Executive Summary

This report summarizes the findings from an inventory of the anthropogenic greenhouse gas emissions for the University of New Hampshire, Durham campus, from 1990–2003. The purpose of completing the inventory is to clarify the sources of emissions and to guide short- and long-term reduction policies including education and research. The UNH inventory adapts the guidelines of the Intergovernmental Panel on Climate Change (IPCC), a panel of more than 2000 international scientists organized by the World Meteorological Organization and United Nations Environment Programme in 1998, to a university community. The emissions are reported in Metric Tons Carbon Dioxide Equivalents (MTCDE), according to their Global Warming Potential (GWP) to provide the relative contribution of each gas to forcing climate change.

Human activities have led to an enhanced greenhouse effect, commonly referred to as global warming. Since the dawn of the Industrial Age, carbon dioxide concentrations have risen by almost 30%, methane has more than doubled, and nitrous oxide has increased about 15%. In its third assessment report published in 2001, the IPCC concluded, "In light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last fifty years is likely to have been due to the increase in greenhouse gas concentrations." It is certain that human activities have significantly increased concentrations of greenhouse gases in the atmosphere and contributed to the enhanced greenhouse gas effect. While it is unclear exactly what the impacts of a changing climate will be, it is clear that there will be important ecological and therefore human ramifications.

The global average surface temperature has increased over the twentieth century by about 0.6°C. The World Meteorological Organization reported in December 1999 that the 1990s were, globally, the warmest decade since instrumental measurement started in the 1860s. Satellite data shows that there was likely a 10% decrease in snow cover since the late 1960s in the Northern Hemisphere. Northern summer sea-ice extent has decreased by 10-15% and become 40% thinner. Tide gauges have shown that the global average sea level rose 0.1-0.2 meters during the twentieth century. Climate in New England is also changing. Air temperatures in the Northeast United States have increased more than 1°C over the past century, with the greatest warming occurring in southern coastal regions and during the winter season. Precipitation across the region has increased almost 10%, and the growing season length has increased by eight days. Ice out days on lakes are 6-15 days earlier. At Seavy Island, Portsmouth, NH, sea level has risen by almost 0.18 meters (7 inches) in the last century.

With over 15,000 community members, UNH consumes a large amount of energy and therefore is responsible for a significant quantity of greenhouse gas emissions. As a microcosm of society at large, studying UNH's energy use and emissions provides the opportunity to reduce those emissions and educate the university community and the state concerning the significance of energy choices and climate change.

This inventory is an important component in UNH's Climate Education Initiative (CEI). The CEI is a university-wide program integrating the *why* and *how* of greenhouse gas reductions into the teaching, research, operations, and engagement activities of UNH, making it a *climate protection campus*. To achieve its long-term educational goal, the ethics, science, technology, and policies of greenhouse gas reductions must be integrated into the university's community identity and practices. Through this systematic approach, all members of the UNH community are increasing their knowledge and effectiveness in advancing emission reductions in their civic and professional lives.

The explicit goals of the UNH Climate Education Initiative are to:

1) Reduce CO_2 and other greenhouse gas emissions.
2) Educate students and other members of the UNH community about the relationship between human activities and climate change.
3) Strengthen research on impacts, mitigation, and adaptation related to climate change and variability.
4) Develop as a model sustainable community in the state and region.

UNH Emissions - Findings

- UNH emits on average about 60,300 Metric Tons of Carbon Dioxide Equivalents (MTCDE) each year. On average, the yearly percent increase in emissions is 1.8%.
- There has been a net increase (+24.9%) in total emissions from 1990 to 2003 (Figure ES-1).
- When UNH's "upstream emissions" are included in the calculation, the total emissions for the university increase by about 15%. Upstream emissions are the emissions associated with the collection of the source fuel (such as crude oil), and the transport, storage, and refining of the fuels as they are brought to the location of combustion (such as the automobile or university boiler).

