# Getting It Done

## Effective Sustainable Policy Implementation at the University Level

*A four-step process has awakened The Pennsylvania State University to its ecological impact and is moving it toward sustainable resource-use policies.*

**by Joshua M. Pearce and Christopher F. Uhl**

### Introduction

In the last 30 years, there has been a growing awareness worldwide of the necessity to reverse the omnipresent processes of ecological degradation and biotic impoverishment and to move toward sustainable practices. In spite of the burgeoning list of ecological problems caused by resource exploitation, manufacturing, transportation, and waste disposal, many people, including research scientists, often think of environmental problems as detached from their everyday lives and personal behavior patterns. However, a growing number of scientists believe that it is important to improve the ecological performance of their own institutions. For example, more than 40 faculty members at The Pennsylvania State University, well versed in both the causes and implications of climate change, recently endorsed the following statement to encourage the university to adopt a policy consistent with scientific knowledge:

> We are Penn State scientists who are familiar with the causes and effects of climatic change as summarized recently (January, 2001) by the United Nations Intergovernmental Panel on Climate Change. We endorse this report and

**Joshua Pearce** is a doctoral candidate in materials engineering at The Pennsylvania State University, where he holds degrees in chemistry and physics. His research interests are green design and solar cell materials and device physics. He currently teaches courses on materials, energy, and society.

**Christopher Uhl** is a professor of biology at The Pennsylvania State University, where he teaches ecology and environmental science and conducts research in the realms of human ecology and sustainability science.

> observe that the further accumulation of greenhouse gases commits the Earth irreversibly to further global climatic change and consequent ecological, economic and social disruption. The risks associated with such changes justify preventive action through reductions in emissions of greenhouse gases. Our familiarity with the scale, severity, and costs to human welfare of the disruptions that the climatic changes threaten leads us to introduce this note of urgency and to call for Penn State to take a leadership role in early action to reduce its greenhouse gas emissions via the most cost-effective means.

As institutions with significant access to the latest knowledge of both ecological problems and sociotechnical solutions, universities have the responsibility to lead society toward sustainable policies (Uhl and Anderson 2001).

Convincing university leaders that their institutions suffer a sustainability deficit and then actually getting them to implement sustainable practices are two separate challenges. An ad hoc group of faculty, staff, and students known as the Green Destiny Council (GDC) united to accomplish these twin goals. This article will describe the process that the GDC used to move Penn State toward sustainability. The process follows four steps and is applicable to both teaching and research universities. First, the foundation of an argument for policy changes is established with an ecological audit of the university using sustainability indicators. From these indicators, a general mission can be formalized to direct decision making. Next, a detailed ecological and economic analysis of a university facility is made to establish sociotechnical solutions that can finally be extrapolated to form specific policies that guarantee more sustainable practices for the entire university.

**Audit of sustainability indicators.** At Penn State, a group of faculty, staff, and students participated in defining the university's sustainability indicators. The process consisted of dividing the university into nine systems: energy, water, materials, food, land, transport, buildings, community, and research. The group then defined sustainable practices for each university system. For example, a sustainable energy system would be based on renewable energy and be highly efficient and nonpolluting. Hence, the energy indicators measured if Penn State's energy system was becoming less dependent on fossil fuels, less wasteful, and less polluting over time. In all, 33 indicators were developed for gauging sustainability of the university. Guided by these indicators, Penn State's performance in the nine systems was analyzed. In most cases, the data for the indicators already existed but had never been used to assess sustainability. For example, preexisting university maps showed that the proportion of green space covered by impervious surfaces on campus had increased by 50 percent between 1970 and 2000 (The Pennsylvania State University Green Destiny Council 1998). Often the data for the various indicators were plotted, and depending on the trends over time, indicated a movement toward or away from sustainability. The first *Penn State Indicators Report* roused considerable dialogue both within the university and in the regional and local media (The Pennsylvania State University Green Destiny Council 1998). The report depicted an institution whose performance, measured by sustainability indicators, was not exemplary. Exposure in the media generated awareness in all sectors of the Penn State community of the need for improvement. A second report was released two years later (The Pennsylvania State University Green Destiny Council 2000). These two reports provided a benchmark for measuring improvement or regression in terms of sustainable practices, but, in and of themselves, these reports did not have the power to effect policy change. However, they did form the basis for a credible call for the creation of a comprehensive and formally stated ecological mission for the university.

