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# **Sustainable Computing Internship Summary Report**

Campus Sustainability Task Force

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August 2008

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The concept of “sustainable computing” at Indiana University is complex and requires much consideration. Initial methods to move toward sustainable or “green” computing might focus on lowering the environmental impact of personal computers by making them more energy efficient, including less toxic materials in their production, and ensuring that they are properly disposed of. While these concepts do underlie many of the initiatives any sustainable computing program might include, they are also overly simplistic and lack the broad vision required to enact real change in a campus environment. Cornell University’s official definition of Sustainable Computing<sup>1</sup> is “a principle that embraces a range of policies, procedures, programs, and attitudes that run the length and breadth of any use of information technologies. It is a holistic approach that stretches from power to waste to purchasing to education and is a life-cycle management approach to the deployment of IT across an organization. The concept of Sustainable Computing considers total cost of ownership, the total impact, and the total benefit of technology systems.” Computing at Indiana University includes personal computers, IT infrastructure (including wired and wireless networks and voice services), Student Technology Centers and Residential Technology Services, printing consumables such as toner, ink, and paper, servers, departmental IT services, research computing including multi-million dollar hardware and intricate relationships with other institutions, technology classrooms, projection systems, physical as well as data security systems, and data centers with their massive energy consumption and complicated back-up systems. This partial list of what might be included in “campus computing” provides one with an idea of just how large a project it is to make such a system “sustainable”.

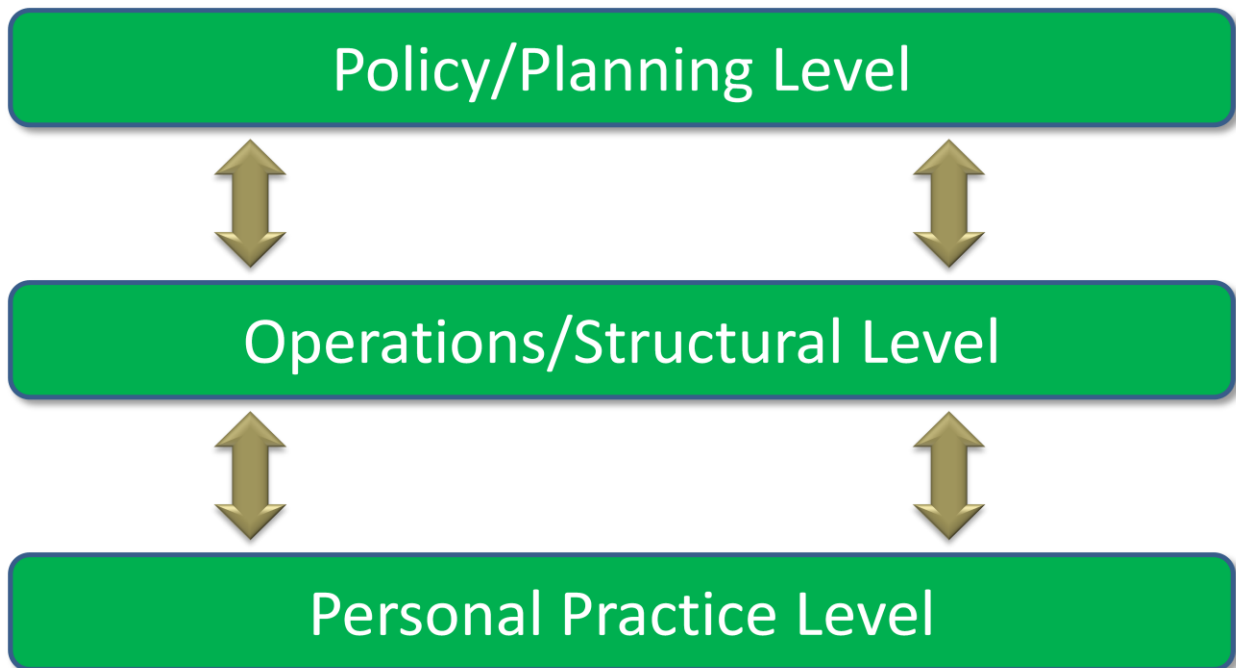
To understand the full complexity, one must also consider more than the machines and wires which make computing possible. The large amount of technology which must be supported on campus also necessitates well over 1000 IT support staff including UITs professional staff, consultants, and departmental IT staff, who in turn must be given work space and their own computers to do their job well. Taking these staff into consideration may be regarded as beyond the scope of a sustainable computing initiative by some, but their footprint and practices are intimately connected to all other aspects of campus computing and must be part of the equation. In addition, due to the distributed support model on campus, the roughly 350 Local Support Providers (LSPs) and departmental IT Directors are extremely influential in helping shape IT habits and practices on campus.

IT workforce support models are governed by formalized operational procedures established to provide consistent and continuous services on campus. Many decisions which affect the environmental sustainability of computing must be weighed against the potential for loss of such services. In addition, resources in the form of staff time and operating budgets are tied to the campus’ ability to change to more sustainable models of computing. Examples include the potential increase in maintenance of printers if duplex printing were set as the default in the Student Technology Centers, the support issues associated with powering down computers on campus if this prevents them from receiving their security patches and application updates, and the staff time needed to think of creative solutions which might save energy or resources.