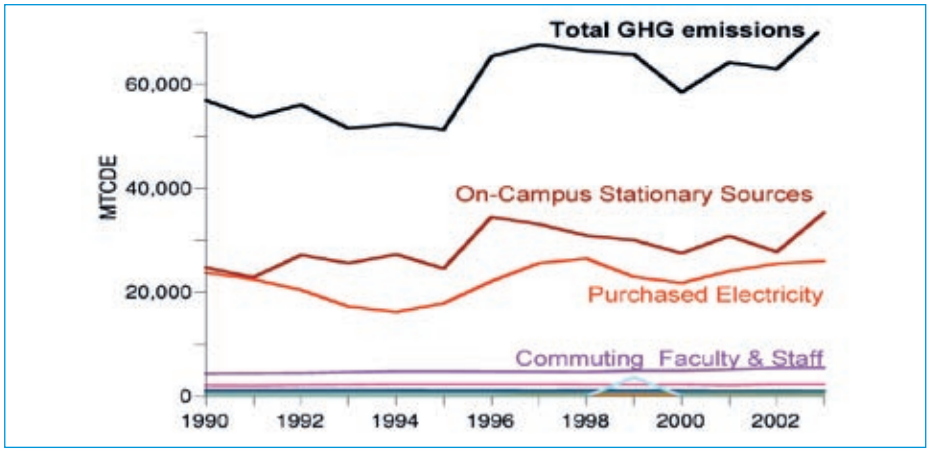

Figure ES-1: Total UNH Direct Emissions 1990-2003
Greenhouse gas (GHG) emission sources and total GHG emissions in metric tons of carbon dioxide equivalents (MTCDE). The lines on the bottom of the graph that are not labeled represent emissions from commuting students (pink), university fleet (blue), agriculture (green), solid waste (brown) and refrigeration (light blue).

Source	1990 MTCDE	2003 MTCDE	% Change
On Campus Stationary Source	24,776	35,366	30
Purchased Electricity	23,827	25,977	8
Transportation: Commuting Faculty/Staff	1,183	1,049	-13
Transportation: Commuting Students	2,097	2,288	8
Transportation: University Fleet	4,408	5,459	19
Agriculture	663	725	9
Solid Waste	N/A	236	N/A

Table ES-1. Percent Change in Emissions per Source for 1990 and 2003. The year 1990 is used as the base year in accordance with international and national protocols. Calculations of solid waste emissions for the years 1990-1996 were not possible because the make-up of waste was not known.

Findings Continued

- The major sources of UNH's emissions result from on-campus stationary sources (49%) and purchased electricity (37%), with all forms of transportation adding up to 13% of total emissions. Solid waste disposal, agriculture and refrigerant releases make up the remaining 1%. (Table ES-2)
- UNH relies predominantly on fossil fuels to meet its energy needs. In fiscal year 2003, the university's energy needs were met by using 81% fossil fuels (coal, oil, gasoline, diesel, natural gas, and propane), 14% nuclear, 5% hydroelectric power production, and 0% renewable. This includes on-campus production, off-campus electricity production, and transportation.
- Total energy use has increased (+33.5%) and energy use per student has also increased (+14.5%) from 1990 to 2003. The increase is due to major new construction projects and significant addition of air conditioning to campus buildings.
- Energy use per square foot has decreased (-5%) from 213 KBtu per SF in 1989 to 204 kBtu per SF in 2003.
- From 1990 to 2003, dependence upon electricity generated by a regional provider has restricted UNH's ability to achieve more aggressive reduction goals.
- Projected emission reductions with a combined heating and power (CHP) facility, approved by the UNH Board of Trustees in February 2004, will exceed internationally established reduction goals (40%) including those called for by the New England Governors and Eastern Canadian Premiers (NEG/ECP) Climate Action Plan (Figure ES-2).
- In order to maintain its "beyond compliance" status resulting from the CHP, UNH will need to continue pursuing aggressive medium and long-term reduction policies.

Source	% MTCDE
On-Campus Stationary Sources	49
Purchased Electricity	37
Transportation: Commuting Faculty / Staff	8
Transportation: Commuting Students	3
Transportation: University Fleet	2
Agriculture / Solid Waste	1

Table ES-2: Sources of UNH's Emissions, by percent, for fiscal year 2003. Total greenhouse gas emissions were 71,000 metric tons of carbon dioxide equivalents (MTCDE).

