Greening Harper House
Budget-Conscious Environmental Solutions for the Center for Environmental Studies and Other Small Buildings

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This building is a powerful example that green architecture doesn't demand a cleared site and a new foundation—that we know tricks enough these days to make any building work both for its users and for the planet.

-Bill McKibben on Middlebury’s Franklin Environmental Center, a LEED-platinum historic building

As the Center for Environmental Studies and Williams College administrators work to create a more environmentally-friendly campus, sustainable reuse of the College’s many historic buildings can significantly lower the impact of the built environment. The construction, operation and demolition of buildings accounts for 48% the United States’ greenhouse gas emissions, so the built environment has great potential for reducing energy use and emissions (“Sustainability by the Numbers,” 2009). In the effort to make the Williams campus more sustainable, greening buildings be a priority—the value of sustainable design extends beyond the environment, enhancing education and community to reconnect humans with the natural world. While any particular structure may not make a large difference in the College’s energy consumption or environmental footprint, many buildings together can make a significant impact. Williams College owns over 80 structures containing less than 5,000 square feet, most of which are historic residences (either dormitories or rental properties) or residences converted into administrative offices; the same small-scale environmental solutions can be applied to almost all of these buildings to great reward.

Greening its many historic buildings provides Williams a fitting way to distinguish itself from its peer institutions. The College is renowned for the wide variety and high quality of its campus architecture, so environmental initiatives that adapt historic buildings for a sustainable future would only strengthen the College’s resources. Williams lagged behind some of its competitors in making its new construction projects green, and sustainable building practices have become mainstream enough (especially among colleges) that only the most cutting-edge
technologies and ideas garner much outside attention. The College would be one of the first, however, to have a widespread focus on greening extant buildings, so a strong commitment to sustainable design for its historic structures would give Williams a distinctive form of environmentalism.

The work is particularly relevant in the current economic crisis, when new construction is delayed and money for new, state-of-the-art environmental buildings has evaporated. In addition, extant structures (especially the historic ones built of high-quality materials) have significant embodied carbon emissions, between five and 15 gallons of gasoline per square foot, that cannot be recovered; demolition and new construction only adds to the emissions of a project (“Sustainability by the Numbers”). According to the National Trust for Historic Preservation, recent research suggests that an energy-efficient new building takes 35-50 to save the amount of energy lost in demolishing an existing building (“Sustainability by the Numbers,” 2009). Simple, cost-saving energy and resource conservation measures can be implemented on most historic buildings, allowing the College to apply the same basic guidelines to numerous structures. Williams should devote special attention to Harper House, the Center for Environmental Studies building, which could be retrofitted and renovated to make a prototype green building.

**Background and History of Harper House**

After several decades at Kellogg House, the Center for Environmental Studies (CES) moved to temporary quarters in Harper House (Figure 1) in summer 2008. Kellogg must be moved to make way for construction of the Stetson-Sawyer library, and will be renovated once moved; Williams has indefinitely delayed the construction project in response to the current economic slump, and, in turn, delayed CES’s return to its permanent building. The Center for
Environmental Studies will be in Harper House for an indeterminate period of time—through 2011, at least—and so CES could make a worthwhile investment in “greening” the building.

Figure 1: Harper House, 54 Stetson Court (A. Johns photograph, Williams College map).
Built as a residence around 1911, Harper House has seen a series of additions that have approximately doubled the size of the original house. The 4,356 square foot building was a private residence until 1996, when the late George and Sylvia Harper left it to the school; Williams promptly converted the building into administrative office space. The College’s Philosophy Department occupied the house, which has retained many elements of its domestic past, from 1996 until the Center for Environmental Studies took over in summer 2008. The back wing, once a semi-detached apartment, includes two finished rooms in the basement (which is at
grade on the rear façade, forming a walk-in basement), but they and the larger unfinished basement are unoccupied. The first floor contains five offices, two bathrooms, a computer lab and library, a large seminar room, a kitchen, a pantry, a lounge, and two glassed-in porches (Figure 2). The second floor contains six offices, four bathrooms, and a second pantry (Figure 3). The building has seen minimal renovations since its time as a residence, and so many features of domestic living linger amidst the office space: numerous closets, several fireplaces, a wood stove (on the ground floor of the back wing apartment), a butler’s pantry, and other oddities.