Funding an approval for changing operations related to IT services on campus is managed by individuals in charge of planning and policy development. This level of campus computing moves slowly, with intense scrutiny paid to how funds are allocated and how all initiatives align with the official IT strategic plan (ITSP), established at the request of then President Miles Brand by the Vice President of IT, Michael McRobbie<sup>2</sup>. We are at a crucial point in this process, as the first strategic plan ends in 2008 and the new plan (ITSP2) is being outlined. Inclusion of the concept of sustainable computing at this level of planning would ensure that it is deeply embedded in the plans of all IT professionals at IU.

However, ultimately many of the planning and policy initiatives only affect change if individuals decide that their personal beliefs align with said initiatives. While the employees of IU may be required to follow certain guidelines, their personal habits are nearly impossible to monitor or change by force. For example, while it is possible to mandate that all computer monitors are turned off in the evenings, there are not ways to enforce this policy inexpensively. There are ways, however, to provide individuals with software which reminds them or actually enacts energy saving settings, alleviating the need for people to remember to make these changes. Thus, policy can prompt changes in the operations level, providing mechanisms for individuals to change their habits or practices. The flow of influence moves in the opposite direction as well, with individuals encouraging structural/operational changes, such as students demanding paper recycling or duplex printing, which then prompts requests from the IT professionals on campus to obtain funding to enact such changes, encouraging the people who establish policies to include sustainability in strategic plan development.

A diagram, then, of the complicated layers and associations might look like this:



This document serves to provide a benchmark for future change. It is a “state of sustainable computing” at IU, aiming to outline the complexity of the situation, highlight sustainable practices and structures which are already in place or are in the planning phase, and suggest improvements when possible. It was developed as a result of secondary research as well as 28 in-depth interviews with IT professionals on campus.

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# Purchasing

The IU Purchasing Department is responsible for procurement of IT and IT-related consumables such as paper and toner. Using EPIC, IU's online purchasing system, departments can customize and order from many of the largest IT vendors directly, including Dell, Apple, HP, Lenovo and more. Purchasing has a business to business (B2B) agreement with many of these vendors, which streamlines processes and makes purchasing more efficient. IU contracts with major suppliers to obtain special pricing and puts out bid requests for computer "bundles" which meet minimum requirements. This allows departments to purchase computers with the knowledge that the machines will be robust enough to run software purchased and supported by IU. Vendors who are awarded bids must agree to allow students to purchase a "bundle" at the same price as the university. Thus, any "green" requirements IU imposes on their vendors will possibly have a trickledown effect, helping students make green purchases as well.

There are numerous universities which have made a broad commitment to purchase only recycled paper and/or Energy Star Certified<sup>3</sup> or EPEAT registered<sup>4</sup> IT equipment. For example, Cornell's official policy<sup>5</sup> states "The systems we purchase are Lead-Free, RoHS Compliant, EPEAT registered, and Energy Star® certified". Duke has "Environmentally Preferable Purchasing (EPP) Guidelines"<sup>6</sup>.

The federal government also has established firm policies regarding the purchasing of IT. The Department of Defense (DoD), General Services Administration (GSA), and National Aeronautics and Space Administration (NASA) must all "use of Electronic Products Environmental Assessment Tool (EPEAT) when acquiring personal computer products such as desktops, notebooks (also known as laptops), and monitors pursuant to the Energy Policy Act of 2005 and Executive Order 13423, 'Strengthening Federal Environmental, Energy, and Transportation Management.'"<sup>7</sup>

Currently, no formal policy exists at IU regarding the purchasing of green computers, paper which is made from sustainable sources or paper which has post-consumer content. However, several positive steps are being made in this direction (outlined below). Even without such policies in place, green options exist within the EPIC system. For instance, in January of 2008 IU spent \$10,000 on recycled paper and almost \$50,000 on other paper<sup>8</sup>. Nevertheless, it is difficult to distinguish these green options from their more traditional counterparts within the system. The EPIC system either does not import the green features (such as Energy Star Compliance or EPEAT registered) or such green qualities are not currently being sent from the vendors. Thus, even if customers are concerned about energy efficiency or material makeup of components (including the percentage that is post-consumer, percentage made from raw materials, and number of toxic materials involved in processing), the purchasing system does not assist with these aspects of the decision making process.

## **Positive Practices:**

In lieu of formal policy change, the IU Purchasing Department is making numerous smaller steps towards sustainable computing. These come in the form of raising awareness, promoting green products and vendors, and using increasingly strong contract language requiring vendors to explain and justify their environmental practices. In addition a green purchasing comment was added to the main Purchasing page<sup>9</sup>, stating "The Indiana University Purchasing Office recognizes the environmental impact it can make through purchasing decisions. To ensure that the impact is minimal, the purchase department encourages the use of environmentally preferable products and services on all IU Campuses". A master's capstone project completed by Jessica Johnson from the School of Public and Environmental Affairs offered sample wording for Request for Proposal (RFP), contract language, and bidder response specifications which the Purchasing Department can use as a template for establishing firmer and more specific green purchasing policies.