**Ecological mission.** To alter university policies to the extent demanded by sustainability, the concept needed to be institutionalized (Uhl and Anderson 2001), which was accomplished in the following process. First, several members of the GDC drafted an ecological mission for the university. Next, to open the process and cultivate support, especially among faculty and staff in positions of leadership, the GDC invited 150 university leaders (including all top administrators) to review the proposed mission. The GDC asked reviewers to indicate a stance on each mission element (i.e., support, do not support, undecided) and encouraged them to include specific reactions to any or all of the components. In this way, university leaders began to share ownership of the concepts and ideas within the proposed mission. The GDC then modified the language of the mission to address the reviewers' concerns, then summarized it in an internal report that was circulated to the reviewers. Finally, the GDC wrote a consensus statement that offered a clear, concise vision to guide future Penn State decisions.

This ecological mission statement was unanimously approved by the Faculty Senate and signed by the university's president (University Faculty Senate of The Pennsylvania State University 2001). It called on the university to fully incorporate 10 long-term goals into all future strategic plans (see www.bio.psu.edu/greendestiny/publications/gdc-eem.pdf):

- Significantly reduce polluting emissions associated with the usage of fossil fuels
- Conserve and protect water resources
- Minimize solid, liquid, and hazardous wastes
- Utilize, to the fullest extent possible, food produced using sustainable practices
- Create and abide by a land ethic that promotes stewardship of natural processes, ecosystems, and the conservation of green space
- Promote and use sustainable transportation options
- Strive to create sustainable campus environments by considering ecological impacts in the planning, design, construction, renovation, and maintenance of all university facilities
- Promote ecological literacy by modeling sustainable practices
- Act as a "role model" for students and society for ecological sustainability
- Act as a lead institution in promoting and supporting research for a sustainable world

The act of formally embracing these principles was an important first step in institutionalizing sustainability at Penn State. Two months later, the Finance and Business Administration created a formal "Environmental Stewardship Strategy," which, for the first time, provided concrete initiatives to further the goals of sustainability (The Pennsylvania State University Finance and Business Administration 2001). For example, to encourage environmentally responsible purchasing policies, the university committed to actions such as

- holding a U.S. Environmental Protection Agency's Energy Star purchasing program briefing for the university's purchasing staff (summer 2001);
- initiating Energy Star purchasing policies where possible to make cost-effective decisions about purchasing energy-efficient products (summer 2001);
- encouraging Purchasing Cardholders (university employees authorized to acquire materials, supplies, and services for a specified university administrative area by using the purchasing card) to purchase Energy Star products (fall 2001);
- encouraging vendors to offer more environmentally friendly alternative products (ongoing).

**Ecological and economic analysis of a university facility.** A detailed ecological and economic analysis of a high-profile university facility illustrated exactly what could be done to move toward sustainability and how it could save money in the long term. It, thus, paved the way for moving the concept of sustainability from general platitudes to concrete actions. The Mueller Biology Building, which is located at the center of campus and typical of much of Penn State's aging infrastructure, was chosen for analysis. The study began as an assignment for a senior-level biology class. Analyzing the building as an ecosystem, students generated recommendations in terms of technical efficiency and behavioral changes to cut the building's ecological impact in half while creating healthier working conditions for all occupants in an economically responsible manner. The students were divided into groups, each researching a particular domain of impact (e.g., electricity, water, paper, carpet) to determine (a) annual consumption; (b) the ecological impact of that consumption; (c) the availability of lower-impact alternatives that would not impair the research, teaching, administrative, or outreach activities of the building occupants; and (d) the ecological impact reductions to be realized if these alternatives were adopted. This initial work was completed and passed along to graduate students and faculty for fact checking, methodological rigor, synthesis, and criticism.