Figure 3: Harper’s bathroom-rich second floor (plans from Williams College Facilities).
The College must take great care in working on Harper House, as an earlier underground oil spill is likely to complicate renovations and major construction projects. Soon after receiving Harper House, the College discovered that a storage tank under the driveway had leached \#2 heating oil into the soil (D. Clark). Most of the contaminated soil was removed, but as with many petroleum leaks, slightly-contaminated soil remains over a large area; as long as this soil is not disturbed, it is not deemed a human health risk. Therefore, the land below and around Harper House is subject to an Activity and Use Limitation: should the College do any work on the building that requires disturbing the soil, it would have to file extensive paperwork (including a Health and Safety Plan), constantly monitor excavated soil for traces of petroleum, and divert all contaminated material to a hazardous waste dump. Although most renovations would not require disturbing soil around Harper House, and so would not fall under the AUL, the rigorous permitting could add complications (and expenses) to any big construction project at the building.

**Electricity Consumption**

Electricity use at Harper House has risen sharply since the Center for Environmental Studies moved in, presumably because CES uses the building more intensively than the Philosophy Department, the building’s previous occupants. The majority of Harper’s electricity goes to power the kitchen refrigerator, fluorescent overhead lights, a photocopier, three printers, approximately 12 desktop computers, a microwave, and a large-screen television and media center (which is usually turned off through its power strip). A variety of smaller appliances, including a paper shredder and fax machine, contribute to the building’s energy consumption.

The building used 6,212 kWh of electricity in 2008, at a cost of $1,007 (Figure 4); the increased electricity consumption in September-December 2008 has continued into 2009, indicating that CES’s additional consumption is a long-term trend. Simple observation suggests
that, although faculty and staff usage of Harper House has declined with the advent of CES, the building’s student usage has increased enough to raise the overall electricity consumption. The CES faculty are almost all members of other departments, and so the intensity of use has decreased while the number of occupied offices (10) remained constant. Three of the CES faculty members split their time between offices in Harper and offices elsewhere on campus; two other offices belong to faculty who have long commutes and regularly work from home, rarely using their Harper House offices.

Figure 4: Harper House electricity use, January 2008-April 2009. The Center for Environmental Studies moved into the building in August 2008 (data and graph from Sustainability at Williams).
Unlike the Philosophy Department, however, the Center for Environmental Studies leaves Harper House open to students 24/7 during the school year, and their presence more than makes up for the decline in faculty/staff occupation. (The building’s overall energy consumption is small, and so a small difference in electricity demand, like the increase since CES moved into the building, will be statistically significant.) The student usage of Harper is particularly energy-intensive because it is often after dark—even energy-conscious nighttime occupants have to turn on electric lights that daytime occupants can do without—and also involves heavy computer/electronics use. Of the 96 Williams buildings with real-time electricity monitoring, Harper House ranked 81st in energy intensity per square foot during the 2008-2009 school year, using less energy per square foot than all but 16 other buildings (Sustainability at Williams, 2009). This puts the building’s electricity consumption approximately in the middle of similarly-sized buildings.

**Heating Fuel Consumption**

Harper House ranks worst for fuel consumption per square foot among the 31 monitored campus buildings. And, not surprisingly, heating oil was building’s most expensive utility: 4,029 gallons of #2 home heating oil cost the College $10,074 (D. Clark). The fuel goes to produce hot water for the building’s radiators. Harper House may not be the most fuel-inefficient building on campus, because many Williams buildings are on the College steam lines and so their proportion of the co-generation plant’s fuel consumption is not monitored. But most of the other 30 structures whose #2 oil use is monitored are similar to Harper: small, historic wood-frame buildings housing administrative offices or student dormitories. A 2007 energy audit rated the furnace at 78% efficiency (Figure 5), making it a candidate for replacement—new units have upwards of 92% efficiency, and the Department of Energy suggests homeowners consider
replacing furnaces that perform at under 80% efficiency (DOE, 2009). Much of the house’s poor fuel efficiency can be blamed on a combination of an inefficient furnace and under-insulated building. The building requires more heat to maintain a certain ambient interior temperature, and the furnace, in turn, requires more fuel to produce that heat. Harper House is a maze of passageways and rambling additions, so the building’s ratio of exterior walls to internal volume is relatively high; the increased surface area provides more opportunities for air infiltration, leaving Harper at a disadvantage when compared to more compact buildings that squeeze more interior volume into the same exterior surface area.