Specific examples of positive practices already in place include:

- Purchasing is working on a “featured vendor agreement” Here they specify the bundles and what IU insists on having, such as 3 business day turn around on warranty, minimum technical requirements, etc. We might be able to include EPEAT and Energy Star here.
- Recent bid request documents sustainability-related requirements. For example, the most recent toner bid contained section H6 and section H22, calling for documentation which impact recycling and e-waste practices:

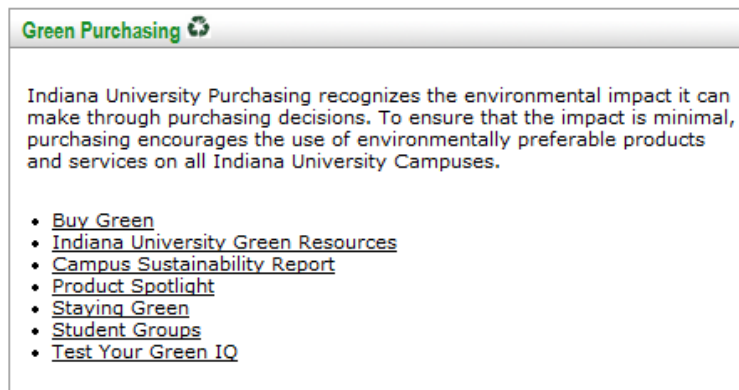
“H6 Recycling

- H6.1 Provide a statement of the manufacturer’s recycling policy
- H6.2 Provide a statement of vendors recycling policy
- H6.3 What portions of the recycling are being performed within the state of Indiana?
- H6.4 Where are the components that cannot be recycled sent; how are they disposed?
- H6.5 What type of packaging do you utilize inside the boxes?
- H6.6 Do you reuse the boxes for packaging?
- H6.7 Would you be willing to implement a program on campus to collect and recycle spent toner cartridges whether or not those cartridges were purchased from your company? If so, please describe. “

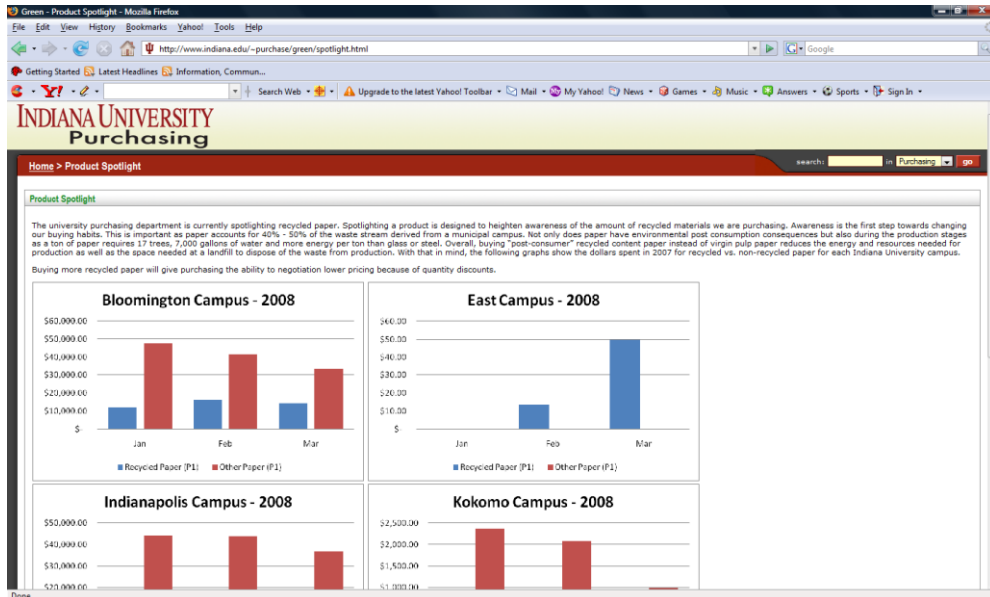
“H22 Outsourcing

- H22.1 Do you manufacture the cartridges or do you outsource? If you outsource, from where do you buy your cartridges and where are they located?
- H22.2 Do you dispose of your own cartridges? If so how?
- H22.3 Do you outsource the disposal of cartridges? If so, to where?”

- A large section on the front page of their website promotes green purchasing and linking to many resources to learn more:



- Product Spotlights – IU Purchasing Department provides a “Product Spotlight” to encourage people to better understand how their purchasing decisions make a cumulative difference. This also enables them to become better informed about green options. The most recent spotlight was on recycled paper. Future spotlights might simply list the green product lines offered by IT vendors.



### Suggestions for improvement:

- Plan to adopt a strict policy requiring that all university IT purchases are Energy Star compliant, EPEAT certified, Lead Free, and made of post-consumer materials when possible. This policy should be implemented in phases, slowly increasing the percentages of such purchases over the next 5 years. This allows vendors to adapt their product lines accordingly, especially the small local businesses we contract with.
- Require vendors to clearly label their green computers and consumables and upload such information into the EPIC system.
- Promote only EPEAT and Energy Star compliant products on the main purchasing page.
- Purchase recycled paper in bulk to lower the cost per ream for departments. Last year there were over 400 different types of paper purchased, many of which were essentially the same product but from different vendors within the EPIC system. Send out a bid for 30% and 100% post-consumer recycled paper which is rated safe for copier and printer use, requesting bulk purchasing discounts. Promote the winning bid on the main purchasing page and via emails sent to the largest departmental purchasers, indicating the lower price and the environmental difference they can make.
- Post a "spotlight on green computers" on the purchasing website, similar to the current spotlight on paper.
- The computer "bundles" offered on the purchasing website should always be green computers.
- Word bid requirements in such a way that other sustainable practices are influential in the process. For instance, ask that vendors agree to take back IT equipment at the end of its lifecycle, take back their packaging materials or use less packaging materials, agree to trade in old equipment toward the purchase of new equipment, or provide modular solutions which allow for easy upgradeability as opposed to disposal at the end of lifecycle.

