The NREL Environmental Footprint: Resource Use at the Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado

Edited by Mark Easter

Researched and written by Gina Adams, Jill Baron, Geneva Chong, Mark Easter, Steve Del Grosso Nancy Gus, Kristen Howerton, Dan Manier, and Andy Parsons

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PREFACE

The Natural Resource Ecology Laboratory (NREL) has as its mission "to ensure the sustainability of the Earth's ecosystems through the generation and application of new knowledge". For more than 35 years, ecosystem scientists at the Natural Resource Ecology Laboratory have strived to understand how natural and managed ecosystems are maintained locally and across the globe and how ecosystems respond to a variety of changing conditions. NREL's scientists, working as interdisciplinary teams, have led the world in research on the interplay between physical and biological processes while assuring the highest quality science and best information is available to the scientific community, managers, policy makers and the public.

Recently, numerous scientific reports, from the NSF Science Board [1],the National Research Council [2] [3], and elsewhere, have addressed the immediate need to address global environmental problems. These reports have challenged the scientific community to quickly and significantly advance our basic knowledge of humans as part of the earth system if we are to make the needed transition towards a sustainable and secure future.

I think it is only fitting then, that NREL, as a leader in environmental science and global sustainability, lead also at the local level here at CSU, by exploring how we utilize natural resources to conduct our research. Might NREL, through careful and honest self analysis of our organization, find new ways to demonstrate sustainable systems and practices for NREL, CSU, and for other research laboratories? CSU President Yates' support for the Talloires declaration[4], underscores this need.

Thus, in fall 2001, I challenged NREL to address and account for our use of natural resources. The ad hoc Committee (Gina Adams, Jill Baron, Geneva Chong, Mark Easter, Steve Del Grosso Nancy Gus, Kristen Howerton, Dan Manier, and Andy Parsons) has spent hours gathering data from us, analyzing the data, examining reports from other audits (including the University of Pennsylvania, Princeton University, Brown University, and Tufts University) and here, presents their findings.

This report and its recommendations are an important, first step of many possible steps towards implementing more sustainable use of resources at the NREL. It enables us to understand ourselves and our contributions to the major challenges concerning sustainability. I applaud the ad hoc Committee's work and dedication, and consider this an exciting achievement for NREL. It is my hope that we at NREL will embrace and discuss this report and where possible, move forward quickly to implement the recommendations. Perhaps our example will be a leading one, providing a stimulus to affect change here and elsewhere for our better future.

Diana H Wall

Diana H. Wall, Ph.D.
Director, Natural Resource Ecology Laboratory
May 30, 2002

[1] National Science Board. 2/2/2000. *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation.*
[2] National Research Council. 1999. *Grand Challenges In Environmental Research.*
[3] Board on Sustainable Development, National Research Council. 1999. *Our Common Journey: A Transition Toward Sustainability.*
[4] Tufts University European Center, Talloires, France. October 4-7, 1990. *Report and Declaration of The Presidents Conference: The Role of Universities and University Presidents in Environmental Management and Sustainable Development.*

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EXECUTIVE SUMMARY

Introduction

In October, 2001, the authors formed an ad hoc committee within the Natural Resource Ecology Laboratory (NREL) at Colorado State University, to investigate resource use and assess the NREL's environmental impacts (our "environmental footprint"). We formed the committee with two major goals: to look honestly at our organization's business and research practices, and identify ways that we could reduce our impacts.

We investigated four major areas of impact:

- Energy consumption within the laboratory
- Business travel and commuting
- Resource use
- Waste stream

We limited our analysis to the NREL employees housed at the Natural and Environmental Sciences Building (NESB) on the Colorado State University campus. Seventy-nine of the NREL's 109 employees work regularly out of the NESB.

The NREL's environmental footprint is most easily quantified in two significant areas- production of greenhouse gases (specifically carbon dioxide, or CO_2) through energy use and travel (Figure 1), and water use (Figure 5). We did not have the resources to quantify other major greenhouse gases (such as nitrous oxide and methane) associated with the NREL's research, although a brief literature search suggests that associated emissions of those gases may be significant.

At least 1,272 tons of CO_2 were produced to through electricity use, heating work facilities and water, fuel burned during travel, and paper manufacturing to support the NREL's research. This averages at least 17 tons CO_2/employee/yr.

An average of approximately 595,000 gallons of fresh water were used each calendar year from 1995-2000. This averages to 7,933 gallons of fresh water/employee/yr.

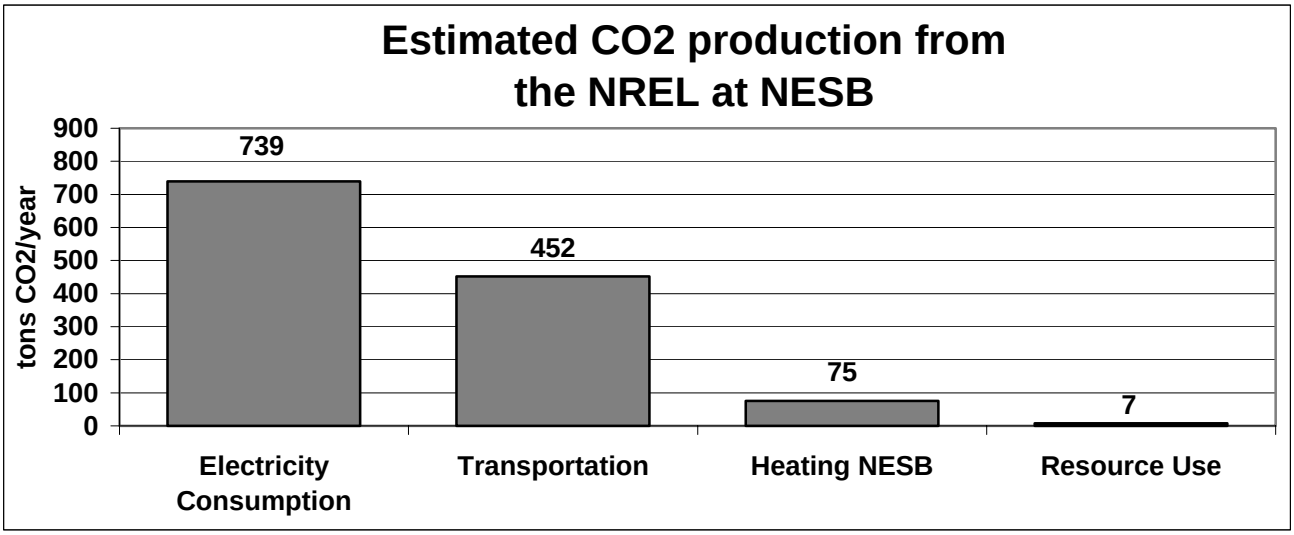

Figure 1. Summary of CO_2 production associated with the NREL.

CO_2 is produced primarily through electricity use at the NESB, and through international travel. Electricity for laboratory equipment, building air conditioning, and building lighting accounts for 77% of the NREL's CO_2 production from electricity use, and international travel accounts for 61% of the impacts from travel.

Opportunities to Reduce Impacts

The NREL can achieve a nearly climate change neutral status with regards to energy consumption by sourcing 100%[5] of its electricity use from energy produced through nonpolluting, alternative means, such as wind power. Before that change is achieved, the NREL can reduce its environmental impact from electricity consumption by at least 115 tons CO_2/yr by implementing the following changes:

- Working with CSU Facilities Management to install motion detectors in hallways, to shut down hallway lights when the building is not being used (reduction of about 54 tons CO_2/yr).
- Working with CSU Facilities Management to solve heat and cooling load balancing problems in the building, so that building climate is regulated at a moderate temperature and air conditioning equipment will be required to operate less. The potential reduction cannot be quantified at this time, however it is expected to be significant since most offices in the building are currently 62-66° throughout the year.
- Replace obsolete computing equipment and shutting down computers and monitors at night (reduction of about 35 tons CO_2/yr). We were unable to quantify the environmental impacts from disposing of old equipment.
- Reduce lighting requirements in individual offices (reduction of about 16 tons CO_2/yr).

The NREL can reduce its environmental impact from travel by at least 100 tons CO_2/yr by implementing the following changes:

- Making Netmeeting and NetConferencing software and equipment available to all employees, and training employees how to use it.
- Using conference calling, internet meetings, and video conferencing to avoid travel to one-third of meetings (reduction of about 85 tons CO_2/yr).
- Employees telecommute one additional day every two weeks, and utilize alternative transportation modes for commuting one additional day every two weeks (reduction of about 15 tons CO_2/yr).

The NREL can reduce its environmental impact from resource use by at least 4.2 tons CO_2/yr, 16,350-32,700 gallons water/yr, and an undetermined amount of organochlorine and other pollutants generated from paper and plastics manufacturing by implementing the following policies:

- Commit to finding an economical and high-quality source for 100% post-consumer waste recycled paper, bleached with a non-chlorine based process (reduction of 4.2 tons CO_2/yr in paper production energy costs, 16 tons of trees harvested for virgin wood fiber, organochlorine pollution associated with chlorine bleaching, and 16,350-32,700 gallons of fresh water used for paper production each year).
- Review office supply consumption and commit to using recycled and recyclable office supplies wherever available.
- Review laboratory procedures and commit to reducing consumption of supplies and materials wherever experimentally sound and safe for employees.
- Increasing the re-use of once-used paper and shipping/packing materials (reduction not quantified).

The NREL reported that it generated 837 pounds of hazardous waste in 2001. The NREL employees demonstrate a high commitment to recycling and waste reduction in the workplace, and hence its greatest opportunity to reduce waste is to reduce consumption. The NREL can reduce its environmental impact from waste production by implementing the following changes:

- Install comprehensive recycling centers at convenient locations, the NREL employees can recycle nearly 100% of recyclable materials in the workplace.
- Review research processes and investigate alternative procedures and practices at the time that research proposals are written and during laboratory procedures, to identify procedures and practices that will generate less hazardous and non-hazardous waste.