The study made it clear that the building's environmental impact is the result not just of the amounts of materials and energy used but also of the types of materials and energy procured. In the case of energy, on an annual basis, the building consumes 2,872,210 kilowatt-hours of electricity and an additional 2,564,019 kilowatt-hours equivalent in heating energy. This energy consumption is linked to the burning of 2,223 tons of coal, which releases more than 5,750 tons of carbon dioxide (a greenhouse gas). On an annual per capita basis, the numbers are sobering: 18 tons of coal, 46 tons of carbon dioxide (The Pennsylvania State University Green Destiny Council 2001). To decrease these figures, the study made policy suggestions encouraging energy conservation, energy efficient retrofits, and the increased use of renewable energy sources.

Following Keniry (1995), the Mueller study also suggested policies to reduce the ecological impact of materials by restricting purchases, to the extent possible, to products that (a) have a high recycled content; (b) are produced in an environmentally sustainable manner; (c) demonstrate maximum durability or reparability; and (d) are energy efficient, nontoxic, and recyclable. Finally, the study made policy suggestions describing how to design new buildings to be five times more energy efficient than the current building stock. Ecological standards for new buildings were adapted from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED™) standards (www.usgbc.org/LEED/LEED_main.asp) and offer a method for Penn State to construct new campus facilities while maintaining its commitment to environmental stewardship.

Remarkably, the study also revealed that it is economically advantageous to reduce the environmental impact of older campus buildings such as the Mueller building. For example, if both behavioral and technical improvements were made to reduce the building's energy use, then more than $45,000 could be saved each year (The Pennsylvania State University Green Destiny Council 2001). If these results are extrapolated based on square foot ratios between Mueller and other College of Science buildings, adopting sustainable policies could save Penn State's Eberly College of Science nearly half a million dollars each year. The GDC found that concentrating on such economic aspects of sustainable policy is a highly effective method to gain the interest and favor of university decision makers.

As with the earlier *Indicators Report*, reviewers' copies of this document were assembled and distributed to selected faculty and administrators to build a larger consensus. Incorporating suggestions and criticism from reviewers, the Mueller study team printed the final report with reviewers' comments on the back cover and officially released it to the university community in a public ceremony on the steps of Old Main (the main administrative building for Penn State). The response to the report was positive (The Pennsylvania State University Green Destiny Council 2001). Soon after the report's release, the *Mueller Report* team and officials from relevant sectors of the university held several meetings, and, within six months, Penn State committed to retrofit Mueller following many of the specific guidelines in the report.

**Implementing sustainable practices.** The publishing of reports such as the *Penn State Indicators Report* and *Mueller Report* did not necessarily guarantee that the university would begin to adopt sustainable policies. Something more was needed. The GDC found that an effective way of making sustainable solutions accessible and convenient to implement is to publish short policy papers focusing on a specific topic that is applicable university wide.

## Low-Hanging Fruit

Universities have finite resources to expend implementing sustainable practices. If the goal is to move the university as far as possible toward sustainability, ecologically sound policies that actually save money should be identified. This is the low-hanging fruit. For example, the first policy paper published by the GDC called for the university to reduce the standard margin settings on word-processing software to use paper more efficiently. Raw data demonstrating the benefits of this strategy came from the *Mueller Report* and

> Universities have finite resources to expend implementing sustainable practices.

was extrapolated to the entire university using the data present in the earlier *Indicators Report* for campuswide paper consumption. Default margin settings in common word-processing packages are 1.25" for the left and right margins and 1" for the top and bottom margins. If all the margins are reduced to .75", 19 percent more area is available for text in a given page of an "ideal" document. This analysis revealed that by reducing the default margin settings in word-processing software to .75" on university computers, Penn State could prevent more than 70 acres of forest from being harvested, divert 45 tons of waste from landfills, and save more than $120,000 in paper and disposal costs each year (see figure 1). Other projects that have negligible capital investments and enormous environmental and economic returns include

- activating Energy Star features on electrical equipment,
- buying recycled toner cartridges that cost less than new ones,
- synchronizing heating and cooling systems so that they do not run simultaneously in the same room,
- asking janitors to turn off lights at night,
- instituting temperature setbacks during breaks,
- replacing paper publications with electronic ones.