# Hardware

While exact statistics are difficult to find, there is no doubt that Indiana University has an astonishing number of computing devices plugged in to its network or power outlets at any given time. While the 2000+ machines in the Student Technology Centers are included in this pool, they are almost insignificant compared to the 13,000 devices (including desktop computers, laptops, and gaming systems) which were registered on the residential network during the 2007-2008 academic year. IU faculty members are provided with computers, as well as the staff who support the departments, amounting to 15,000 computers<sup>10</sup>. In addition, many students who live off campus bring their technology with them during the day, using additional energy when they are plugged in to outlets in academic buildings. Beyond computers, there are an abundance of peripheral devices such as scanners, external drives, webcams, USB hubs, and printers, to name just a few. Powering down these devices when they are not in use would make a substantial change in the amount of energy IU consumes. In addition, it is important to remember that powering down such devices is not always enough, as most electronic devices still draw “vampire power” or “parasitic power” even after users believe they have turned them off. Standby power is estimated to account for at least 5% of residential electricity consumption<sup>11</sup>.

Other universities such as Cornell as well as large businesses are exploring alternative models of computing, such as using thin clients<sup>12</sup>, to combat hardware related sustainability issues. A thin client model is currently being used by the Recreation Sports department at IU for the checkout of sports equipment and towels as well as monitoring the entry and exit of patrons. However, a recent internal UITS study<sup>13</sup> found that the thin client model is not yet robust enough to deliver more bandwidth intensive applications (including those which require sound or video) or to allow for the use of multiple applications at one time. Due to these limitations there are no current plans to alter the Student Technology Centers or administrative machine model by adopting a thin client approach. Other departments on campus have considered the thin client model but are hesitant due to the large capital investment needed to initiate such a project. In addition, there are tradeoffs which need to be considered, such as the power load of the back end required to support thin clients in any quantity.

## Campus owned computers

Interviews with UITS representatives and departmental LSPs indicate that power saving features on many university owned machines are not used and that “sustainable computing” is rarely a part of purchasing decisions or part of the setup process on new equipment for faculty members. In addition, most IT equipment is left on after office hours, over the weekend, and even in empty buildings over the entire summer.

Reasons cited for these practices include:

1. Leaving machines on in order to provide timely services. For instance LaserJet printers require time to power up and warm the fusing element to the point that a printout can be generated.
2. Leaving peripherals turned on because powering them all down is time intensive and sometimes difficult. Suggesting that faculty member crawl behind desks and physically unplug peripherals adds additional duties to very busy individuals and can create support problems as other wires may be damaged in the process.
3. Computers cannot be fully shut down at night because this is when they receive their security patches, application updates, and backups. Requiring that they be completely powered down will leave them vulnerable at boot-up. In addition, Wake on LAN (WOL) technology, which

allows computers to be woken up or even booted remotely, has proven to be inconsistent and problematic, leaving the potential for mass support problems and classrooms without enough machines for students. Such outages could affect the academic mission of the university.

4. Faculty and staff members become angry when power settings interrupt their work by putting their machines to sleep when they leave their computer briefly.
5. Refusing to use power saving features because they may disconnect the computer from the network, thus interrupting any work that requires such a connection.
6. Faculty, staff, and students using screen savers because they assume that such measures use less energy than leaving their computer fully working or that screensavers are still needed to prevent “burning” images into screens.
7. Not purchasing “green computers” because they are assumed to be more expensive or because the IT staff do not have time to do the research on the benefits of such machines.
8. Not purchasing energy efficient servers because the departments don’t pay for their own electricity and will not see the savings that such machines offer.

#### **Positive Practices:**

In addition to some wasteful practices, there are in fact many sustainable actions regarding hardware on campus. These include

- Condor, a program through UITS, allows users to make use of the processing power of the unused STC computers at night. Researchers from departments may apply to become a part of this program, enabling them to avoid purchasing high end computers for their data processing needs. The STC machines are in essence enrolled in a computer grid, where many machines are linked together to harness their collective processing power. When a student logs into an STC machine, it is immediately removed from the Condor project, enabling the student to use it as they normally would. Thus, while it may appear that these computers are simply left on and wasting energy all night long, there is at least the potential that they are involved in research projects. In addition, we share our Condor resources with Purdue’s much larger Condor pool. So it has the potential for being used by researchers outside IU, and in relation to the TeraGrid, outside Indiana and possibly the US. The actual usage numbers of the Condor project were not obtained for this report.
- At least one dept does shut their computers down every evening and limits number of computers they make available to students during summer hours.
- Some departments are investigating the use of power strips which prohibit standby power drainage or simply using regular power strips to allow faculty and staff to easily turn off all of their peripherals at once.
- One interview revealed that departments may be willing to use the highest energy settings (sleep and hibernate) “when the technology improves”.

#### **Suggestions for improvement:**

- A group of IT professionals on campus need to discuss the complex problems associated with security and application update scheduling and powering down machines. A report from Cornell has suggested many ways to change these practices<sup>14</sup>. The IT managers from IU departments and UITS employees should evaluate these possibilities and decide whether they fit within our support models.
- A campaign suggesting easy ways for people to power down peripherals and monitors by putting them on a standard power strip and asking that they be turned off at night and on

weekends would save approximately 31 % of the energy consumed by individual workstations on campus<sup>14</sup>.