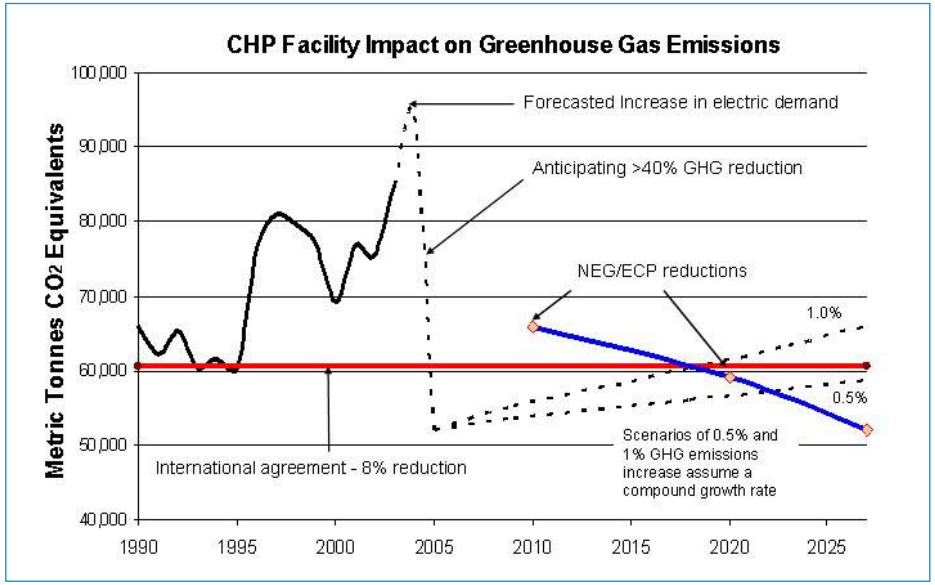

Figure ES-2: Prediction of Impact to UNH's Greenhouse Gas Emissions with a Combined Heating and Power (CHP) Facility. The dotted line represents the drop in emissions when the CHP comes on line in 2005.

Conclusions and Recommendations

General

- **UNH is Making Progress.** UNH has initiated policies that reduce emissions in its campus operations. Despite a growing population of faculty, staff, and students, greenhouse gas emissions have increased at a significantly slower rate than the national average. This was primarily due to a shift from carbon-intensive energy production (such as an incinerator) to natural gas use on campus and energy efficiency projects of the UNH Energy Office. According to a study completed by the US Department of Energy, UNH Energy Office saves $4 million a year (compared to other schools in UNH's peer group in 2000) in reduced consumption due to its efficient use of energy.

- **Energy Consumption Continues to Increase.** Energy consumption and greenhouse gas emissions have increased over the past fourteen years due to infrastructure expansion and added air conditioning. This increase now outpaces efficiency upgrades and behavioral changes resulting from educational efforts.

- **Sustainability Makes Financial Sense.** As a result of rigorous financial and environmental analysis, the UNH Board of Trustees approved the construction of a combined heat and power facility (CHP) slated to come on line in the fall of 2005. Calculations of emissions under the CHP scenario beginning in 2005 project a 40% decrease in the university's greenhouse gas emissions (Figure ES-2). This level of emissions reduction will move UNH well beyond internationally agreed upon reduction targets including those established by the New England Governors and Eastern Canadian Premiers Climate Action Plan. Importantly, these emissions reductions will be achieved with existing technology deployed through a financially-sound business model thereby improving public and environmental health as well economic productivity and competitiveness.

Source-Specific

On-campus Stationary Sources

- **Conclusion:** The production of energy on campus, referred to as "on-campus stationary sources," is the largest producer of emissions, 49% in fiscal year 2003 (Table ES-2). The majority of emissions from on-campus stationary sources occur through the combustion of fossil fuels in the Central Heating Plant to produce steam and hot water.

- **Recommendation:** 1) UNH should maintain its commitment to build the combined heating and power facility (CHP) that will supply the university with energy-efficient heat and electricity. This type of plant uses heat produced in electric generation to heat and cool buildings. This local energy production technology avoids the larger waste heat losses (typically 60%) at large utility power plants. 2) UNH should broaden the reach of educational efforts to further reduce the on-campus stationary source emissions directly through changes in the behavior of UNH's community members.

Purchased Electricity

- **Conclusion:** The production of energy off campus through electric power generation is the second largest contributor of greenhouse gas emissions, 37% in fiscal year 2003 (Table ES-2). UNH purchases its electricity from the New England pool of energy providers and in 2003 purchased 57,844,401 kilowatt hours. Even with the new CHP facility, UNH will still need to purchase 10-20% of its electricity. The fuels used to produce this electricity in New England since the early 1990s have shifted to less carbon intensive fuels (e.g. natural gas, hydroelectric, and nuclear energy). Renewable energy sources account for approximately 0% of the energy market available to UNH.

- **Recommendation:** Despite the anticipated reduction in purchased electricity and the deregulation of the electric market, UNH should factor the educational and social benefits of cleaner power into the decision of what kind of electric production methods to support such as renewable energy sources (biomass, solar, wind, etc.). The CEI Working Group in conjunction with university officials should conduct an analysis of options for green energy procurement available under the recently deregulated energy market and provide recommendations to the UNH administration. Options should include financial analysis of forming or joining a green energy purchasing consortium.