[5] At the present time, the Platte River Power Authority distribution grid cannot distribute electricity directly from the PRPA wind farm to specific "wind energy" customers. Though an exact figure is unknown, it has been estimated by the Colorado Renewable Energy Society (personal communication) that the existing power management system in Northern Colorado could source 20-40% of its current load requirements from wind power. CSU may therefore directly reduce its climate change impact from energy use by up to 40% (and indirectly offset its climate change impact by 100% and become climate change neutral) by sourcing its electricity from wind power.

ENERGY CONSUMPTION

Overall Energy Use

Most employees of The Natural Resource Ecology Laboratory are located in the Natural and Environmental Sciences Building (NESB) on the CSU campus. Electricity consumption in NESB averages 187,800 kilowatt hours (KWH) per month at a cost of over $8000 per month (307 tons of CO_2 per month)[6]. The air conditioning unit for the building consumes 22% of this energy. About 111 kWH/yr are attributed to other uses that could not be quantified in this study, including operation of safety systems, the elevator, building ventilation, and others.

The building environment and hot water are heated exclusively with steam generated by natural gas fired boilers at the CSU central steam generating facility, which is considered to be the second most efficient means available on campus to heat buildings. Active and passive solar are considered to be the most efficient, but solar design elements were removed from building design criteria during the value engineering review when the building was designed[7]. During FY1999 to 2002, an average of 1,288 BTU's of natural gas were burned to produce steam for the NESB, yielding an average of 75 tons of CO_2 to heat the building and produce hot water used within the building.

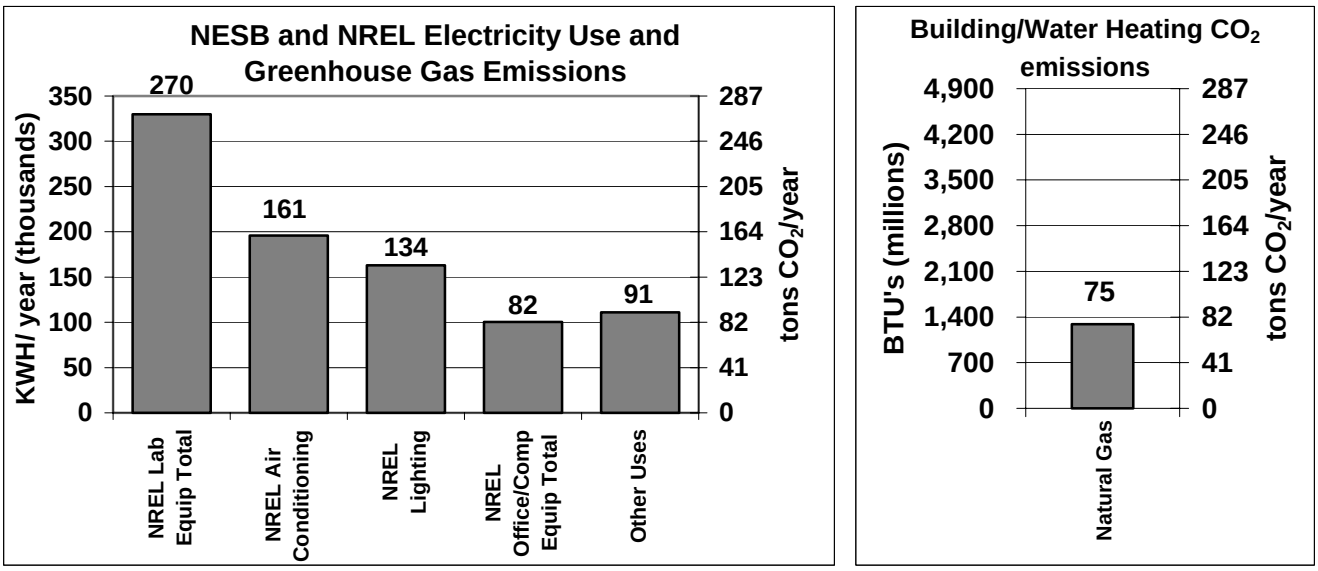

Figure 2. Summary of energy use in the NREL at NESB.

Laboratory/Office Equipment and Lighting

Laboratory Equipment accounts for the largest single use of electricity at the NREL, totaling 329,000 kWH/yr (270 tons CO_2/yr) (Figure 2). Building air conditioning and building lighting are the second and third largest categories of electricity use, at 196,000 and 178,000 kWH/yr, respectively (161 and 134 tons CO_2/yr).[8]

The largest single consumer of electricity in the NREL other than building operation costs is the large drying oven used by multiple projects to dry soils and vegetation samples. This is followed by the Mass spectrometer, the

[6] based on 1.64 lbs CO2 generated per kWH of electricity. The Cadmus Group. 1998. *Regional Electicity Emmission Factors Final Report.*

[7] CSU Facilities Department. April, 2002. Personal Communication.

[8] NREL occupies approximately 40% of the Natural and Environmental Sciences Building, however our overhead electricity use is less than 40% of the non-quantified energy use. Other major electricity draws in the NESB include the Forest Production Lab (FW Smith, Forest Sciences), Dr. Dan Binkley's laboratory (Forest Sciences and NREL), the Advanced Technology Laboratory (UNIX computing lab with 24+ computers, managed by the College of Natural Resources), laboratory equipment in the Soil, Water, and Plant Testing Laboratory, Educational Studies computer laboratories, and the Department of Landscape Architecture. Thus, the total electricity consumption of NREL includes the itemized uses noted above, and some small unknown fraction of the remaining electricity draw of the building associated with building maintenance and other unquantifiable sources.

Leco CHN analyzer, smaller drying ovens, and multiple refrigeration units. Soil, vegetation, and chemical laboratory equipment represent 77% of our itemized electricity consumption (15% of NESB total).

Due to the poor heating/cooling balance in the NESB ventilation system, electric space heaters are used throughout the year in approximately one in four offices at the NREL in NESB. These account for up to 35,100 kWH/yr (28.8 tons CO_2/yr).

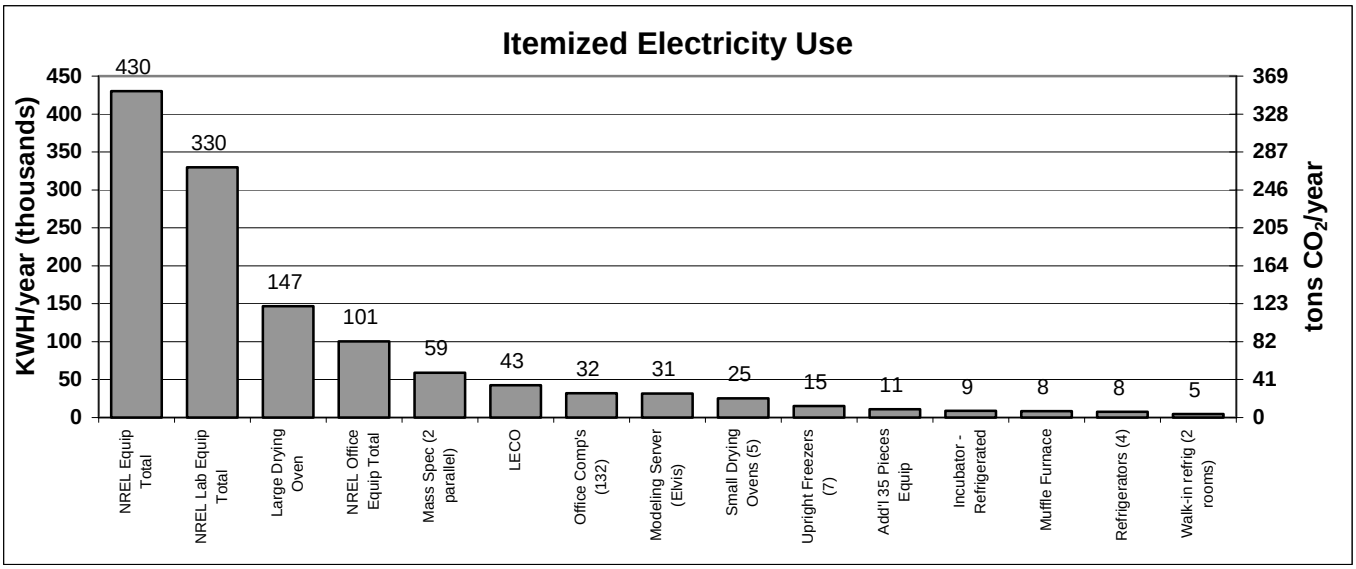

Figure 3. Selected, itemized electricity consumption by equipment type classification or piece of equipment.

Computer and other Equipment

The remaining electricity used at the NREL is consumed by computers and other office equipment (16% computers, 7% others). A typical computer uses about 120 Watts/hour. Conventional monitors use 75 Watts/hour, and the CPU uses 45 Watts/hour[9]. Shutting down monitors when they are not used is the most effective way to reduce energy used by computers at the NREL[10].

Opportunities to Reduce Impacts

We estimate that the NREL can make the most significant reductions in its ecological footprint from energy use in the following ways:

[9] Tufts University. 2002. *Computer Energy Saving Initiative.* http://www.tufts.edu/tie/tci/Computers.html

[10] Reducing the "on time" for monitors by 40 hours per unit month would result in a 104 KWH per week (420 KWH per month) reduction in electricity use, about 1% of the NREL's electricity consumption.

Table 1. Impact reduction methods associated with energy use.