![Image of energy audit report]

Figure 5: the furnace’s 78% efficiency (A. Martin image).
Water Consumption

In 2008, Harper House used 123 CCFs of water, or about 92,004 gallons, at a cost of $1353 (D. Clark). This represents a slight increase in consumption from the previous year, probably attributable to an increase in student usage (following the same pattern as the electricity consumption). The building has five full bathrooms and two half-bathrooms, plus a kitchen sink and two utility sinks, for a total of 10 sinks, seven toilets, and five bathtubs/showers. The major water use is limited to the toilets, kitchen dishwasher (run once daily), and sinks. The six offices on the second floor have between them four bathrooms (two en suite from when the offices were bedrooms), while the first floor contains two bathrooms and the basement yet another; five of these bathrooms also contain a shower or bathtub, unnecessary in an academic office building. Some of the fixtures leak or drip, and all of the toilets exceed the 1992 Federal Energy Policy Act standard of 1.6 gallons per flush.

Sustainability Recommendations

One of the first steps towards a sustainable Harper House should be energy audit, which will give a much better sense of the building’s air leaks and energy sinks. According to the Department of Energy, the audit should include a blower-door test, which measures the “tightness” of the building envelope, and can uncover specific problem sites; an evaluation of the building with a thermal imaging system to pinpoint areas of heat loss and poor insulation; and a room-by-room evaluation of energy use and potential savings (DOE, 2009). The Pittsfield-based Center for Ecological Technology (CET) provides free energy audits through the MassSAVES program, and should be able to perform one for Harper House.

The most basic efficiency work is relatively inexpensive and pays for itself quickly, but other steps come at little additional cost when a building is undergoing more complex
construction. Although most of the campus-wide suggestions are familiar to environmentalists, these conservation measures are not uniformly implemented in the College’s small buildings. Beyond Harper House, there are many simple steps the College can take to “green” its small buildings, a generic checklist of sorts to consider for every small structure.

**Electricity**

One of Harper House’s greatest assets is its copious daylighting—every office and large room has at least one window and a direct outside view—which is integral to a healthy building and makes the inhabitants happier and more productive. Harper uses a mix of fluorescent and compact fluorescent lights (CFLs) to illuminate interior space. CFLs require a greater initial investment than incandescent bulbs, but can save as much as $30 over a bulb’s lifetime because they last longer and have require less electricity (DOE, 2009). Harper House has no visible incandescent bulbs—installing CFLs is an easy fix for the environmentalists who patronize the building—but the College should be particularly vigilant to replace incandescents wherever possible across campus.

The Department of Energy estimates that heating water accounts for 14-25% of a building’s electricity consumption, and the College can take several steps to make electric water heaters more efficient (DOE, 2009) Williams can set all its domestic hot water heaters to a less energy-intensive (but still hot) 120 degrees, an adjustment plumbers can easily make as part of routine maintenance. In addition, insulating hot water storage tanks can reduce standby heat losses by 25–45%, saving an estimated 4-9% in water heating costs; the College has an economy of scale and the experienced tradesmen to cheaply create insulating blankets for its various water heaters (DOE, 2009).
Heating

Harper House’s heating oil consumption is vastly expensive (over $10,000 dollars in 2008), but the building provides numerous opportunities to reduce heat losses and reduce oil consumption. The building envelope is far from tight and, although a thermal imaging system would be needed to detect some of the air infiltration, strong winter drafts expose the most egregious leaks. Harper House is rife with leaky doors, especially, and so one of the first steps in curtailing heat loss is sealing the gaps between doors/windows and their frames, usually with weatherstripping or caulk. Both materials provide flexible, easily-installed protection against air infiltration at less than a dollar per foot, and effective air sealing often pays for itself in energy savings within a year (DOE, 2009). This meticulous weatherstripping effort could be easily and effectively expanded beyond Harper to other small, historic buildings on campus.

Harper House already has storm windows on all 41 first- and second-floor exterior windows, but the College should routinely check the storms on Harper and other historic buildings. Storm windows provide better insulation than new double-paned windows at a lower expense—new windows require greater energy and labor to manufacture and install—and storm windows have the added benefit of preserving a historic façade’s appearance. There is always a trade-off between natural light/outdoor views and energy efficiency, especially in older buildings with leaky single-pane glass windows, but storm windows can eliminate much of the heat loss for great rewards in energy savings and occupant comfort. The National Trust for Historic Preservation estimates that it can take 240 years to recoup enough money in energy savings to pay back the cost of installing new windows, let alone negate the embodied carbon emissions in historic windows and the emissions generated in their disposal (“Historic Wood Windows,” 2).
Installing storm windows is a relatively easy step that can yield substantial energy savings and decrease drafts or other air infiltration.

