent tubes can be purchased to meet your lighting and design requirements, as they are available in a variety of lengths, diameters, and with different light characteristics. According to Flex Your Power, to ensure the efficient lighting energy performance, the fluorescent tube must match the ballast (the device that modifies a building’s power for the fluorescent tube). Ballasts are available in magnetic or electronic models. The more-modern electronic ballast, matched with an efficient fluorescent tube, can reduce the energy cost as much as 50%. One of the most common ways to save significant energy is upgrading T12 lamps with magnetic ballasts, found in most buildings, to T8 lamps with electronic ballasts. Many manufacturers offer T8/electronic ballast combinations. (The designation T12 or T8 refers to the size of the lamp.) The chart below was developed by the U.S. Department of Energy’s Federal Energy Management Program (FEMP) to illustrate energy and cost savings of efficient fluorescent/ballast combinations. According to the DOE, the best available lighting system could provide energy savings of over 30% when used to replace a conventional system of two lamps plus a ballast. Simpler replacements can also generate great savings.

Cost-Effectiveness Example			
Performance	Base Model	Recommended Level	Best Available
Lamp and Ballast Type	T12, 34 watts, magnetic ballast	T8, 32 watts, electronic ballast	T8, 32 watts, electronic ballast
Rated Lamp Output — 2 Lamps	5300 lumens	5600 lumens	6000 lumens
Actual Light Output with Ballast (a)	4738 lumens	5018 lumens	5256 lumens
Input Power	82 Watts	62 Watts	57 Watts
Annual Energy Usage	295 kWh	223 kWh	205 kWh/td>
Annual Energy Cost	\$17.70	\$13.40	\$12.30
Annual Energy Cost Savings — 2 Lamps + Ballast	-	\$4.30	\$5.40
Annual Energy Cost — 2 Lamps Only	-	\$1.30	\$1.80
Lifetime Energy Cost Savings — per Lamp (b)	-	\$2.80	\$3.90

(a) Not including fixture performance, which affects total light output from the luminaire.
 (b) Lifetime energy cost savings is the sum of the discounted value of annual energy cost savings based on average usage and an assumed lamp life of 5 years. Future energy price trends and a discount rate of 3.4% are based on federal guidelines (effective from April 2000 to March 2001).
 Cost-Effectiveness Assumptions: Usage assumption is 3,600 operating hours/year. Assumed electricity price: \$0.06/kWh, the Federal average electricity price in the United States.

Source for information and chart: US Dept. of Energy and Flex Your Power
http://www.fypower.org/com/tools/products_results.html?id=100212

Appendix Three. Carbon Dioxide Equivalents

(Adapted from Power Engineering http://pepei.pennnet.com/display_article/313217/6/ARTCL/none/none/1/Conducting-a-Greenhouse-Gas-Emission-Inventory/)

The scientific community recognizes that not all GHGs are equal. A parameter called “global warming potential” (GWP) was defined to compare the different GHGs to each other with respect to potential harm to the atmosphere. GWP is defined by the World Resources Institute as “A factor describing the radiative forcing impact (in other words, degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO₂”. GHG emissions are converted to CO₂ equivalents (CO₂-e) by multiplying the quantity of a specific GHG by its GWP. So, by definition, the GWP of CO₂ is 1.0. An example of how emissions for a hypothetical business are converted to CO₂-e is in Table 1 below.

Table 2. An example of how emissions are converted to CO₂-e and global warming potential for common GHGs

GHG	Emissions (Metric Tons)	Global Warming Potential	Metric Tons CO ₂ -e
Carbon Dioxide	10,000	1	10,000
Methane	500	21	10,500
HFC 134a	1.0	1300	1300
Sulfur hexafluoride	0.06	23,900	1434
Totals			23,234

The example is for illustrative purposes and not representative of a typical company.