- Increase the use of programs such as Condor, perhaps even allowing staff computers to contribute their cycles if it is determined that there is no way to safely power them down entirely
- Departments need to commit to adding sustainability options to their purchasing and installation procedures. If they purchase only “green” computers, allow the faculty and staff machines to be installed with some level of energy saving settings, and establish ways for the faculty, staff, and graduate students to power down non-critical equipment they will make a very large impact.
- Look at Student Technology Center usage patterns during the summer and commit to closing 25-50% of the labs, thus powering down all computers, peripherals, and printers during the summer semester. Such a move will require adjusting operating procedures and security measures as well as potentially hiring additional staff to boot and rebuild machines just before the fall semester begins. A cost-benefit analysis is needed to fully understand the environmental and financial impacts of this plan.
- Continue exploring different models of computing, including thin clients, UITS supported software builds for student owned laptops, or offering remote desktop applications to name just a few. Currently the STCs offer 164 Windows applications and 79 Mac applications<sup>15</sup>, many of which are too expensive for the typical student to purchase. While some of this software is available through IUware, much of it is not.
- Make sure to train staff and students when energy savings features are enabled. “If you introduce power management features into your office without telling your staff about it, you can cause concern that the equipment is not functioning correctly. On the other hand, you can enhance staff morale and performance by choosing your equipment well and following its installation with training.”<sup>16</sup>

## Personal Computing Practices

Changing the impact of personal computing on campus must focus on understanding habits and creating awareness campaigns. Success of such measures is often beyond the scope of formal policy, and must be left to the individual for change. The main focus of a Sustainable Computing initiative when it comes to personal computing is to give people the knowledge to make better decisions. There is no way to know exactly how many electronic devices are brought on campus every year. Between the students who come on campus with their laptops, cell phones, and mp3 players to the students who live on campus with their laptops, printers, scanners, gaming systems, video and digital cameras, external drives, webcams, and more, there is a large potential to suggest ways to be more sustainable. Last year over 13,000 unique devices were registered on the residential network alone. Energy consumed by these devices and the peripherals attached contribute significantly to overall electricity use by the residence halls. Providing ways for individuals to easily change their energy consumption habits is a very important part of sustainable computing on campus. Recently several organizations have created free tools for helping with this process, including the Google’s energy-saving gadget<sup>17</sup>, the Environmental Protection Agency’s “EZ Wizard”<sup>18</sup>, and a new dashboard tool called the “Edison” by Verdiem<sup>19</sup>. Stanford produced its own tool, called “BigFix”<sup>20</sup>. When users download this client software the local energy company, PG&E, donates \$15 to their school or department for future sustainability projects.

In addition to energy consumption, e-waste from personal practices is a problem. Recycling of personal electronics and paper is not consistent across campus. Some residence halls collect toners and used batteries, others may collect old cell phones, and others may not collect any items. Paper recycling bins are not standardized across the Residential Technology Centers or Student Technology Centers and often look identical to the trash bins next to them.

While the LSP community may be highly influential regarding departmental computing, faculty members are often the ones with influence over student computing habits. No statistics exist showing the percentage of faculty members who require the printing of class notes and slides, require that work be turned in on paper rather than electronically, or suggest that students print all of their resource materials. However, during interviews faculty preferences were cited as one of the reasons the Student Technology Centers do not make duplex printing the default setting in the labs on campus, as they prefer grading single sided printouts. Other faculty practices and habits can affect the sustainability of computing on campus. Leaving projectors on is rampant across campus and costs money in the form of electricity and new bulbs. Requesting computer labs for entire semesters rather than just on the days a class needs the computers ties up resources and requires the Student Technology Centers and IT Classroom staff to continue adding to the number of labs on campus.

Motivating individuals to change their personal computing practices is another important topic. Informing people about their personal IT impact and hoping that they then want to change is one strategy. Providing incentives in the form of prizes for lowering the number of pages printed or for downloading an energy saving tool is another. The Climate Saver's Initiative<sup>21</sup> has decided to use a combination of techniques. Their "Big 10 Challenge" pits the Universities in the Big 10 against one another in a competition to get the highest percentage of their students, staff, and faculty to sign a pledge to change their IT energy habits. The winning institution gets bragging rights in addition to the possibility for scholarships. Students are also encouraged to submit videos and participate in a viral video contest with prizes.

**Positive practices:**

- The Residential IT Services group has cut back on their consumables, changing from a CD based installation process to a network build called "Get Connected" and permanently wiring all residence halls. This eliminates the dispersal (and later disposal) of over 10,000 build CDs and cables annually, lowering the impact of personal computing on campus.

**Suggestions for Improvement:**

- Participate in the Climate Saver's Initiative Big 10 Challenge. This competition will provide students, faculty, and staff a way to pledge to use the energy settings on their personal computer (not their departmental computers), consider energy ratings upon their next technology purchases, and spread the word about energy reduction. It might also involve the distribution of a free power consumption tool, such as Edison<sup>19</sup>. Statistics on the number of participants will be given to IU, helping us measure our impact on personal computing practices.
- Begin a series of awareness campaigns, geared toward informing students and faculty about their impact on sustainable computing. The campaign might involve coordinating with student groups, the Greek Council, the Residential Halls Association and the RAs, as well as others.
- Offer easy ways for individuals to enable their energy saving settings on their computer, perhaps using Stanford's client<sup>20</sup> as an example or incorporating energy settings into the existing "Get Connected" program which all residents use to register their computers to the IU network.