Windows and doors, however, are responsible for only a fraction of heat loss and air infiltration in historic buildings—the rest comes from a poorly-sealed building envelope. A professional audit’s thermal imaging technology would be necessary to reveal poorly insulated spots in the building’s walls, but the openings around electrical sockets or telecommunications ports, the outsides of window and door frames, and other vents are often poorly sealed (DOE, 2009). Sockets and light switches are relatively easy fixes, since the switchplates can be removed and the wall’s interior quickly treated with spray foam insulation; this should become standard practice around the campus. The poorly insulated areas of the wall without easy access are just that: difficult to reach and difficult to fix; they are largely dependent on major construction work. Any major construction or renovation project that involves removing or stripping down walls should take particular care to properly install effective insulation, either fiberglass batting or spray-in foam insulation.

In addition to improving exterior insulation and reducing air leaks, the College should consider additional insulation between unoccupied basements and occupied first floors, or unoccupied attics and lower stories. This would allow buildings like Harper House, which has an unused basement, to comfortably heat the ground floor without draining heat into the unheated or slightly-heated basement below. Many structures have unfinished basements, which would make installing insulation a relatively easy step: Facilities employees can simply nail fiberglass batting to the unfinished underside of the building. The same is true for attics, although interior ceilings would have to be taken apart and rebuilt, making such a project much more expensive and energy-intensive.
Since Harper House is not on the steam tunnel system, much of its emissions come from the #2 heating oil powering the building’s furnace. CES could reduce those emissions by burning a mix of soybean oil and #2 oil, as the biofuel burns more completely than petroleum products and produces less Carbon Dioxide (CO₂), Sulfur Dioxide (SO₂), and Nitrous Oxide (NOₓ).

Locally, the Center for Ecological Technology offers a bio-heat co-operative program, which sells B-5 (a biodiesel blend of 5% soybean oil and 95% #2 oil) to individual consumers at bulk rates; they claim the additional cost of biofuel (a few cents a gallon) is offset by the bulk discount of the co-op system (CET website). The college already buys its heating oil at bulk rates, which would eliminate any monetary savings from joining the co-op, so purchasing B-5 for Harper House would only add expenses to the CES budget.

**Water Use**

One of the most notable vestiges of Harper House’s residential past is the myriad of bathrooms and sinks in the building. The six full baths, three additional sinks, and one half-bath provide ample opportunities to install (and immediately benefit from) low-flow fixtures and low-flow or dual-flush toilets. Before turning to expensive water-efficient fixtures, however, the College should eliminate the more redundant bathrooms, as fewer fixtures means less chronic dripping. If there is concern about eventually returning Harper House to residential use, fixtures need not be removed; the water supply can simply be turned off (an easily-reversible move that also requires little labor and generates less waste than entirely removing fixtures).

The Center for Environmental Studies had installed low-flow faucets and dual-flush toilets at Kellogg House, and the same technology could benefit Harper House. The CES building deserves investment in items like dual-flush toilets (Figure 6) that make for a more environmentally-friendly building and further the department’s environmental education
mission. The additional costs to purchase and install one of these units, which cost about $300 each, would be offset by water savings from the 0.9 GPF option (Toto Toilets, 2009). Even if dual-flush toilets are too expensive to install routinely in College buildings, faucet aerators (Figure 6) should be installed wherever possible. At several dollars each, these easily-installed units can reduce faucets’ water consumption by a third or more without a significant loss in perceived flow rate. To the extent that aerators reduce hot water demand, they also save electricity costs for hot water heaters throughout campus.

Figure 6: a Toto Aquia dual-flush toilet (left), which has a 1.6 GPF option and 0.9 GPF option (photograph from Toto), and a WaterWise Technologies faucet aerator (right) (photograph from WaterWise Technologies).

Conclusion

Williams College has a fantastic opportunity to reduce the impact of its built environment without detracting from a high standard of living—in fact, many environmental “fixes” will make for healthier, more comfortable, and more productive spaces. Energy efficiency and environmental sustainability should become the expectation, not the exception in the College’s
fleet of small buildings, and numerous small steps can make that a reality. The Williams community looks to CES as a model of energy efficiency and environmentally-conscious behavior, and Harper House should be no exception. As budget cuts force the College to put a hold on new construction, the budget-conscious greening of an extant building like Harper could be a model for similar projects throughout the campus. As home to the Center for Environmental Studies, Harper House should be made the campus’s prototype green, historic building, a testament to the College’s commitment to both historic preservation and sustainability. This project was envisioned not only as a requirement for GEOS 206, but also as a service to CES, a community that has welcomed me with open arms and supported me handsomely in my time at Williams—may this be another step forward in greening the Center for Environmental Studies!
Works Cited