Appendix Four. Transportation Desired Futures Chart

Current Practices	Desired Future (10-20 yr goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What are your employee commuting practices? How do we promote and offer incentives for alternatives to single-passenger vehicles?? • What types of vehicles are we using in our fleets, and how are they selected? What percent of our emissions come from our fleets? What types of driver training or maintenance requirements do we have to cut down on emissions? • How are we combining and minimizing fleet and business travel? • How is business travel contributing to our emissions? • Are our offices equipped for video and teleconferencing? • Are we using alternatives to travel, such as teleconferencing? • Do we offer opportunities for flexible schedules, telecommuting? 	<p>Describe your ideal future:</p> <ul style="list-style-type: none"> • Employees are commuting from home, or using bikes and public transportation to come to the office. • All offices are equipped with systems for videoconferencing. Travel is cut down to a minimum and meetings are held via video or phone. • Fleets are purchased based on efficiency and low-emissions. Drivers are trained for safe travel and proper vehicle maintenance. Alternative fuels are used in vehicles and routes are minimized. 	<p>Describe transition options to work toward the ideal future:</p> <ul style="list-style-type: none"> • Develop incentive packages for telecommuting, use of vanpools/carpools and biking. Install bike racks and look at opportunities for installing showers. • Purchase/subsidize transit passes for employees. • Apply for tax credits for annual transit passes for employees. • Provide an area for commuters to connect and share rides. • Apply for tax credits to purchase video and teleconferencing equipment. • Minimize in-town business travel and use bike peddlers. • Meet with your travel agency to set restrictions on travel (e.g. lowest number of stopovers, promotion of rail over plane, automatic offset charge for tickets, etc). • Install GPS navigation systems in fleets to find most direct routes. • Develop a company policy for business travel and set restrictions on trips.

Appendix Five: Zero Waste Desired Futures Chart

Current Practices	Desired Future (10-20 yr goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What steps have we taken to reduce our waste? • What items that we produce are we reusing? • What items that we buy are refurbished or previously owned? • What percent of our waste are we currently recycling? • What items are we currently recycling? • What items could we reuse, buy refurbished or recycle that we are currently buying new or disposing of? • What actions have we taken in our supply, production and distribution chain to reduce waste? • What incentives do we offer staff / customers to reduce waste? 	<p>Describe your ideal future:</p> <ul style="list-style-type: none"> • Implement a zero waste policy • Support from employees and customers on zero waste policy • Established relationships with suppliers and distributors to reduce waste throughout the entire supply chain, including waste generated by other businesses 	<p>Describe the transition options to work toward the ideal future:</p> <ul style="list-style-type: none"> • Identify processes that generate waste or use materials inefficiently. Then estimate the volumes and communicate the numbers. • Consider incentives for staff and / or customers to reduce waste and reuse items (e.g. reward staff for using refurbished office equipment; provide incentives for customers to bring in their own bags). • Talk with your suppliers and distributors to reduce packaging or replace current shipping containers with reusable containers • Track your waste reduction programs and continually adjust and adapt to meet new goals. • Educate staff and customers about waste reduction efforts. • Talk to your city or county waste disposal department about efforts your company can take to reduce waste. • Identify items that can be purchased in bulk or without packaging. • Develop standard opportunity procedures that reduce unnecessary printing and set a double-sided printing standard

Appendix Six: Sample Zero Waste Business Principles

(Developed by the Grassroots Recycling Network)

Your business may want to consider adopting these principles, or developing your own set of guiding principles that will assist you in your transition to a zero waste business.

From: <http://www.grrn.org/zerowaste/business/index.php>

These **Zero Waste Business Principles** establish the commitment of companies to achieve Zero Waste and further establish criteria by which workers, investors, customers, suppliers, policymakers and the public in general can assess the resource efficiency of companies.