- Offer incentives for changing practices, such as a drawing for all students who download the energy saving client on their personal computers
- Ensure that opportunities for sustainable computing behaviors such as the recycling of used toner cartridges, batteries, cell phones, and paper are convenient to all students, faculty, and staff. This will involve partnering with the units responsible for recycling on campus.
- Begin a campaign to suggest ways faculty can help make computing more sustainable by grading assignments electronically, not requiring the printing of all reading materials, and more.

## Printing

Printing across campus comes in many forms. Departments allocate funds for their faculty and staff printing needs. The majority of students use their print quota in the Student Technology Centers or Residential Technology Center to print out their assigned class reading as well as the homework they turn in.

Every semester students pay a Student Technology Fee, of which approximately 10% pays for student printing<sup>22</sup>. This “print quota” varies based on the type of individual and their responsibilities<sup>23</sup>.

Individual Type	Pages	Additional Information
Undergraduates	650 pages per semester	rollover available
Graduate students	1,000 pages per semester	rollover available
Student organizations	400 pages per semester	with faculty sponsorship
Faculty	200 pages per semester	funded by Research Technologies
Dissertation bonus	500 pages (one time only)	upon faculty request
AI bonus	500 pages	Automatic
Residential bonus:	100 pages	Automatic

**Table: Print Quota Distribution**

Using the Pharos Uniprint system<sup>24</sup>, the Student Technology Centers have installed print release stations, which consist of a computer with the Pharos print management software interface connected to many of the printers in the STCs (STCs) and the Information Commons(IC). The release stations require students to walk to the printer, log into the computer, and select the jobs they wish to print. Pharos internal documentation<sup>25</sup> claims that their clients can “reduce waste and recycling costs by up to 80%” by using their product and that “To achieve campus green initiatives, colleges and universities must find ways to prevent waste from being created in the first place.”

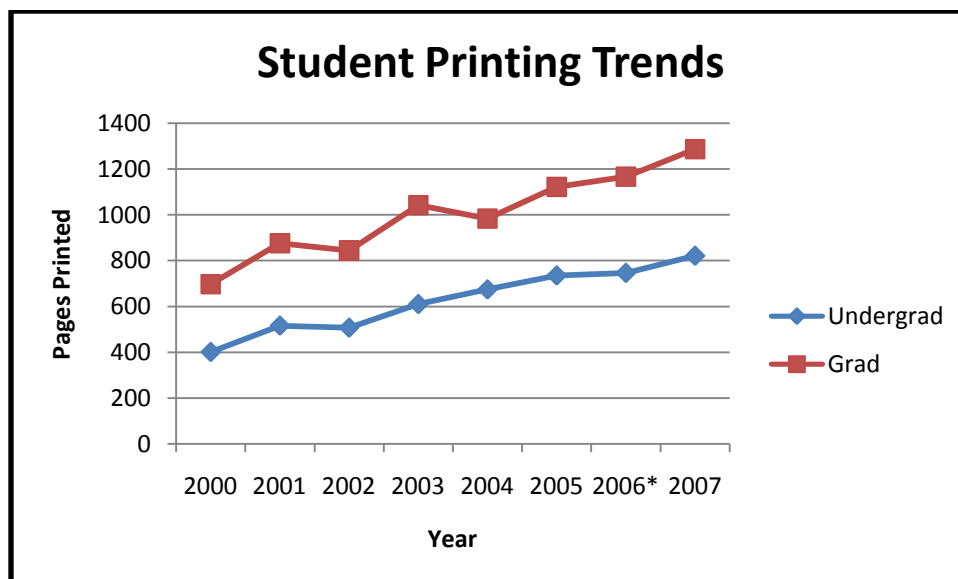
The combination of a managed print system along with the addition of the print release stations has already shown promise as a way to curb wasted printouts on the IUB campus. As seen in the table below, paper consumption trends overall have risen over the past three years, with over 36 million pages being printed in 2008. However, in the locations with the print release stations, such as the Student Technology Centers and the Information Commons, there has been a much smaller increase (just 3.5%) than in other locations (16.1% and 34.3%). Interviews with the STC print team indicate that print release stations are the number one most requested service by partner locations, such as the libraries. While exact numbers of the pages saved by such a system are difficult to obtain, anecdotally the print team reports that abandoned print jobs are almost never found and recycled paper bins which

used to require emptying on a daily basis now only must be emptied weekly. They estimate a 10-25% reduction in paper waste.

	2006	2007	2008		Percent Change
<b>STC/IC</b>	18,345,936	19,307,943	19,073,423	19,007,024	3.5%
<b>RTC</b>	6,245,892	6,471,850	7,682,650	7,443,505	16.1%
<b>Libraries</b>	4,753,850	4,997,218	6,590,578	7,238,240	34.3%
<b>TOTAL</b>	29,345,678	30,777,011	33,346,651	33,688,769	8.6%

**Table: Total printed pages**

Individually, most students stay well below their quota. During the 2006-2007 academic year, the average undergraduate printed 395 pages in the fall and 426 pages in the spring, falling 479 pages below their 1300 yearly quota. However, as more resources are put online and more instructors place PDFs of documents to be printed by the student in OnCourse, the yearly print totals are steadily increasing.