Change in Use	Potential CO_2 Reduction (tons/yr)
CSU campus switch to sourcing 100% of its electricity from a nonpolluting, alternative means such as wind power, to offset greenhouse gas production.	295[11]
Reduce the use of high draw chemical laboratory equipment. Possible ways are to turn off drying ovens, the CHN analyzer, and the mass spectrometer during extended periods of non-use, or where down time is practical. Shutting down the large drying oven for a total of 4 weeks per year (only an 8% reduction in use) would conserve 11,700 KWH/yr.	9.6
Reduce refrigerated storage requirements.	not calculated
Install motion sensors in hallways to shut off hall lights when the building is not in use, but allow for lights to be turned when needed for safety purposes. When asked whether they would support such a measure, 100% of the NREL employees surveyed on energy use said yes.	54
Reduce lighting use in offices by 1/3 (use only two bulbs out of three in each bank). Note that each office is wired to allow use of one, two, or three bulbs in each bank of lights.	16
Replacing the HP modeling supercomputer with a set of clustered nodes saves 26,300 kWH/yr.	22
Replacing CRT monitors with equivalent LCD monitors reduces electricity consumption of each computer by about 40% (about 2/3 of the electricity used by a CRT monitor), saving about 32,000 kWH/yr[12] [13]. LCD monitors have a life expectancy of ten years compared with three for a CRT monitor. The life-cycle cost of a 17" (19" CRT equivalent) LCD monitor projected over ten years is $721 compared with $1069 for CRT monitors[14].	13
Turn off or "hibernate" office computers at night and when not being used for more than 15 minutes. Enable the Power Management feature for your monitor (see the NREL computer support staff for help on how to do this).	not calculated
When buying a new office computer, consider a laptop. Laptops typically use about one quarter of the energy of a desktop system[15].	not calculated

[11] At the present time, the Platte River Power Authority distribution grid cannot distribute electricity directly from the PRPA wind farm to specific "wind energy" customers. Though an exact figure is unknown, it has been estimated by the Colorado Renewable Energy Society (personal communication) that the existing power management system in Northern Colorado could source 20-40% of its current load requirements from wind power. CSU may therefore directly reduce its climate change impact from energy use by up to 40% (and indirectly offset its climate change impact by 100% and become climate change neutral) by sourcing its electricity from wind power.

[12] Currid, Cheryl. 2000. *Energy management for your home office*. http://www.technocopia.com/homeoff-20000501-energy.html

[13] Perry, Christian. 2001. Flat Panels- *They're here, they're affordable, they're hot*. http://www.arstechnica.com/guide/flatpanel/flatpanels-1.html

[14] Calculated as follows: LCD initial cost ($700) + electricity for 10 yrs ($21) = $721. CRT initial cost ($300) * (10 yrs / CRT life expectancy of 3 yrs) + electricity for 10 yrs ($69) = $1069.

[15] U.S. Department of Energy. 2000. *How to buy an energy-efficient personal computer*. http://www.eren.doe.gov/femp/procurement/pdfs/computer.pdf

Photocopiers and networked printers are currently configured to go into an idling mode after a period of 30 minutes of non-use. While idling, they draw the minimum amount of electricity required to sense when a print or copy job has been ordered, at which time the machine powers up to print.

Our calculations assume that personal and networked computers are shut down each evening, which is consistent with the results of our energy use survey of the NREL employees (Appendix E). Whereas some system-critical computers must remain on at all times (such as file and backup servers, web servers, and computational systems). Most desktop systems may be shut down when not being directly used by an employee[16].

[16] "The belief that frequent shutdowns [of PCs] are harmful persists from the days when hard disks did not automatically park their heads when shut off; frequent on-off cycling could damage such hard disks. Conventional wisdom, however, has not kept pace with the rapid technological change in the computer industry. Modern hard disks are not significantly affected by frequent shut-downs. Shutting down computers at night and on weekends saves significant energy without affecting the performance. Power-managed equipment also may actually last longer than conventional products. Because most such equipment will spend a large portion of time in a low-power sleep mode, mechanical wear on disk drives and heat stress on other components can be reduced." *User Guide to Power Management for PCs and Monitors*. 1997. Lawrence Berkeley National Laboratory.

TRAVEL

Total Estimated Travel

Scientists, staff, and students at the NREL traveled approximately 652,000 miles for business during 2000 (the most recent year where complete records are available), producing about 325 tons of CO_2 from burning jet, automobile, and bus fuel (Figure 4).

To estimate the NREL's ecological footprint from travel practices, we used the NREL travel accounting records and categorized travel into four categories: in-state, out-of-state, international, and commuting.

For international travel, we could find no published mean travel distance from the United States, so we used two estimates: For travel to Antartica, we used a value of 23,028 round trip miles per person based on travel routing of Denver-Los Angeles-Aukland-Christchurch-McMurdo[17]. For all other international travel, we used an estimate of 12,000 miles round trip based on travel routing of either Denver-Frankfurt or Denver-Tokyo plus one additional 2000 mile round trip leg from either of the Frankfurt or Tokyo hubs. Travel to Asia and Africa can involve significantly more miles traveled, whereas travel to Canada, Central America, or South America usually involves significantly less.

For out of state, domestic travel, we applied the Federal Bureau of Transportation Statistics (BTS) estimate of 1430 round trip miles for the average trip made by air travelers in 2000[18]. We do not have an accurate estimate of distances traveled, however we believe that this estimate may be relatively low, considering that most air travel by the NREL employees is to either the West or East Coast of North America, and the round trip distances are considerably longer (for example, the round-trip distance from Denver to Washington D.C. is 3162 miles).

We based our calculations of CO_2 generation on an average mileage of 22 miles per gallon (mpg) for the CSU vehicle fleet[19], and the estimate that each gallon of petrochemical-based fuel (gasoline or aircraft fuel) yields 36 pounds of CO_2[20]. In-state trips were assigned an estimated round-trip mileage of 150 miles based on estimated distances to the most frequently-traveled destinations for the NREL employees[21]. We estimate that about 2 tons CO_2/yr were generated by in-state travel. No comprehensive records exist for employees traveling in-state using vehicles provided by other agencies (Forest Service, Park Service, and others) and we did not survey employees for this information. Hence, this estimate is likely to be lower than the actual amount of travel that occurred.

The NREL's impacts due to commuting are almost entirely from burning gasoline in automobiles. Commuting between work and home yielded about 41 tons CO_2 per year, based on the U.S. Corporate Average Fuel Economy standard of 27.5 mpg. Respondents to the survey indicated that their average round-trip commute is 6.3 miles. Respondents drove to and from work an average of 2.5 days per week. Respondents used alternative means to commute to and from work an average of 2.3 days per week. This is exceptionally high, indicating a relatively significant commitment to using alternative modes by the NREL employees, compared with less than 0.5 days per week for the general population of Fort Collins[22]. Bicycling is the most popular means of alternative transportation, used an average of 2.0 days per week per employee. Walking, riding the bus, and carpooling were all used about 0.1 days per week by survey respondents (Appendix E).

[17] Compiled from various sources.
[18] U.S. Bureau of Transportation Statistics. 2002. http://www.bts.gov
[19] Personal Communication, CSU Motor Pool, April 2002.
[20] Federal Highway Administration. 1999. *Summary of Travel Trends, 1995 Nationwide Personal Transportation Survey.*
[21] Rocky Mountain National Park and the Central Plains Experimental Range.
[22] City of Fort Collins Transportation Department, personal communication. April, 2002.

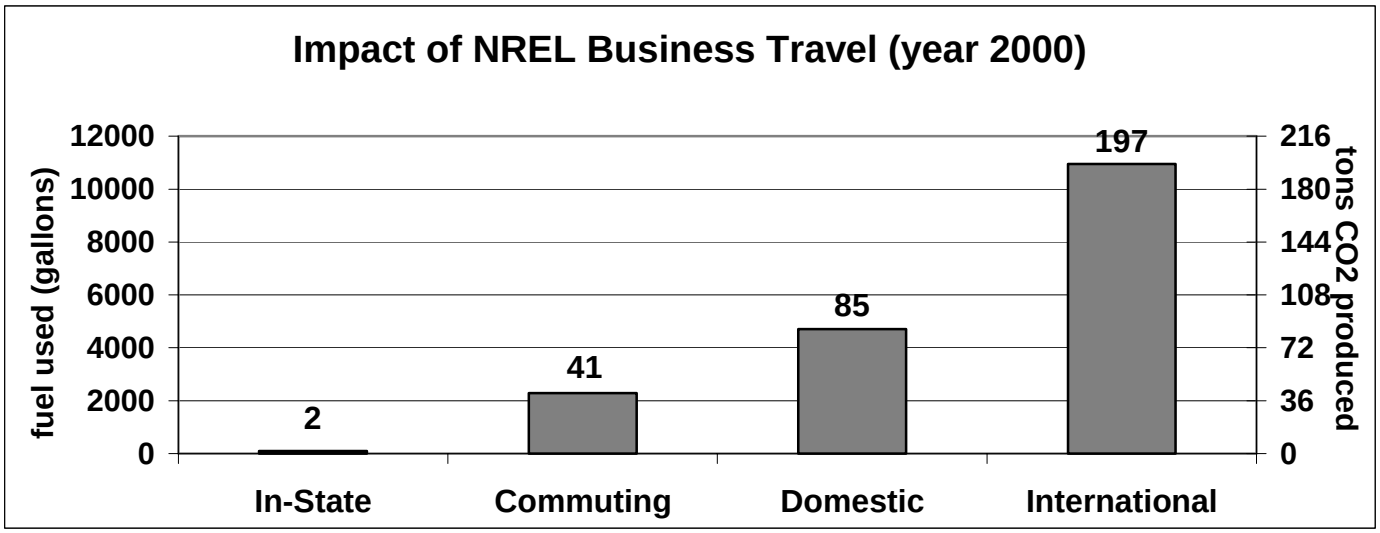

Figure 4. Environmental impacts associated with travel at the NREL, expressed as tons of carbon dioxide produced by four basic modes: In-state travel (generally by automobile), commuting (by automobile or bus), domestic travel (by air), and international travel (by air).

Opportunities to Reduce Impacts

We estimate that the NREL can make the most significant reductions in its ecological footprint from energy use in the following ways:

Table 2. Impact reduction methods associated with travel.