- *Commitment to the triple bottom line* - We ensure that social, environmental and economic performance standards are met together. We maintain clear accounting and reporting systems and operate with the highest ethical standards for our investors and our customers. We produce annual environmental or sustainability reports that document how we implement these policies. We inform workers, customers and the community about environmental impacts of our production, products or services.
- *Use Precautionary Principle* – We apply the precautionary principle before introducing new products and processes, to avoid products and practices that are wasteful or toxic.
- *Zero Waste to landfill or incineration* – We divert more than 90% of the solid wastes we generate from Landfill and Incineration from all of our facilities. No more than 10% of our discards are landfilled. No mixed wastes are incinerated or processed in facilities that operate above ambient biological temperatures (more than 200°F.) to recover energy or materials.
- *Responsibility: Take-back products & packaging* - We take financial and/or physical responsibility for all the products and packaging we produce and/or market under our brand(s), and require our suppliers to do so as well. We support and work with existing reuse, recycling and composting operators to productively use our products and packaging, or arrange for new systems to bring those back to our manufacturing facilities. We include the reuse, recycling or composting of our products as a design criteria for all new products.
- *Buy reused, recycled & composted* - We use recycled content and compost products in all aspects of our operations, including production facilities, offices and in the construction of new facilities. We use LEED-certified architects to design new and remodeled facilities as Green Buildings. We buy reused products where they are available, and make our excess inventory of equipment and products available for reuse by others. We label our products and packaging with the amount of post-consumer recycled content and for papers, we label if chlorine-free and forest-friendly materials are used.
- *Prevent pollution and reduce waste* – We redesign our supply, production and distribution systems to reduce the use of natural resources and eliminate waste. We prevent pollution and the waste of materials by continual assessment of our systems and revising procedures, policies and

payment policies. To the extent our products contain materials with known or suspected adverse human health impacts, we notify consumers of their content and how to safely manage the products at the end of their useful life.

- *Highest and best use* – We continuously evaluate our markets and direct our discarded products and packaging to recover the highest value of their embodied energy and materials according to the following hierarchy: reuse of the product for its original purpose; reuse of the product for an alternate purpose; reuse of its parts; reuse of the materials; recycling of inorganic materials in closed loop systems; recycling of inorganic materials in single-use applications; composting of organic materials to sustain soils and avoid use of chemical fertilizers; and composting or mulching of organic materials to reduce erosion and litter and retain moisture.
- *Use economic incentives for customers, workers and suppliers* – We encourage our customers, workers and suppliers to eliminate waste and maximize the reuse, recycling and composting of discarded materials through economic incentives and a holistic systems analysis. We lease our products to customers and provide bonuses or other rewards to workers, suppliers and other stakeholders that eliminate waste. We use financial incentives to encourage our suppliers to adhere to Zero Waste principles. We evaluate our discards to determine how to develop other productive business opportunities from these assets.
- *Products or services sold are not wasteful or toxic* – We evaluate our products and services regularly to determine if they are wasteful or toxic and develop alternatives to eliminate those products which we find are wasteful or toxic. We evaluate all our products and offer them as services whenever possible. We design products to be easily disassembled to encourage reuse and repair. We design our products to be durable, to last as long as the technology is in practice.
- *Use non-toxic production, reuse and recycling processes* – We eliminate the use of hazardous materials in our production, reuse and recycling processes, particularly persistent bioaccumulative toxics.¹⁵¹ We eliminate the environmental, health and safety risks to our employees and the communities in which we operate. Any materials exported to other countries with lower environmental standards are managed according to the current standards in the United States.

Appendix Seven : Materials Questionnaire

Materials	Financial Motivation		Material Questions			
	How much do we spend on buying, storing, shipping, & recycling/dumping of this material (estimated)?	How much could we save if we reduced the use of this material by 20 percent?	How could we stop using this material altogether?	How could we reduce our use of this material?	How could we or someone else reuse this material?	If the material was in the garbage, how could we recycle it?
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Source: Lane County Resource Efficiency Toolkit. Available by calling William Alsdorf at (503) 229-5913, within Oregon (800) 452-4011. By e-mail at Alsdorf.William.H@deq.state.or.us

Appendix Eight: Desired Futures for Product Design

Current Practices	Desired Future (10-20 yr goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What are our products made of? How long do they last? • What steps have we taken to reduce emissions in our products? • Can our products easily be recycled or the materials be reused? • Do we have a take-back policy? • How are our products distributed? • Have we made efforts to cut down on packaging or distribution-related emissions? 	<p>Describe your ideal future:</p> <ul style="list-style-type: none"> • Products and services are evaluated on a regular basis to determine emissions level, and alternatives are developed to reduce emissions. • Products are designed to be easily disassembled to encourage reuse and repair. • Products are designed to be durable, to last as long as the technology is in practice. • Customers/clients can bring back products at the end of the product’s life for disassembling and recycling/reuse. • Packaging is eliminated or minimal, and all necessary packaging materials are recyclable, compostable, or reusable. 	<p>Describe the transition options to work toward the ideal future:</p> <ul style="list-style-type: none"> • Assess your products and identify where materials can be cut out, reduced, substituted. • Assess your packaging and distribution practices to identify where reductions can be made and packaging materials can be replaced by lower-emission alternatives. • Take responsibility for your products throughout their life cycle and communicate with customers.