Transportation (Commuting Students, Faculty/ Staff and Transit)

- **Conclusion:** Transportation at UNH is the third largest contributor of greenhouse gas emissions, 13% in fiscal year 2003 (Table ES-2). The emissions result from the daily commuting habits of students, staff, and faculty as well as the operation of UNH's two transit systems. With approximately 2,800 faculty and staff commuting daily, and an additional 4,000 students commuting 3.5 times a week to campus, transportation via single-occupancy vehicles is a community-wide concern. Since adopting a Transportation Demand Management (TDM) policy, policy performance and efficiency has improved through a wide variety of projects undertaken by UNH Transportation Services and Campus Planning. However, full policy implementation has been notably slowed by two factors: 1) faculty contract negotiations nullified a tiered pricing system for campus parking improvements, 2) limited implementation of transportation policies by the Town of Durham called for under its 2002 master plan update.

- **Recommendation:** 1) UNH should continue to incorporate principles of Transportation Demand Management (TDM) into decisions made regarding all forms of transportation and campus development. TDM is a tool to maximize mobility while reducing congestion and the resulting pollution. TDM includes: an efficient transit system, carpooling, parking management strategies, alternative mode incentive programs, bicycles and pedestrian infrastructure enhancements, and housing and scheduling management. 2) The university fleet should continue to replace its diesel-burning fleet with more advanced sustainable technologies such as compressed natural gas, low sulfur–low emission diesel and/or electric/hybrid technologies. Diesel that remains part of the UNH fleet should be biodiesel sourced and regionally produced. 3) An

aggressive education campaign to address the "car culture" mentality should occur to emphasize the availability of other choices such as transit, carpooling, and cycling including regional intercity transit and rail travel options. 4) Work with the Town of Durham to fully implement its transportation policies as called for under the town's 2002 master plan update.

Agriculture, Solid Waste, and Refrigerants

- **Conclusion:** This category makes up a small percentage of UNH's emissions, less than 1.5% in fiscal year 2003. The category includes emissions from UNH's dairy, swine, and equine facilities in addition to emissions from solid waste deposited in landfills. In 2002 and 2003, there were no emissions from refrigerants.
- **Recommendation:** Agriculture: UNH should pursue viable opportunities to capture methane from agriculture (dairy, equine, and swine) for energy use. Solid Waste: Continue to pursue integrated waste management to reduce waste streams and improve recycling efficiency.

In 2003, a *Computer Purchase and Disposal Procedure* proposal was presented to the administration that outlined steps for a disposal policy that is both environmentally and fiscally responsible.

Community

UNH Policy

- **Conclusion:** UNH energy policy, including the efficiency projects of the Energy Office, have to date been driven largely by economics and technology. However, two factors point to the importance of placing UNH energy policy in a broader educational context. First, energy demand will likely continue to increase without purposeful policies to mitigate that trend that include an explicit community ethic to conserve energy. Second, with the establishment of the Office of Sustainability Programs in 1997, UNH has committed itself to a university-wide educational goal of ensuring that all of its graduates develop the competence and character to advance sustainability in their civic and professional lives. UNH Policy can only be achieved through modeling energy efficiency and other greenhouse gas reduction policies and integrating those practices into teaching, research, and engagement activities of the university.

- **Recommendation:** 1) UNH should continue aggressive efforts to increase its energy efficiency and reduce its emissions in all areas. 2) UNH should approach energy decisions keeping in mind not only direct financial costs, but also the environmental and educational effects of efficient energy production and consumption. 3) UNH should incorporate sustainability into implementation of all aspects of the recently updated campus master plan including sustainable design and construction principles, projects of the Campus Energy Office, transportation Demand Management and sustainable landscaping.

Education

- **Conclusion:** The educational goals of the Climate Education Initiative can only be achieved by integrating the *why* and *how* of greenhouse gas reductions across the teaching, research, operations and engagement activities of the UNH land grant mission.

- **Recommendation:** 1) UNH should continue its strong commitment to the *climate protection campus* a part of its community identity, and work with the Climate Education Initiative Working Group to track progress towards long-term goals using CEI indicators. 2) UNH should incorporate emission reduction education, expectations, and concrete guidelines into its Freshman orientation activities both online and on-campus.