Change in Use	Potential CO_2 Reduction (tons/yr)
Use conference calls, net meetings, or video conferencing for 1/3 of all travel that does not involve field work. This assumes that 1/3 of all travel is for fieldwork (with the exception that 100% of Antarctica travel is for fieldwork and nearly all in-state travel is for field work), which we assume cannot be reduced.	85
Employees telecommute one day per week.	7.5
Employees use alternative transportation one day per week.	7.5

CSU and the NREL now have state-of-the-art E-conferencing facilities available for conducting scientific meetings. In our survey of the NREL employees, 21% of respondents indicated that they reduced travel in the past year by conference calls or E-conferencing. Seventy-nine percent of those surveyed indicated a willingness to use conference calls or E-conferencing in the future to reduce business travel.

RESOURCE USE

Paper

Office paper is the largest contributor to the non-hazardous recycle/waste stream at the NREL. The organization currently prints or copies onto 110 reams of chlorine-bleached, 30% post-consumer waste recycled (PCWR) paper each month (55,000 sheets). This equates to 505 paper sheets/employee/month, or a total of 3.3 tons paper/yr used in printers and photocopiers at the NREL. This does not include mailings and flyers received from other CSU departments or mail received from outside the University. This equates roughly to a per-person equivalent of three quarters of one average-sized pulp tree per year harvested for paper production[23]. Total energy required to produce paper for printing and photocopying at the NREL is 10,200 kWH/yr (8.4 tons CO_2/yr). The total water required was 32,700-65,400 gallons[24] [25] [26]. An undetermined quantity of organochlorines, associated with chlorine bleaching of paper, was produced in the process. This analysis does not take into account transportation costs to ship paper to the NREL from its point of manufacture.

Water Use

Water use is metered for the entire Natural and Environmental Sciences Building (Figure 5). Water use during the year 2001 was the highest on record, caused by a stuck ball valve in the NESB air conditioning system. The error was not discovered until March, 2002, but the equipment has since been repaired. We did not investigate the details of water use directly attributable to the NREL, since water is not metered within the building and estimating water use without instrumentation is prone to error. Total water use averaged 1.49 million gallons per year for the NESB, between 1994 and 2000.

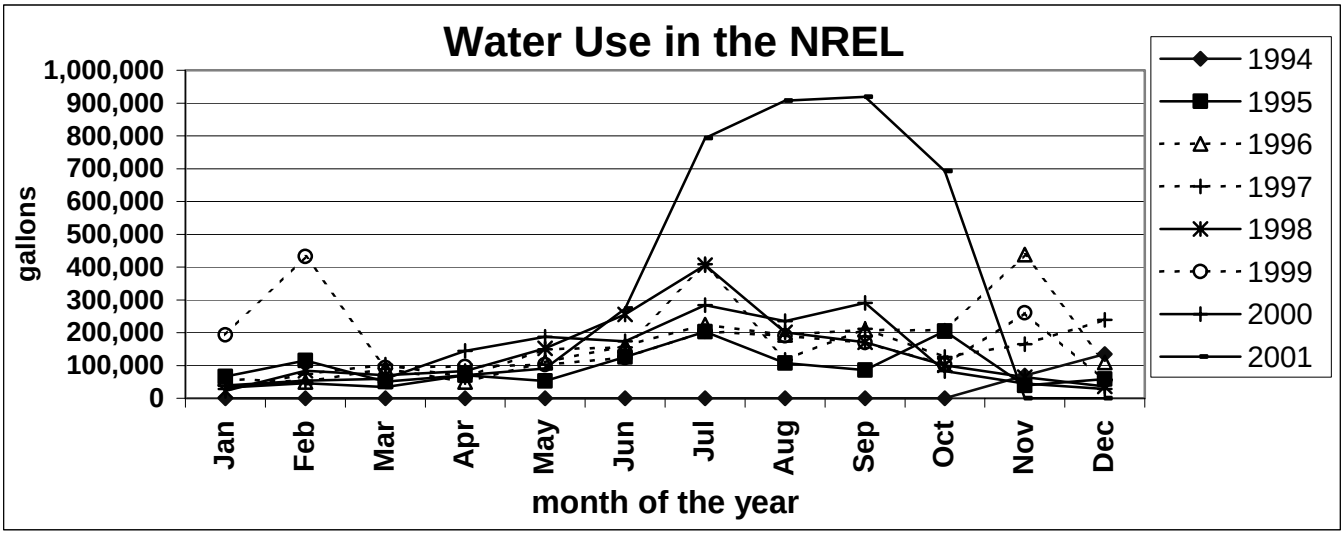

Figure 5. Water use in gallons for the NESB, 1994-2001.

Office Supplies

NREL currently spends $6000/yr on supplies purchased through the central administrative offices, or $55/person/yr. No volume or mass-based estimate of quantity used is available for this study. This cost does not

[23] http://www.ecomall.com/biz/paper.htm
[24] Rethink Paper. 2002. *Paper efficiency: What it is, and how to achieve it.* .http://www.rethinkpaper.org/toolbox/toolframe.cfm?pageName=effuse
[25] Thermo Electron Corporation. 2002. *Every Step of the Way.* http://www.thermo.com/eThermo/CMA/PDFs/Various/1File_11907.pdf
[26] Printing Alternatives Promoting Environmental Responsibility. 2002. *What's Wrong with Magazine Production?* http://www.ecopaperaction.org/problem.htm.

include supplies purchased on individual projects. Whenever possible the products purchased through the NREL's administrative offices are made of recycled materials (they must have a comparable price to the other, non-recycled options). For example, the NREL has just started purchasing recycled post-its. Nearly all laser printer cartridges are now recycled by CSS, and CSS collects inkjet cartridges and donates them to local schools for them to recycle as a fund-raising project.

Cleaning Supplies

Colorado State University has a contract for all cleaning supplies with Butcher's (http://www.butchers.com/index.htm). In general, the University has a policy of using the best products available for the environment and the people who are exposed to the chemicals. One third of the evaluation of a new product is based on environmental concerns. For example, all products are labeled as safe to dispose of down sink drains, and all containers are recyclable. The University follows philosophies developed in *Protecting the Built Environment: Cleaning for Health*[27].

Opportunities to Reduce Impacts

We estimate that the NREL can make the most significant reductions in its ecological footprint from resource use in the following ways:

Table 3. Impact reduction methods associated with resource use.

Change in Use	Potential CO_2 Reduction (tons/yr)
Commit to finding an economical and high quality 100% PCWR, non-chlorine processed paper for general use within the laboratory.	4.2
Evaluate paper use within the laboratory using the method defined by *Rethink Paper*	Not determined
Work with Facilities Management to find alternative cleaning materials for use at the NREL. For example, non-chlorine based cleaning supplies, which use hydrogen peroxide as an alternative, may be used on a trial basis to assess their effectiveness.	Not determined
Review supply use and find ways to reduce supply expenditures and hence supply consumption. Doing so could make a substantial portion of the supply budget available for purchasing recycled products where they are available, in place of products produced with virgin materials.	Not determined

Switching to a higher recycled content in our office paper, using totally chlorine free bleached paper, and reducing paper use offer our greatest opportunities for reducing the NREL's impacts related to resource use. The benefits are significant:

- Recycled paper requires 60% less energy to manufacture than from virgin materials like wood pulp.
- Producing a ton of paper from virgin fiber requires approximately 20 trees harvested for pulp.
- Producing paper from recycled materials usees 30-50% less water than producing paper from virgin fibers.
- Viable alternatives to using chlorine in the paper bleaching process exist, and oxygen-based bleaching processes are now being used throughout the industry, eliminating the production of highly harmful organochlorines associated with chlorine bleaching.

[27] Barry, Michael. 1994. http://www.eren.doe.gov/femp/techassist/greening_toolkit/purchasing.html

In October 2000, the NREL began to purchase 30% post-consumer waste recycled (PCWR) paper manufactured by Eureka[28]. At the time, CSS investigated using their 100% PCWR recycled paper in the NREL's photocopiers and laser printers. The 100% PCWR paper worked well in inkjet printers, but it tended to bunch and jam in the laser printers. The 30% PCWR product works fine in all equipment and it actually costs $0.10 less per ream than 100% virgin fiber paper purchased under the state contract, saving approximately $120 per year.

Using the 30% PCWR paper is a substantial improvement over virgin fiber paper, however it means that 70% of the NREL's paper comes from virgin wood fiber- trees cut for the sole purpose of making paper. No 30% PCWR or 100% PCWR paper is currently included in the state contract, leading us to believe that purchasing staff could leverage the considerable volume buying power of CSU toward finding a high-quality 100% PCWR paper product that is produced without chlorine, and which is comparably priced to the current 100% virgin fiber, chlorine-bleached paper that is used by most employees at CSU.

[28] Eureka is a division of Georgia Pacific, www.eurekarecycled.com

WASTE STREAM

General Waste

The largest contributor to the non-hazardous waste/recycle stream at the NREL is office paper (see previous section on *Resource Use*). We estimated the amount of general office waste generated each year using a stratified-random sample survey of the NREL staff. We sent out a survey to a randomly-selected subset of employees, stratified proportionally across employee categories. The survey was sent to 25% of employees, and 88% of those responded. According to this survey, the NREL average employee receives 33 pieces of mail per month. Eighty-two percent of these items are currently recycled, and surveyed employees indicated that this amount would approach 100% if the appropriate service and bins are provided (Figure 6). Eighty-four percent of those surveyed indicate they would prefer CSU and other announcements by email rather than by paper; 11% prefer to get them in paper form so they can be posted.

All those surveyed currently recycle cardboard and recyclable food containers. All respondents indicated they would recycle chipboard if storage bins for such materials were made available. Styrofoam packing peanuts are not a significant waste item and all respondents indicated they would reuse them if a convenient way to do so was established. About 1.2 batteries/month are recycled and two per month are disposed of as trash. All respondents indicated that they would recycle batteries if adequate facilities were available to do so.