\* average print statistics for 2006 based on doubling fall totals due to a lack of totals available for spring

Student printing represents only a portion of overall print numbers on campus. Departmental printing by faculty, staff, and students is also a contributor to the large amount of paper our campus consumes. Some departments on campus provide no limits on the number of pages their students can print. Data provided by the IU Purchasing Department indicates that last year the IUB campus spent over \$580,000 on copy/printer paper, amounting to over 91 million sheets of paper. Placed end to end, we could make a line of paper which stretches from Bloomington Indiana to Beijing China<sup>26</sup>. Of this paper, only 16.5 million pages had any recycled content at all. Approximately 140,000 pages or just 1.5% were 100% post-consumer recycled paper. Moving toward purchasing 100% post-consumer paper for the IUB campus could have a significant impact on our environmental footprint. A comparison of the wood, energy, and water needed to generate paper in addition to the Carbon Dioxide (CO<sub>2</sub>) and solid waste created by its manufacturing is provided by the Environmental Defense Fund and PaperCalculator.org<sup>27</sup> below. The 91 million sheets of paper IU printed amounts to 1,422,500 pounds of paper at 5 pounds per

ream. If all of the copy paper IU purchased was 100% post consumer recycled paper we could cut CO2 emissions by almost 1.5 million pounds and would use over 6 million less gallons of water to produce it.

<b>Lifecycle Environmental Impact</b>		
The following is a break down of the environmental impact of your choices for different grades of paper.		
<b>Recalculate</b>	<b>Standard IU Copy Paper</b>	<b>Recycled Paper</b>
<b>Paper</b>	Uncoated Freesheet (e.g. ▾)	Uncoated Freesheet (e.g. c ▾)
<b>Quantity per year</b>	142250 Pounds ▾	142250 Pounds ▾
<b>% Postconsumer</b>	0	100
<b>Wood Use</b>	<b>2,466 tons</b>	<b>0 tons</b> 2,466 tons less
<b>Total Energy</b>	<b>27,286 million BTU's</b>	<b>15,404 million BTU's</b> 11,883 million BTU's less
<b>Greenhouse Gases</b>	<b>4,047,152 lbs CO<sub>2</sub> equiv.</b>	<b>2,547,777 lbs CO<sub>2</sub> equiv.</b> 1,499,375 lbs CO <sub>2</sub> equiv. less
<b>Wastewater</b>	<b>13,567,233 gallons</b>	<b>7,343,656 gallons</b> 6,223,577 gallons less
<b>Solid Waste</b>	<b>1,620,476 pounds</b>	<b>821,281 pounds</b> 799,195 pounds less

Toner is another consumable which plays a significant part in sustainable printing. Empty toner cartridges are a form of e-waste, contributing dangerous chemical to landfills. To avoid this, IU often purchases remanufactured toner, putting out bids requiring information about the recycling and remanufacturing habits of vendors. Several companies provide toners to campus, most of which are local Indiana businesses. All toners for the Student Technology Centers are remanufactured.

The printers themselves can have an impact on sustainability. For instance, according to the University of Michigan Green Computing Guide<sup>28</sup>, “laser printers use as much as 27 times more energy than an inkjet.” However, inkjet printers are not robust enough to meet the needs of the higher usage locations such as the computer labs on campus. Energy consumption is not the main concern at the purchasing phase of the STC and RTC printers. Extensive testing of printers for reliability and durability are performed on all models under consideration and laser printers are the only ones which meet these standards. Among laser printers, however, it is now the informal policy of the STCs to purchase the smaller 4300 series Hewlett Packard printers<sup>29</sup> which are faster, cheaper to maintain, and use less power than the 8150 series printers<sup>30</sup>. Both of these printer lines are Energy Star compliant. The print team has also been working to extend the lifecycle of most printers from 3 to 4 years by relocating printers from high-use to lower-use locations, typically getting roughly 1 million (for the HP 4350’s) to 1.5 million (on the HP 8150’s) pages printed before retirement. During one interview a print team member remarked “we use printers until they are no longer functioning. We rebuild them from parts from other ‘dead’

printers until we can no longer piece them together.” They do their own warranty work and are certified to perform such maintenance.

Print settings are a final consideration. Duplex printing is now available on all STC provided printers, including the color printers. However, duplex is not the default setting due in part to a survey they conducted indicated that faculty members were not fond of grading on double sided pages. In addition, print maintenance personnel have been told by industry professionals that the process of generating a duplexed printout causes extra wear and tear on printers, leading to increased paper jams, creating additional need for support staff, trips to labs, and increased hardware turnover (printer parts needing to be shipped across the country to repair the printers) and e-waste in the form of broken trays. IU is not alone in these practices. The University of Michigan states<sup>31</sup> “Unfortunately, one of the biggest problems with duplex printing is that it takes more than twice as long to process, resulting in longer queues and more abandoned jobs. Also, in analyzing error logs (printer malfunctions), we see a 200-500% increase in jams associated with duplex printing. These jams are the leading reason why system-wide duplex printing is not a viable model for our current environment. When considering our human resource support model (we pay our student roving staff \$75,000 per year for printer support), it would cost between \$150,000 and \$375,000 to address the increased jam rate. Additionally, these figures don't take into account increased printer maintenance costs, time demands on full-time staff, or higher vehicle costs to travel to sites to remedy the problems. The actual cost increase to support duplex printing would be very difficult to calculate but we do know it would be prohibitively high!”