## Using the Right Decision-Making Metric Leads to Sustainable Practices

Even though much of the fruit of sustainable practices will save money in the long term, institutions can miss the "harvest" when the switch to sustainable practices entails large initial investments. To improve the probability of implementation of large-scale sustainable practices, the economic justification should be customized for the sector of the university that will be affected by the change and the vocabulary should reflect that which is utilized. For example, at Penn State, the physical plant engineers are familiar with simple payback (i.e., the time it takes for an improvement to pay for itself), whereas administrators are more comfortable with rate of return on an investment. To transfer from one economic vocabulary to the other, information on the lifetime of the sustainable innovation (i.e., project or device) is needed. The relationship is summarized in the equation: $P/S = (1–e^{-RT})/R$, where P is the principal investment, S is the savings from environmental improvements per year, R is the rate of interest in percent, and T is the lifetime of the sustainable innovation. P/S is thus the payback time for the sustainable improvement. A graphical method simplifies the transition from one economic indicator to another by plotting the lifetime of a sustainable improvement as a function of payback time for given rates of interest.

This graph, as shown in figure 2, is extremely helpful in illustrating the economic argument for many sustainable innovations. As an example, consider the 701 magnetic ballast T-12 fluorescent lights in the Mueller building. The *Mueller Report* estimates the payback time for replacing a T-12 magnetic ballast fluorescent light fixture with a more energy efficient T-8 electronic ballast light fixture is 6.1 years for the 77 lights in the hallways and stairwells that are left on 24-7 and approximately 10.4 years for the less frequently used remaining lights in the classrooms and offices. Neither of these investments appears to be economically appealing in the simple payback model because the lifetime of the ballasts is not taken into account. However, assuming that electronic ballast lasts 25 years, the return on investment is well over 8 percent in the classrooms and more than 15 percent in the hallways (The Pennsylvania State University Green Destiny Council 2001). The point is this: Environmental improvements should be considered the

Figure 1 **Economic Savings from Default Margin Reductions at Penn State**

| | Status Quo | With .75" Margins[f] | Savings |
|---|---|---|---|
| Paper (reams/year)[a] | 950,350 | 905,208 | 45,142 |
| Disposal (tons/year)[b] | 950 | 905 | 45 |
| Forest Acres[c] | 1,524 | 1,452 | 72 |
| Purchase of Paper Cost[d] | $2,584,952 | $2,462,166 | $122,786 |
| Disposal Cost[e] | $4,750 | $4,525 | $225 |
| Total Cost | $2,589,702 | $2,466,691 | **$123,011** |

**Notes**

a. One ream contains 500 sheets of paper

b. Reams x (2 lb./ream) x (1 ton/2000 lbs.)

c. Tons x 70.6ft$^3$ wood per ton of paper/44ft$^3$ of wood produced/acre/year

d. Reams x $2.72/ream, Penn State General Store (www.generalstores.psu.edu/)

e. Tons x $5/ton for disposal

f. The reduction in paper use is based on the following conservative estimates: Page savings will only be realized for approximately 50 percent of documents (a 1.5 page paper would gain no reduction in paper use for margin reductions); 50 percent of paper is used for printing or photocopying printed documents; and 19 percent more area is available with .75" margins. Thus, the total reduction in paper use is .50 x .50 x .19 = 4.75 percent. Finally, it is assumed that all university paper is recycled (Penn State pays $48/ton for land filling of nonrecyclables and only $5/ton for recyclables).

Source: Data from *The Penn State Indicators Report* (2000)