Survey results suggest that the nearly all office paper, newspaper, cardboard, aluminum, glass, steel, and plastic used at the NREL is recycled. The NREL appears to recycle a higher percentage of these items than the university wide average (~50%)[29]. Consequently, the largest potential for the NREL to reduce its environmental impact is to reduce usage.

Chemical Laboratory Wastes

The NREL generated at least 837 pounds of hazardous waste through its research activities in 2001. Most of the NREL's chemical waste is generated by regular use of particular processes and/or equipment, falling into two general categories:

- Equipment such as the LECO CHN analyzer, the LICOR gas analyzer, the Alpkem autoanalyzer, and the mass spectrometer, which generate waste as a by-product
- Sampling processes that measure total C, microbial N, Lignin, and ^{14}C.

These wastes have been quantified based on their disposal weight and frequency, separated by solid or liquid state, as noted in disposal requests addressed to Environmental Health Services (Appendix A). Solid waste is dominated by Alkaline batteries, and several metals and chemicals generated by the LECO analyzer. Liquid wastes far outweigh solid wastes and are dominated by ethylene glycol used in water nutrient analyses, as well as several other chemical solutions generated by the Alpkem autoanalyzer, total Carbon estimates, the Mass spectrometer, and other water content analyses.

It is important to note here that the NREL's hazardous waste production has dropped very significantly in the past decade, primarily by changing analytical processes to those that generate less waste. For example, determining soil carbon and nitrogen concentrations using the LECO CHN analyzer has reduced dichromate waste by nearly an order of magnitude.

The cost of disposal of all hazardous wastes is covered under overhead paid to the University. Federal cost accounting standards for research grants require that such services be provided by grantee institutions, and hence there is no institutional accounting practice whereby waste generation can be charged to individual projects or researchers. Hence, there is little or no financial incentive to reduce the NREL's output of these items. Costs and benefits involving generation of these wastes need to be addressed in a philosophical manner in project design

[29] CSU Recycling Program. April, 2002. Personal Communication.

stages to assess the amount of information provided, the ecological cost of generating contaminants, and potential analysis options, which may reduce the waste amount or generate different, less hazardous wastes.

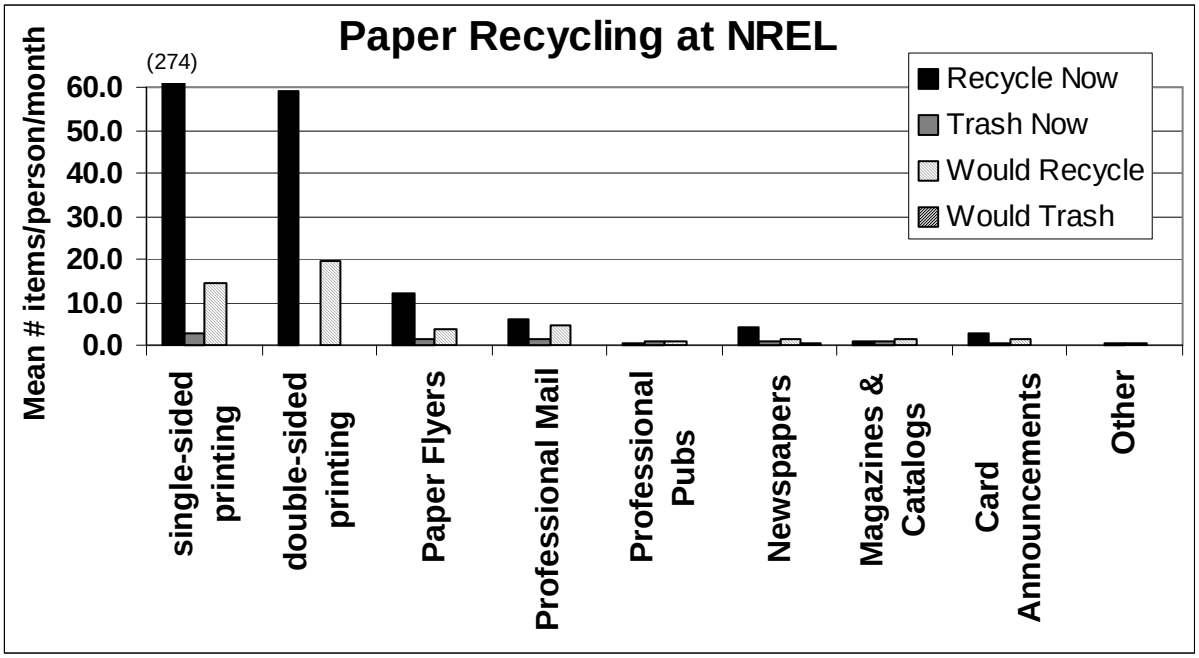

Figure 6. Survey results indicating paper waste generated in the NREL and current and potential disposal mechanisms.

Opportunities to Reduce Impacts

We estimate that the NREL can make the most significant reductions in its ecological footprint from the waste stream in the following ways:

Table 4. Impact reduction methods associated with the waste stream.

Change in Use	Potential change
Install comprehensive recycling stations in the West, Center, and North wings of the NREL.	Increase recycling participation to nearly 100%
Investigate alternative laboratory procedures.	Reduce the amount of hazardous and non-hazrdous waste generated
Evaluate materials use and experimental procedures when research proposals are written and during project implementation, to reduce consumption.	Reduce the amount of hazardous and non-hazrdous waste generated

NREL's high commitment to recycling suggests that the organization could achieve a nearly 100% recycling rate for all recyclable waste materials simply by providing convenient, adequate storage facilities for those materials. We recommend that the NREL work with CSU Facilities Management and Recycling Program staff to install recycling stations at three locations within the building (north wing, building center, west wing) where employees may recycle their waste materials.

We recommend that recycling bins for the following products be added to the existing bins:

- glossy paper and colored office paper
- paperboard
- batteries
- mixed containers (steel, aluminum, #1 and #2 PET

To reduce chemical laboratory waste, we recommend that alternatives be used where practical and experimentally sound. One example of such an alternative is for determination of microbial biomass. The current method for the NREL involves a digestion technique which generates an assortment of hazardous wastes. The alternative uses a high temperature soluble C/N analyzer which is made by Shimadzu (TOC Vcpn is the version that some the NREL researchers currently contract for use). That method generates harmless salts as by products, and the per-sample cost is actually less than current techniques.

Other simple, individualized efforts should include conservative use of paper towels and latex gloves, and reusing (when safe and experimentally sound) gloves, sponges, sample dishes, etc. We did not quantify the amount of waste generated by these uses, however like hazardous wastes, there is no financial incentive to reducing how often we fill trash cans because University overhead covers this cost irrespective of the amount of waste generated.

CONCLUSIONS

The most significant environmental impacts at the NREL are generated from greenhouse gas production from energy use and travel, resource use (especially office paper), fresh water use, and hazardous waste generated through analytical chemistry.

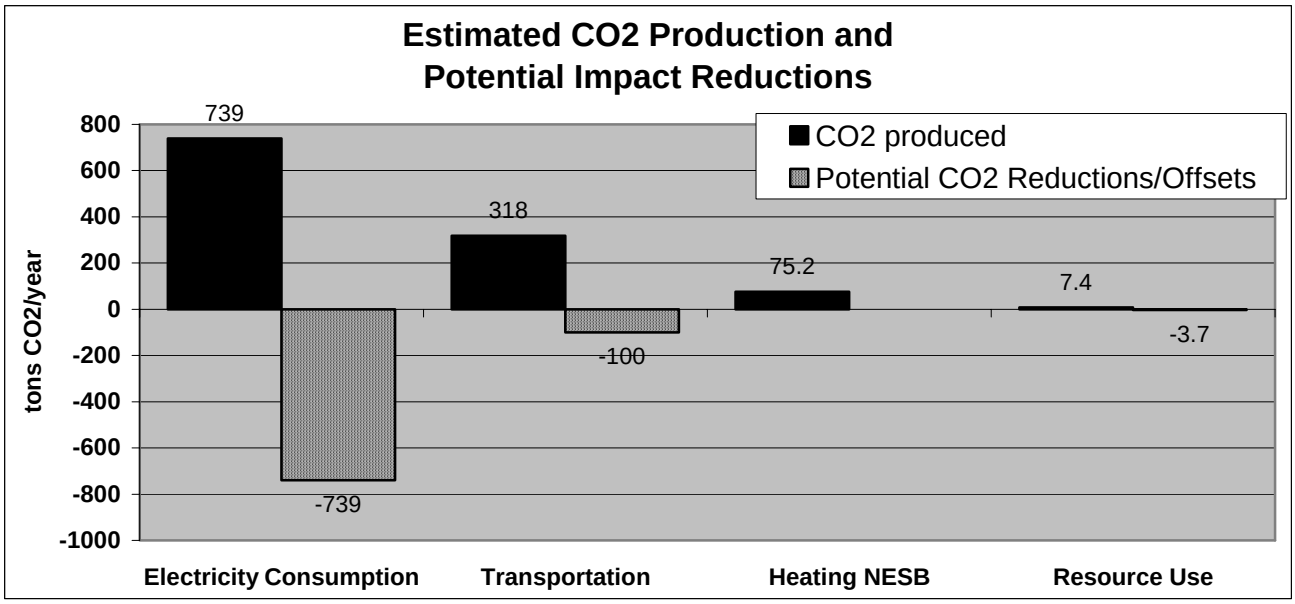

Figure 7. Summary of possible reductions in greenhouse gas emissions related to findings in this report.

Institutional Efforts

There are several institutional changes that will reduce the NREL's ecological footprint. These include:

- CSU commit to sourcing 100% of its electricity needs from nonpolluting, alternative energy.
- Purchasing video/net/teleconferencing equipment and software and training employees how to use it.
- Reducing business/research travel and using alternative modes where possible.
- Committing to converting all paper use to a 100% PCWR, process-chlorine-free paper.
- Installing comprehensive recycling stations at convenient locations within the laboratory.
- Supporting employees who telecommute.