Appendix Nine: Supply Chain Desired Futures

Current Practices	Desired Future (5-15 yr goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What items that we buy are refurbished or previously owned? • What items are we currently recycling? • What actions have we taken in our supply, production and distribution chain to reduce emissions? • Do we work with our supplier to identify low/no emission products that we can purchase? • Have we assessed our supply chain to identify emissions generated through products that we purchase? • Have we evaluated our suppliers to assess the materials/services they provide us? • What type of packaging do we use? How could we reduce our packaging? • How are our products distributed? 	<p>Describe your ideal future:</p> <ul style="list-style-type: none"> • We have a contract with our supplier that outlines our purchasing preferences. • We use zero emissions, zero waste suppliers. • Our products are sourced from recycled or remanufactured elements or rapidly renewable and organically raised plant-based raw materials. • No toxic or harmful materials are used in production or generated during product use. • Quality and durability of purchases are appropriate for intended use. • Our purchased products are designed for re-use and/or easy recycling or composting • Purchased products and services have minimal transportation energy impacts. • We work up and down the supply chain and with other industries in our sector to reduce emissions. • We use minimal to no packaging, and packaging which is used has little to no associated emissions. • Distribution centers and fleets meet “green” standards 	<p>Describe the transition options to work toward the ideal future:</p> <ul style="list-style-type: none"> • Talk with your suppliers and distributors to reduce packaging or replace current shipping containers with reusable containers. • Develop a contract with your supplier that outlines preferences for low/no emission products- if they are not willing to meet your needs, explore alternative vendors. • Identify alternative types of packaging and test for efficiency. • Evaluate your distribution center and distribution means to identify additional ways for reducing emissions.

Appendix Ten: Desired Futures GHG Emissions

Describing your current emissions, setting long-term goals and identifying actions to support your transition to an emissions-free business. Use the chart below as a guide for describing your own practices, desired future and transition steps.

Current Practices	Desired Future (10-20 year goals)	Transition Steps
<p>Describe your current practices:</p> <ul style="list-style-type: none"> • What are our greenhouse gas (GHG) emissions? • Does our business already have established targets for emissions reduction/elimination? • What efforts are already in place to reduce GHG emissions? 	<p>Describe your ideal future</p> <ul style="list-style-type: none"> • Employees engaged in energy conservation and committed to achieving targets. • Transitioning to carbon neutral (zero net greenhouse gas emissions). • Working collaboratively with other businesses to eliminate emissions. • Customers/clients, shareholders, vendors and distributors engaged in efforts to cut emissions. 	<p>The following are transition options can support your work toward the desired future:</p> <ul style="list-style-type: none"> • Be flexible and innovative. • Communicate relentlessly to all employees and stakeholders about your vision and plan. • Assign a team or employee to champion energy improvement efforts. • Conduct annual evaluations of your efforts and adaptively manage to cut emissions. • Measure greenhouse gas emissions in the supply and distribution chain. • Evaluate what similar businesses are doing to cut emissions and lessons that can be learned. • Sign up for renewable energy credits with your local utility and utilize local, state, and federal government incentives for improving efficiency and switching to renewable power (for example). • Ask your local utility to perform an audit of energy practices at your facility. Make recommended improvements (for example).

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- ² Landor, “Press Release: New Survey Conducted Indicates Green is No Longer a Marginalized Issue in the United States.” <http://www.landor.com/index.cfm?do=news.pressrelease&storyid=507&bhcp=1> 1 May, 2007.
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- ¹⁰ IPCC, 2007: Summary for Policymakers. In: “Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change” [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf>
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