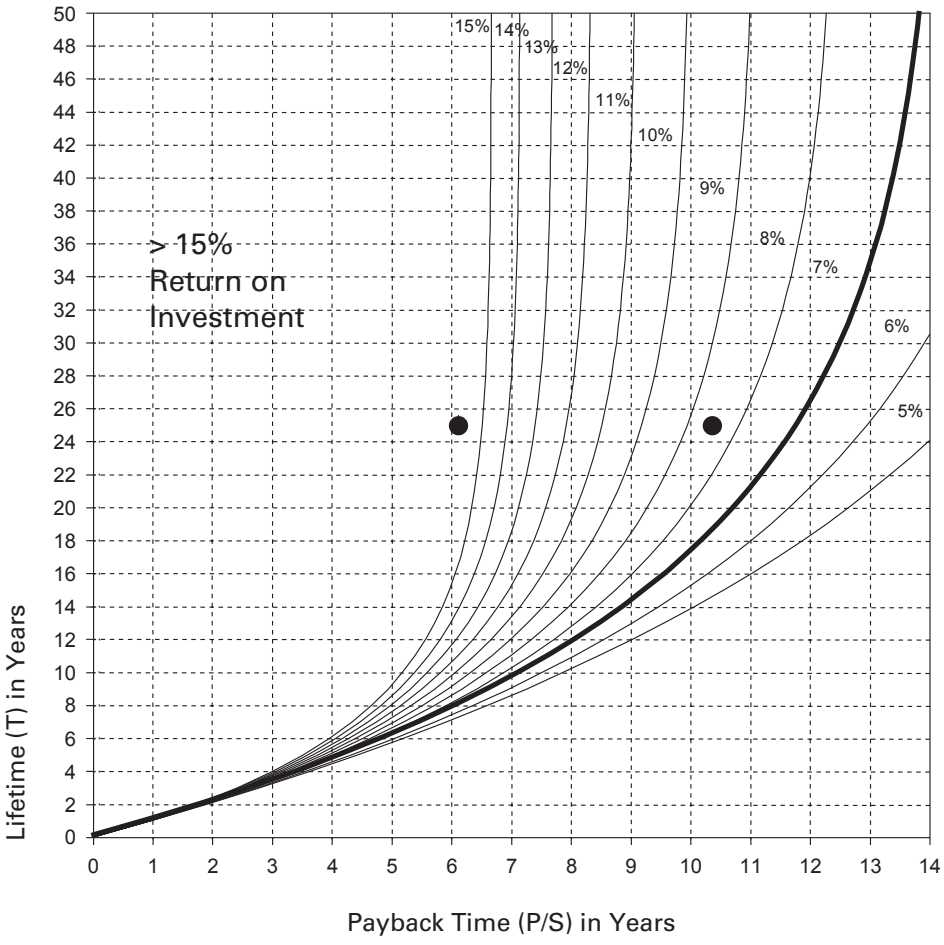
same as market investments from a purely economic perspective. At Penn State, an approximately 7 percent rate of return is expected on long-term investments. Thus, any investment below the 7 percent line is fiscally unacceptable and any investment above this line is fiscally justifiable.[1]

The GDC found that in any economic analysis for the university, all of the assumptions should be extremely conservative to prevent any disagreement over numbers. It is also important for all work to be as rigorous as possible to maintain credibility with decision makers. In figure 1 (paper-margin example), the assumptions were extremely conservative and the possible savings represent a lower-end estimate. In this case, the only investment was the amount of time needed to change margin settings on computers. In other cases, not only is there a large capital investment needed for equipment, but the labor costs can have a significant impact on the economic viability of projects. However, not all costs and benefits can be fully quantified (e.g., the long-term costs of pollution on human health, the psycho-emotional benefits of creating buildings with ample natural lighting, the benefits of good environmental publicity). Pure economics cannot always provide the optimal policy guidelines. In these cases, the university's ecological mission is invaluable for directing decision making.

## Seeing the Whole Picture

Although all sustainable practices benefit the working and learning environments of the university, some save money and some cost more than the status quo operations. A useful method for implementing as many sustainable practices as possible is to consider the improvements in aggregate, thus using the money saved from highly cost-effective improvements to finance the less cost-effective but nonetheless environmentally desirable improvements. In this way, the operation of the university will still cost

Figure 2 **Lifetime of Environmental Improvement Plotted as a Function of Payback Time for Given Rates of Interest**




Note: The lifetime of an environmental improvement is plotted as a function of payback time for given rates of interest (in percent). The 7 percent line represents the return on investment used to make economic decisions at Penn State. The filled circles illustrate the economic data for replacing a T-12 magnetic ballast fluorescent light fixture with a T-8 electronic ballast light fixture with a 25-year lifetime in the hallways (P/S=6.1 years) and the classrooms (P/S=10.35 years) in Penn State's Mueller Biology Building.

less after a number of sustainable practices have been implemented, and the university will be able to enjoy all the benefits of the proposed changes rather than only the low-hanging fruit.