Individual Employee Efforts

The NREL employees have an exceptionally high level of commitment to reducing their ecological footprint. Employees can take additional individual steps to reduce their environmental impacts, including:

- Reducing travel to meetings, and using video/net/teleconferencing wherever possible.
- Shutting off computers, monitors, and appliances when they are not used.
- Purchasing energy-star compliant computers and appliances when older equipment is replaced.
- Replacing CRT with LCD monitors and using laptop computers wherever possible.
- Using alternative transportation or telecommuting from home wherever possible.
- Reducing paper use as defined by the organization *Rethink Paper*.
- Purchase and use 100% PCWR, process-chlorine-free paper in inkjet printers throughout the laboratory.
- Using recycling stations at the NREL for all recyclable waste..
- Evaluate research practices to reduce consumption of office materials and chemicals, and cut production of hazardous and non-hazardous waste.

APPENDIX A: Hazardous wastes generated in chemical laboratory analyses determined from disposal requests, in year 2001.

Note: Disposal weights include containers and the sum of items listed in the left column.

Item	QUANTITY (per annum based on a 2yr. average of disposal weight)		Analysis (Use)	disposal mechanism
SOLIDS				
batteries, Alkaline	32.0	lbs	various	EHS
copper turnings/sticks w/tr. hydrochloric acid	17.8	lbs	LECO	EHS
kaolin, calcium ox, tungsten ox	13.3	lbs	LECO	EHS
sodium hydrox, Mg perchlorate	11.8	lbs	LECO	EHS
Soda lime	3.3	lbs	LICOR (CO_2)	EHS
glass wool w/tr. NaOH and Mg perchlorate	2.4	lbs	LECO	EHS
barium carbonate (ppt)	2.3	lbs	alkalinity	EHS
cupric sulfate, potassium sulfate	2.0	lbs	ALPKEM	EHS
ferric chloride (anhydrous sublimed)	2.0	lbs	broken jar	EHS
alumina	2.0	lbs	LECO	EHS
magnesium perchlorate w/ glass wool and paper	2.0	lbs	LECO	EHS
deoxycholic acid	1.6	lbs	Animal digestion*	EHS
asparagine (DL)	1.3	lbs	amino acid*	EHS
glutamic acid	1.0	lbs	amino acid*	EHS
alumina w/tr. oil	1.0	lbs	vacuum pump	EHS
broken quartz, tr. quartz wool and copper	0.8	lbs	MASS SPEC.	EHS
boric acid	0.5	lbs	ALPKEM	EHS
alanine	0.5	lbs	amino acid*	EHS
aminoglutanic acid	0.5	lbs	amino acid*	EHS
lipase (porcine pancreas)	0.5	lbs	Animal digestion*	EHS
antimony metal dust	0.5	lbs	LECO	EHS
chromium oxide	0.5	lbs	MASS SPEC.	EHS
cobaltous/cobaltic oxide silvered	0.5	lbs	MASS SPEC.	EHS
towels and glove w. vacuum pump oil	0.5	lbs	MASS SPEC.	EHS
dimethyl oxocyclohexyl, hydorxyethyl, glutarimide	0.5	lbs	misc. microbial*	EHS
ketoglutarate sodium salt	0.5	lbs	misc. microbial*	EHS
naphthyl acid, phosphate, sodium	0.5	lbs	misc. microbial*	EHS
vitamin B6, hydrochloride	0.5	lbs	misc. microbial*	EHS
antimony w/ glass wool	0.3	lbs	LECO	EHS
leucine	0.3	lbs	ALPKEM	EHS
glutamine	0.3	lbs	amino acid*	EHS
chloramphenicol	0.3	lbs	antibiotic*	EHS
fluorescein isothrocyanate	0.3	lbs	misc. microbial*	EHS
methyl-benzothiazolinone hydrozone, hydrochloride	0.3	lbs	misc. microbial*	EHS
quinine hemi-sulfate	0.3	lbs	misc. microbial*	EHS
glucosamine hydrochloride	0.1	lbs	amino acid / sugar *	EHS
isoleucine	0.1	lbs	amino acid*	EHS
glycerophosphate	0.1	lbs	Animal digestion*	EHS
mercuric chloride	0.1	lbs	anti-bacterial (not used anymore)	EHS
tetracycline hydrochloride	0.1	lbs	antibiotic*	EHS
bovine hemoglobin	0.1	lbs	misc. microbial*	EHS
cellobrose, glucopyranosyl, glucose	0.1	lbs	misc. microbial*	EHS

nicotinamide-adenine dinucleotide, reduced disodium salt, water	0.1	lbs	misc. microbial*	EHS
phosphatase alkaline (intestinal)	0.1	lbs	misc. microbial*	EHS
zinc powder	0.1	lbs	?	EHS
phytase	0.1	lbs	Animal digestion*	EHS
gamma globulins	0.1	lbs	antibiotic*	EHS
gentamicin sulfate	0.1	lbs	antibiotic*	EHS
streptumycin sulfate	0.1	lbs	antibiotic*	EHS
nystatin (mycosatatin)	0.1	lbs	anti-fungal*	EHS
collagenase (bacterial)	0.1	lbs	misc. microbial*	EHS
chromium triox contamination on towels, gloves, weight boat	0.1	lbs	NOx	EHS
guanosine dihydrate	0.03	lbs	DNA*	EHS
guanosine, phosphoric acid, disodium salt, water	0.03	lbs	DNA*	EHS
adenosine	0.03	lbs	enzyme	EHS
adenosine, phosphoric acid monohydrate	0.03	lbs	enzyme	EHS
cytidine, phosphoric acid	0.03	lbs	RNA - lipids*	EHS
cytrdine	0.03	lbs	RNA - lipids*	EHS
uridine	0.03	lbs	RNA - lipids*	EHS
uridine, phosphate disodium, water	0.03	lbs	RNA - lipids*	EHS
batteries, NiCad	0.002	Lbs	various	EHS
myoglobin (whale skeletal muscle)	0.01	lbs	misc. microbial*	EHS
LIQUIDS				
ethylene glycol, transmission fluid, water	157	lbs	LOCH VALE - nutrients in PPT	EHS
mercury as phenyl mercuric acetate, Kclsoln	120	lbs	preservative for KCl (rarely used now)	EHS
sodium nitroferricyanide, Na-salicylate, Na citrate, Na-K-tartrate, Na hypochlorite, Na phosphate, NaOH	92.5	lbs	ALPKEM	EHS
potassium dichromate, phosphoric acid sulfuric acid mixture	85.5	lbs	total C	EHS
antimony potassium tartrate, ascorbic acid, ammonium molybdate, dowfax, sulfuric	85	lbs	ALPKEM	EHS
antimony potassium tartrate, ascorbic acid, ammonium molydbate, sulfuric, hydrochloric acid, sodium hydrox, sodium bicarb	53.5	lbs	ALPKEM	EHS
compressor oil, water	27	lbs	MASS SPEC	EHS
methylene chloride, methanol, hexane, water, sediment (halogenated waste)	26	lbs	LOCH VALE - organic	EHS
methanol w/tr. Chlorophyll	16.5	lbs	LOCH VALE - chlorophyll A	EHS
sodium salicylate, potassium chloride EDTA, sodium citrate, sodium hypochlorite and sodium nitroferricyanide	15	lbs	ALPKEM	EHS
chloroform	6	lbs	MICROBIAL N	EHS
acetic acid, formalin, ethanol, water	6	lbs	root preservative	EHS
diphenyloxazole, phenyloxazolyl, benzene in toulene-methanol mix	4.5	lbs	no longer used	EHS
pentaerythritol ester (AS no. 60424-33-9), alkylated phenyl-alpha-naphtylamine (AS no. 68259-36-9), dibutylphthalate(AS no. 84-69-5)	4	lbs	misc. microbial*	EHS

vaccum pump oil w/tr. Chloroform	3.5	lbs	microbial N	EHS
mercury and Hg contaminated glass+paper	3	lbs	broken thermometers*	EHS
vaccum pump oil	3	lbs	MASS SPEC	EHS
hydrofluoric acid soln	3	lbs		EHS
acrinidine orange, formaldehyde	2.5	lbs	microbial stain*	EHS
perchloric, water	2.5	lbs	Phosphorus	EHS
monoethanolamine	2	lbs	LIGNIN	EHS
ethylene glycol, monomethyl ether	2	lbs	shipping error (not normally used)	EHS
opti-flour (see MSDS)	1.5	lbs	14C	EHS
benzene, methanol	1.5	lbs	LOCH VALE - organic	EHS
sodium lactate	1	lbs	misc. microbial*	EHS
phenol, sodium hydrox	1	lbs	no longer used	EHS
Chromium triox	0.75	lbs	NOx	EHS
zinc bromide	0.75	lbs	particle separation	EHS
hionic-flour (see MSDS)	0.5	lbs	14C	EHS
scintiverse (see MSDS)	0.5	lbs	14C	EHS
sodium hypochlorite (bleach)	0.5	lbs	ALPKEM and sterilizer for quarantine solutions	EHS
phenethylamine	0.5	lbs	animal digestion	EHS
nitrophenol	0.5	lbs	misc. microbial*	EHS
glycerol, PBS soln	0.25	lbs	lubricant for glassware	EHS
dinitro fluorobenzene	0.25	lbs	misc. microbial*	EHS
phenol (lactophenol), water	0.15	lbs	fungi stain*	EHS
pronase	0.0625	lbs	antibiotic*	EHS
alpha-naphthol	0.0625	lbs	misc. microbial*	EHS
glutamate dehydrogenase	0.035	lbs	amino acid*	EHS
streptomycin sulfate	0.03	lbs	antibiotic*	EHS
sodium pyruvate	0.03	lbs	misc. microbial*	EHS

APPENDIX B: Top energy-consuming research equipment at the NREL.

Note: Refrigerator energy estimates are based on yearly estimate provided by PG&E website.

Item ('*' indicates to be replaced or added in near future)	age	Extented E (KWH / mo.) (Encorporates usage in days per month)	COST ($ based on 2001 average cost of $0.0427 / kWH)	Usage / Purpose / Research Application
large drying oven	31	12223.4	513.38	general
Mass Spec (2units together)		4915.0	206.43	Isotope anal
LECO CHN analyzer	7	3561.6	149.59	veg-soil C&N
Incubator - large refrigerated	15+	726.6	30.52	multiple uses
muffle furnace	15+	688.6	28.92	soil C
small drying oven 3	15+	423.1	17.77	general
small drying oven 2	15+	423.1	17.77	general
small drying oven 1	15+	423.1	17.77	general
Drying oven, small	<1	423.1	17.77	soil-veg
Drying oven, small	<1	423.1	17.77	general esp. veg.-soil
Freezer (upright)	25	200.0	8.40	storage
Refrigerator (ovr-undr) wall	20+	180.0	7.56	Sample storage
Refrigerator (ovr-undr) GE	20+	180.0	7.56	chem storage - Alpkem
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Freezer (upright) Wall	<5	180.0	7.56	Sample storage
Refrigerator (ovr-undr) Mtag	2	140.0	5.88	chem storage - Alpkem
Refrigerator (ovr-undr) Mtag	2	140.0	5.88	chem storage
ball mill	8	117.0	4.92	veg-soil
Centrafuge - large		101.4	4.26	multiple uses
Incubator		94.4	3.96	multiple uses
Incubator		94.4	3.96	multiple uses
Refrigerator (1/2 size)	20	80.0	3.36	Radioactive storage
Shaker - recipro	20+	69.2	2.91	general chem
Shaker - recipro	10	69.2	2.91	general chem
Centrifuge - high speed w/refrige		58.5	2.46	multiple uses
Alpkem	9	42.4	1.78	soil-veg-water chem
Centrifuge - small		30.5	1.28	multiple uses
Centrafuge - small		30.5	1.28	multiple uses
balance 5-place	7	23.7	1.00	mass spec

APPENDIX C: Top non-research equipment and appliances used at the NREL.

Note: Refrigerator energy estimates are based on yearly estimate provided by PG&E website.

NON - LABORATORY APPLIANCES	Extented E (KWH / mo.) (Encorporates usage in days per month)	COST ($ based on 2001 average cost of $0.0427 / kWH)	Usage / Purpose / Research Application
Refrigerator	140.0	5.88	food and beverage
Microwaves (2)	46.6	1.96	food and beverage
Hot water tap	15.9	0.67	beverage
coffee pot	12.7	0.53	
Copy machines (2)	658.9	27.67	official use
Paper sorters (2)	35.6	1.50	official use
Computers, 132 total units (PC, Mac, Laptops, and Unix)	2686.5	112.83	individual / project uses
Elvis (system)	2619.9	110.04	all NREL computing
New system computer			all NREL computing
General Use Printers	478.7	20.10	all NREL
Heaters (estimated 20 units used 6 mos. per year and 32 hrs. per week from survey)	240.0	10.08	personal uses
Coffee pot (estimated 20 units used 6 mos. per year)	10.6	0.45	personal uses
Battery Charger (or other low draw, low use appliances estimated as 20 units used 12 hrs per week from survey.)	6.1	0.26	personal uses
Clock (or other medium draw, frequent use appliances estimated as 20 units 730 hours per month from survey)	1424.6	59.83	personal uses
Lamp	0.5	0.02	personal uses
Small office appliances (heaters, clock, radio, light, etc.)	1681.8	70.6	SUMMARY CLASS
TOTAL	8,376.7	351.8	SUMMARY CLASS
NREL EQUIPMENT TOTAL (ALL NREL EQUIP AND APPLIANCES)	35,851.7	1,505.8	

Appendix D: Survey of the NREL employees at NESB

Dear NREL Employees; January 22, 2002

As part of the Environmental/Resource Use Audit I authorized in November, the Resource Use Audit Committee is assessing current NREL energy use, transportation impacts, and waste stream impacts, and other related issues. Their goal is to quantify our "ecological footprint", and define ways that we can reduce our impacts through reasonable changes in business practices. They've determined that a survey of current practices by NREL employees is necessary for us to accomplish this goal.

Filling out the survey should take less than 20 minutes of your time, and the information will be invaluable to their efforts to reduce our environmental impacts. We hope that you can assist them by completing the survey.

Assessing resource use is a difficult issue, particularly since the units of measure for trash and recycled materials are quite different from how we look at office and lab materials when we order and use them. We consume materials daily in individual units, and trying to translate things like hours of computer use, or individual soft drink containers, and even informational brochures into units like BTU's, cubic yards and pounds of recovered materials is a difficult task. They've tried to make the survey questions as readable and understandable as possible.

Questions are likely to arise, however, when individuals try to assess their resource use. The survey is divided into three main categories: waste stream, electricity use, and transportation. If you have any questions or need clarification on any of the questions, I encourage you to contact Mark Easter regarding electricity use or transportation at x7662, marke@nrel.colostate.edu or Gina Adams regarding waste stream issues, x1984, gadams@nrel.colostate.edu. Please return completed surveys to Mark Easter, NREL, NESB B252 before Wednesday, January 23rd.

Thank you for your assistance in this matter.

Sincerely,

Diana Wall, Ph.D.
Director

Waste Stream Issues

Thank you for assisting the resource use committee by filling out this survey!

Please answer the questions below on how much you personally are able to reduce your waste by reducing usage and switching from trash to recycling. For each of the waste categories below we ask you how much you currently send to trash and recycling and how much you "Would Trash" and "Would Recycle" if you cut down usage and recycled as much as possible. Please estimate the average quantity per month, in the units shown for each item. Please record any additional items under "Other". If you currently make special arrangements for recycling specific items, please note this in the comments.

ITEM	Recycle Now	Trash Now	Would Recycle	Would Trash	Comments
1. ***Mail (estimated number of items per month)*** (When considering how much you '**Would Recycle**' assume that recycling containers will be available on second floor of NESB for all items)					
Magazines/ Catalogs	_____	_____	_____	_____	_____
Newspapers	_____	_____	_____	_____	_____
Paper Flyers	_____	_____	_____	_____	_____
Professional Mail	_____	_____	_____	_____	_____
Professional Pubs	_____	_____	_____	_____	_____
Card Announcements	_____	_____	_____	_____	_____
Other	_____	_____	_____	_____	_____

2. CSU does not currently enable staff or faculty to leave the mailing lists or receive electronic mailings for items such as announcements, flyers and the newspaper Comment. If the option was available, would you prefer to receive these items by email? _____

FYI: You can remove yourself from many commercial mailing lists by calling 1 888 567 8688

3. ***Office Paper (estimated number of sheets per month)*** (For 'Would Trash' and 'Would Recycle' please also consider whether you can reduce your waste of one-side used paper waste by printing/copying double sided or on once used paper)					
One-side	_____	_____	_____	_____	_____
Double-sided/ once-used	_____	_____	_____	_____	_____
4. ***Corrugated Cardboard (estimated number of one foot cubed box equivalents per month)*** (Recycling container available on first floor of NESB)	_____	_____	_____	_____	_____
5. ***Chipboard (e.g. cereal boxes, non-corrugated cardboard) (estimated number of one foot cubed box equivalents per month)*** (There are no recycling facilities for chipboard at the present time)	_____	_____	_____	_____	_____

Please go on to the next page

(Waste stream, cont'd)

ITEM	Recycle Now	Trash Now	Would Recycle	Would Trash	Comments
6. ***Styrofoam peanuts (You can recycle styrofoam peanuts on campus by calling facilities for pickup. Other forms of Styrofoam cannot be recycled on campus). (Estimated cubed foot volume per month)***	_____	_____	_____	_____	_____
7. ***Batteries (number per month)*** (Recycling available at Environmental Health Services on campus)					
AAA	_____	_____	_____	_____	_____
AA	_____	_____	_____	_____	_____
C	_____	_____	_____	_____	_____
D	_____	_____	_____	_____	_____
Car Batteries	_____	_____	_____	_____	_____

8. What is the primary factor (if any) that prevents you from recycling batteries (e.g. don't know where to, too far, etc.?)

_____

_____

9. ***Aluminum Containers (number of drink can equivalents per month)*** (Recycling container in kitchen of NESB)	_____	_____	_____	_____	_____
10. ***Steel Containers (number of standard food can equivalents per month)*** (Recycling container in kitchen of NESB)	_____	_____	_____	_____	_____
11. ***Plastic Containers (number one drink container equivalents per month)*** (Recycling container in kitchen of NESB)	_____	_____	_____	_____	_____
12. ***Glass Containers (number of one drink container equivalents per month)*** (Recycling container in kitchen of NESB)	_____	_____	_____	_____	_____
13. ***Other***					
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

14. ***Reusing printer paper:*** What percentage of your monthly printing could be printed onto once-used paper on shared network or personal printers? current____ % potential_____%
Comments: _____

15. What is the primary factor (if any) that prevents you printing/copying on both sides or on paper that is already used on one side? _____

Please go on to the next page

(Waste Stream, cont'd)

16. ***Water***

We welcome your comments of ways that we can reduce the amount of water used and water waste at NREL:

_____
_____
_____
_____
_____
_____
_____
_____

16. Are there any waste stream issues or factors that we have not addressed above, but which you feel should be addressed by the Resource Use Audit Committee? Attach extra paper if needed.