For example, the *Mueller Report* suggested that, when possible, the biology department should purchase paper that is made from 100 percent postconsumer recycled content, manufactured by a "totally chlorine free" process, containing wood fiber from sustainably managed forests, and originating from within the mid-Atlantic region. This sustainable paper costs more than standard copier bond. However, the report also suggested printing documents using slightly smaller fonts, narrow margins, and reduced line spacing to the extent possible; setting all printer defaults to "duplex"; and reusing the clean side of single-sided pages for draft printing. All of these suggestions would save money as well as decrease environmental impact. Thus, when viewed as a whole, the paper system could encompass all the ecologically superior suggestions while still reducing Mueller's per capita paper costs by almost $25 per year (The Pennsylvania State University Green Destiny Council 2001).

## Using Long-Term "Systems Thinking" Leads to Sustainable Practices

Creating a sustainable institution requires long-term thinking. Hence, for decision making to be sustainable at the university level, it should be guided by the question: What is in the best long-term interest of the entire university? This question gives many universities the opportunity to make organizational adjustments to ensure long-term thinking, which can save them millions of dollars while encouraging the adoption of sustainable practices.

For example, at many universities such as Penn State, the decisions concerning the funding of new construction and renovation are often made independently from those concerning the costs of operating and maintaining infrastructure. Capital projects are funded by the state (for state schools), the university's general funds, and gifts, whereas tuition and state appropriations fund operation and maintenance. With the operating costs over a building's lifetime roughly equal to the initial cost of building construction, every time money is donated for new infrastructure it must be matched by another sector of the university. Thus, there is no built-in incentive to conserve university resources when designing and constructing new buildings.

In addition, this organizational structure forces university leaders to make decisions that are not in the best long-term economic or environmental interests of the university community. For example, consider the dilemma the dean of Penn State's Eberly College of Science recently faced. He had to decide between funding a recirculating water-cooling system for new scientific equipment or paying the salary of a new faculty member. The recirculating water system would conserve water. In addition, in the long term, it would save the university money by offsetting water and sewage fees (operating costs), which might be

> Creating a sustainable institution requires long-term thinking.

used for more generous faculty salaries or offsetting tuition increases. However, under the current organizational structure, the College of Science is not responsible for the costs of water and sewage. Thus, there is no incentive to make the long-term economically and environmentally rational decision for the entire university. The result: Thousands of Penn State dollars go down the drain.

At Penn State and other universities facing similar dilemmas, such unfortunate policy ramifications could be corrected by one simple policy change: University administration could require that for every development project a fund be set aside[2] to finance the operation and maintenance of that project. The annual income from such a fund and a gradual draw on its capital would suffice to pay for the operation and maintenance of the project over its lifetime. The more efficiently a project or building was designed to operate, the smaller this additional sum would need to be. The real advantage of this policy is that it would encourage the designers of new facilities (and the renovators of older ones) to think in the long term. Rather than optimize a building or device to minimize *initial* cost, the design will minimize *total* cost (initial plus maintenance and operation). Thus, a policy change concerning only long-term economic thinking would catalyze a move to an integrated process of design, construction, and maintenance in order to maximize efficiency, save money, and decrease environmental impact. This "intelligent" building commissioning policy would reduce building operating costs, provide better facilities, and decrease waste costs without impairing the research, teaching, outreach, maintenance, operation, administrative, and fund-raising functions of the university.

## The Short Policy Paper

The GDC found that expressing policy suggestions in succinct, single-page documents increases the probability that they will be considered for implementation. For example, the GDC has presented an economic argument for paper margin reductions and up-front funding of operational costs for new buildings to the university as one-page policy papers (www.bio.psu.edu/greendestiny/publications.shtml).

A single page is far more likely to be read than a long, complex document. Limiting the concept to one page will also guarantee that it is focused enough for easy implementation.

As is the case with all GDC reports, there are several steps leading up to the formal release of these short policy papers. First, a draft of the policy paper and the relevant data packet are circulated among some faculty and, in some cases, to affected units to ensure accuracy of calculations, uncover hidden assumptions, and assess overall viability. Suggestions are requested and incorporated into the final draft. Besides adding academic weight to an argument, this approach invites others to share ownership of the policy.

The GDC delivers the policy papers to those with the authority to make decisions but who are not responsible for details. The details are included in a separate packet that outlines all assumptions and calculations as transparently as possible and is made available to those who would actually be responsible for implementation of the policy.