_____
_____
_____
_____
_____
_____
_____
_____
_____

Energy Use

1. How many computers do you use at work:

#	Monitor Type (for laptops, list additional monitors used with your laptop)	
___ laptops	___ CRT	___ LCD Flatscreen
___ PC/Windows	___ CRT	___ LCD Flatscreen
___ Unix/Linux	___ CRT	___ LCD Flatscreen
___ Apple	___ CRT	___ LCT Flatscreen

2. Do you use the Power Saving Features on any of these machines? (# of machines)

___ always ___ sometimes ___ to some degree ___ never ___ would like to but I don't know how
___ cannot because computer doesn't support it, or it doesn't work correctly on my computers

3. Do you need to leave your computer(s) on at night for backup purposes? (# of machines)

___ yes ___ no ___ sometimes

4. Do you either shut off your computer and/or monitor at night or have them configured to go into standby or hibernation mode when you are gone? (# of machines)

___ yes ___ no ___ sometimes

Please go on to the next page

(Energy Use, cont'd)

If no, would you be willing to work with support staff to have your computer(s) address any concerns you have, and learn how to put your computer and monitor into standby mode when you are gone?

___ yes ___ no ___ possibly

5. Do you have any appliances, lamps, floor heaters, or other electrical equipment requiring electricity in your office besides your computer? If so, please list them below

Description	Hours used/month	Current Draw (Amperes) or wattage (X if you don't know)

6. Do you turn your office lights off at night or when you leave the room?

___ yes ___ no ___ sometimes

7. CSU facilities is considering installing a set of motion sensors to control the hallway lights at NREL at night. Motion detectors would be installed in each hallway, and would be set to turn on the lights whenever a person steps into the hallway, and turn off the lights after twenty or so minutes of inactivity. The main purpose of having these sensors would be to shut off the hallway lights late in the evening when nobody is working in the building. What do you think about this possible arrangement?

_____
_____
_____
_____
_____
_____
_____
_____

8. Are there any energy issues or factors that we have not addressed above, but which you feel should be addressed by the Resource Use Audit Committee?

_____
_____
_____
_____
_____
_____
_____
_____
_____

Please go on to the next page

Transportation

1. How do you commute from home to work?

# days of the week	transportation mode
___	car
___	walk
___	carpool
___	bicycle
___	bus

2. How many miles is your commute (round trip): ___ miles -or- ___ km

3. Do you participate in the city or CSU Smart Trips program? ___ yes ___ no ___ sometimes

4. When traveling to the airport to travel for business, how do you get there?

Percentage of trips	transportation mode
___	car
___	carpool
___	shuttle

5. In 2001, did you use NREL or CSU teleconference facilities, videoconferencing, or net meeting software to reduce business travel?

___ no ___ yes ____ # domestic airline trips avoided ____ # int'l airline trips avoided
____ # of trips by car/bus avoided

6. Would you be willing or are you able to use NREL or CSU teleconference facilities, videoconferencing, or net meeting software to reduce business travel?

___ no ___ yes ____ sometimes/maybe/other: _____
_____
_____
_____

7. Are there any transportation issues or factors that we have not addressed above, but which you feel should be addressed by the Resource Use Audit Committee?

_____
_____
_____
_____
_____
_____
_____
_____
_____

Please go on to the next page

Are there any other issues that you'd like to share on resource use, conservation, or anything not addressed in this survey that you feel should be?

Thank your for filling out this survey!

Appendix E: Results of the Survey of the NREL employees at NESB

Issue	Ques #	Category	SubCategory	total	mean
Waste Stream	1	MagazinesCatalogs	Recycle Now	13.5	0.71
			Trash Now	17.5	0.92
			Would Recycle	22.5	1.18
			Would Trash	0	0.00
			Comments		
		Newspapers	Recycle Now	69	3.63
			Trash Now	16.5	0.87
			Would Recycle	21	1.11
			Would Trash	10	0.53
			Comments		
		PaperFlyers	Recycle Now	208.5	10.97
			Trash Now	22.5	1.18
			Would Recycle	62.5	3.29
			Would Trash	1	0.05
			Comments		
		ProfessionalMail	Recycle Now	106.5	5.61
			Trash Now	24.5	1.29
			Would Recycle	77	4.05
			Would Trash	3	0.16
			Comments		
		ProfessionalPubs	Recycle Now	5.75	0.30
			Trash Now	14.5	0.76
			Would Recycle	19	1.00
			Would Trash	0	0.00
			Comments		
		CardAnnouncements	Recycle Now	51	2.68
			Trash Now	11	0.58
			Would Recycle	26.5	1.39
			Would Trash	0	0.00
			Comments		
		Other	type	0	0.00
			Recycle Now	2	0.11
			Trash Now	4	0.21
			Would Recycle	6	0.32
			Would Trash	0	0.00
			Comments		
	2	ElectronicMailings			
Issue	**Ques #**	**Category**	**SubCategory**	**total**	**mean**

	3	OneSided	Recycle Now	4660	245.26
			Trash Now	50	2.63
			Would Recycle	243	12.79
			Would Trash	0	0.00
			Comments		
		DoubleSided	Recycle Now	1007	53.00
			Trash Now	0	0.00
			Would Recycle	331	17.42
			Would Trash	0	0.00
			Comments		
	4	CorrugatedCardboard	Recycle Now	16	0.84
			Trash Now	0	0.00
			Would Recycle	2.5	0.13
			Would Trash	0	0.00
			Comments		
	5	Chipboard	Recycle Now	1.1	0.06
			Trash Now	7.1	0.37
			Would Recycle	8.85	0.47
			Would Trash	0	0.00
			Comments		
	6	StyrafoamPeanuts	Recycle Now	0.375	0.02
			Trash Now	0.125	0.01
			Would Recycle	0	0.00
			Would Trash	0	0.00
			Comments		
	7	AAABatteries	Recycle Now	0.167	0.01
			Trash Now	0.083333333	0.00
			Would Recycle	1.083333333	0.06
			Would Trash	0	0.00
			Comments		
		AABatteries	Recycle Now	1.25	0.07
			Trash Now	4	0.21
			Would Recycle	5	0.26
			Would Trash	0	0.00
			Comments		
		CBatteries	Recycle Now	0.25	0.01
			Trash Now	0	0.00
			Would Recycle	0	0.00
			Would Trash	0	0.00
			Comments		
Issue	**Ques #**	**Category**	**SubCategory**	**total**	**mean**
		DBatteries	Recycle Now	0.25	0.01

			Trash Now	0.25	0.01
			Would Recycle	0	0.00
			Would Trash	0	0.00
			Comments		
		CarBatteries	Recycle Now	0.5	0.03
			Trash Now	0	0.00
			Would Recycle	1	0.05
			Would Trash	0	0.00
			Comments		
	8	BatteryRecyclingObstacles	Comments		
	9	AluminumContainers	Recycle Now	43.5	2.29
			Trash Now	0	0.00
			Would Recycle	25	1.32
			Would Trash	0	0.00
			Comments		
	10	SteelContainers	Recycle Now	8.083	0.43
			Trash Now	0	0.00
			Would Recycle	3	0.16
			Would Trash	0	0.00
			Comments		
	11	PlasticContainers	Recycle Now	36.025	1.90
			Trash Now	0	0.00
			Would Recycle	19	1.00
			Would Trash	0	0.00
			Comments		
	12	GlassContainers	Recycle Now	12.025	0.63
			Trash Now	0	0.00
			Would Recycle	7	0.37
			Would Trash	0	0.00
			Comments		
	13	Other1	Recycle Now	0.025	0.00
			Trash Now	0	0.00
			Would Recycle	0	0.00
			Would Trash	0	0.00
			Comments		
		Other2	Recycle Now	0	0.00
			Trash Now	0	0.00
			Would Recycle	0	0.00
Issue	**Ques #**	**Category**	**SubCategory**	**total**	**mean**
			Would Trash	0	0.00
			Comments		

	14	ReusePrinterPaper	current		
			potential		
			Comments		
	15	ReusePrinterPaperObstacles	Comments		
	16	Water	Comments		
	17	OtherWasteStream	Comments		
EnergyUse	1	Laptop	Laptops	6	0.32
			LaptopCRT	2	0.11
			LaptopLCD	4	0.21
		PC	PC	12	0.63
			PCCRT	11	0.58
			PCLCD	0	0.00
		UNIX	UNIX	2	0.11
			UNIXCRT	2	0.11
			UNIXLCD	0	0.00
		Apple	Apple	2	0.11
			AppleCRT	1	0.05
			AppleLCD	0	0.00
	2	Power Savings	always	11	0.58
			sometimes	1	0.05
			ToSomeDegree	1	0.05
			never	0	0.00
			WouldLiketo	3	0.16
			Cannot	1	0.05
	3	LeaveComputerOn	yes	3	0.16
			no	14	0.74
			sometimes	3	0.16
			comments		
	4	ShutOffMonitor	yes	17	0.89
			no	2	0.11
			sometimes	0	0.00
			comments	0	0.00
		ShutOffMonitorTrain	yes	3	0.16
			no	0	0.00
			possibly	1	0.05
Issue	**Ques #**	**Category**	**SubCategory**	**total**	**mean**
	5	Appliances	Description		

			Hours		
			Watts		
			Description		
			Hours		
			Watts		
	6	Lights	yes	16	0.84
			no	0	0.00
			sometimes	3	0.16
			comments		
	7	MotionDetectors	Comments	19	1.00
	8	OtherEnergyIssues	Comments		
Transportation	1	Commute	car	47.00	2.47
			walk	2.00	0.11
			carpool	1.50	0.08
			bicycle	37.50	1.97
			bus	2.00	0.11
	2	CommuteMiles	miles	119.00	6.26
			km		
	3	SmartTrips	yes	0.105263158	0.01
			no	0.789473684	0.04
			sometimes		
	4	AirportTravel	car	900	47.37
			carpool	210	11.05
			shuttle	590	31.05
			comments		
	5	EConferencing	no	1200	63.16
			yes	400	21.05
			#Domestic	3	0.16
			#Intl	0	0.00
			#CarBus	5	0.26
	6	WillingToEConference	no	0	0.00
			yes	1000	52.63
			SometimesMaybeOther	500	26.32
	7	OtherTransIssues	Comments		
	8	OtherGeneralIssues	Comments		