Expressing policy suggestions in one-page documents increases their likelihood of implementation.

So far, the GDC has released five policy papers by sending personal letters to the university president and press releases to the media. The GDC avoids polarizing or inflammatory language and abstains from assigning blame for inadequacies. Instead, the GDC frames all suggestions as opportunities rather than faults. For example, a paper from the GDC might include a statement such as "Penn State has the opportunity to save more than $45,000 a year in energy costs for the biology building by following the socio-techo suggestions in the *Mueller Report*" rather than "A recent study found that Penn State is wasting $45,000 a year because of antiquated technologies and negligence in the biology building." The GDC's letters specifically ask the president to take an action. At Penn State, the president has been directing the GDC policy suggestions down the chain of command to the relevant decision makers. This very act adds institutional support encouraging the adoption of the sustainable policy. Finally, a follow-through is necessary to ensure that the sustainable policy is instituted. When Penn State decision makers make policy changes, they are thanked and congratulated both at an interpersonal level and in the media (e.g., editorials).

Because each sector of the institution (e.g., academic, administrative, operations) instinctively protects its jurisdiction and autonomy, all-encompassing shifts in university policy are sometimes complicated and slow. Institutional inertia and unintended perverse incentives provide a chronic resistance to sustainable policy implementation. Not all of the sustainable policies suggested by the GDC have been implemented (yet), and some were only partially implemented. The greening of Penn State is a work in progress.

## Conclusion

For large institutions, such as Penn State, the key to implementation of sustainable practices is following a long-term program based on persistence, not insistence. This long-term process encompasses four steps. The first step is to create the impetus to consider sustainability a variable in decision making. The *Indicators Reports* did this by effectively putting the concept of sustainability on the radar screen for university leaders. This has set the stage for asking the question: How might we embody environmental concerns in our teaching, research, and service missions? This question has led to the formulation and approval of an ecological mission for Penn State—the second step. The third step in this process has been to offer a blueprint for sustainable practices by focusing on a single, high-profile building and showing how its ecological impact can be cut in half while saving money for the university. Finally, short policy papers are valuable for extrapolating these findings to the entire university and institutionalizing sustainability.

## Notes

1. It should be noted that this analysis is a short cut and that to be economically rigorous, the net present value analysis between two options is technically more accurate. However, the above equation is valid for all but special cases with uncommon cash flows (e.g., a project with a high return initially that decreases with time will appear desirable from a payback time analysis when, in fact, it may not be).
2. In order to simplify the application of this policy, the additional funds could be put into the current investments that provide for the operations and maintenance budget.

## References

Keniry, J. 1995. *Ecodemia: Campus Environmental Stewardship at the Turn of the 21st Century*. Reston, Va.: National Wildlife Federation.

The Pennsylvania State University Finance and Business Administration. 2001. *Environmental Strategy*. Retrieved December 10, 2002, from the World Wide Web: www.opp.psu.edu/f&benvstrategy/goals.htm.

The Pennsylvania State University Green Destiny Council. 1998. *The Penn State Indicators Report*. University Park, Penn.: Green Destiny Council, Pennsylvania State University.

———. 2000. *The Penn State Indicators Report: Steps Toward a Sustainable University*. Retrieved December 10, 2002, from the World Wide Web: www.bio.psu.edu/greendestiny /publications/gdc-indicators_2000.pdf.

———. 2001. *The Mueller Report: Moving Beyond Sustainability Indicators to Sustainability Action at Penn State*. Retrieved December 10, 2002, from the World Wide Web: www.bio .psu.edu/greendestiny/publications/gdc-mueller _report.pdf.

Uhl, C., and A. Anderson. 2001. Green Destiny: Universities Leading the Way to a Sustainable Future. *BioScience* 51: 36–42.

University Faculty Senate of The Pennsylvania State University. 2001. Senate Recommendations for Developing an Ecologically Sustainable University. *Senate Record* 34(4). Retrieved December 10, 2002, from the World Wide Web: www.psu.edu/ufs/janrec3.html.

**Acknowledgments**

The authors would like to acknowledge helpful discussions and collaborations with Austin Mandryk, Ford Stryker, David Denkenberger, Christopher Russill, and James Eisenstein.