Another printer setting has to do with energy saving features. Currently the printers in most computer labs are set to go into energy save mode after a period of time. Finally, print settings in the form of the default software settings can impact the number of pages printed. For instance, changing the default margins in Microsoft Word from 1.25 inches to 1 inch can make a large difference when multiplied over the thousands of assignments students print every day.

There are many difficulties associated with making changes to the printing system on campus. The cost of using more environmentally sound consumables is considerable. For instance, the copy paper used in the STCs costs \$32.29/case and has 0% recycled content. The same paper with 100% recycled content costs \$46.79/case. Changing to 100% recycled paper would mean a 45% increase in the STC paper budget. Encouraging students to print less is also complicated. Because they have already paid their Student Technology Fee, many hold that it is their right to print as much as they wish. UITS charges \$0.04 per page printed over the quota, which is less expensive than most copy centers charge. So, there is little incentive for students to dramatically change their habits. In addition, despite many outspoken students requesting default duplexing and/or reduced quota expenditure for duplexed jobs, it is important to note that the desire to preserve the environment by reducing the number of pages printed is not shared by all students. Printing continues to increase steadily from year to year. Two IDS articles, written by Emily Brooks<sup>32</sup> and Alexandra Chtchedrina<sup>33</sup> stress a need for an increase in the print quota and/or more printers. Attempts to reduce paper usage by means such as duplex printing are complicated and the tradeoffs are difficult to measure. Changes to the print quota amounts must come at the highest levels of administration and are unlikely. The change would also come with a high degree of negative publicity. In addition, were such changes to come about, it is likely that the burden of providing printing would migrate to the departments which don't monitor the number of pages students print, simply moving the problem as opposed to solving it. Finally, there are habits which are very hard to change. Students have become accustomed to reading their documents on paper and faculty have historically required physical copies of assignments. There is a habit based issue here, as faculty have

required physical copies of work basically from the very beginning. Changing such habits will be a major obstacle in moving to more sustainable computing on campus.

**Positive Practices:** (these comments refer specifically to the Student Technology Centers. Information on the print practices of individual departments was not available at the time of this study)

- Student Technology Centers currently have recently updated to Pharos 7.2. One black and white and one color server have been virtualized, reducing the load on the WCC machine room.
- Where print release stations are deployed we see a 15-25% reduction in wasted paper (abandoned jobs). It is the most requested service from partners. We will eventually have them on all printers. This is a good use of old equipment (the computers used at the release station), significantly extending their lives.
- The STCs are transitioning to smaller laser printers in their lower-use facilities. These are faster, cheaper to maintain, and use less power.
- With color printers, the STCs let them “expire” (warranty wise) and then keep them in production.
- Use only remanufactured toners in the STCs
- The STCs have toner and paper depots on campus so the IT staff do not have to travel as far to restock.
- The STCs Have begun a print reduction campaign

**Suggestions for improvements:**

- Continue the print reduction campaign, possibly involving contests or incentives. Encourage students to print two pages per side of paper to cut their consumption in half.
- Explore the true environmental and financial tradeoffs involved in duplex printing.
- Look to a long term plan of lowering or eliminating the print quota and/or increasing the charge for those who print over their quota.
- Change the default margins in Microsoft Word to 1 inch rather than 1.25 inches.

Note: The recycling of printed paper is handled in the IT Related Waste section of this document.

## IT Related Waste

While the excessive use of energy and masses of printed paper are well known resource drains, a less scrutinized part of sustainable computing pertains to IT related waste. Such “e-waste” can be broken into two broad categories – waste caused by machines and devices which are considered beyond their lifecycle and waste caused by the packaging, installation, and use. Although this waste is often invisible to the students and administrators of IU it is a fact of daily life for the IT professionals in charge of operations on campus.

### End of Lifecycle

Perhaps the most environmentally damaging aspects of Information and Communications Technology is the fact that much of it becomes obsolete and unusable fairly quickly. The process of deciding that a piece of IT equipment is no longer meeting the needs of its users is dictated by personal practices as well as institutional policy. In 1998 Indiana University instituted a mandatory 3 year lifecycle replacement plan for faculty, staff, and Student Technology Center computers as a part of the IT Strategic Plan. This was enacted as a means of bringing all campus equipment up to minimum technical standards, thus

allowing for the delivery of more efficient IT support and ensuring that computers on campus were “modern and in warranty”<sup>2</sup>.

All IU owned equipment, including IT, must go through formal channels for resale or disposal. A large majority are sent the IU Surplus Store to be sold. There are high overhead costs associated with wiping and/or destroying hard drives, rebuilding and testing equipment, palletizing and storing items which cannot be sold immediately, working with customers, and going through a bidding process to sell technology which is no longer functioning. While a portion of the sale of IT is given back to departments, many devices are sold for much less than the costs associated with preparing them for sale. For this reason, some departments send their items to the store and never receive any credit. This happens primarily when the equipment sent to the store is worth less than \$150 on the open market. Approximately 60% of the sales at surplus are computers. However, due to the large expenses of wiping hard drives and rebuilding the machines, IT represents only 50% of the income for surplus stores. For security reasons the Surplus Store is required to wipe every hard drive clean. Because the store staff are not qualified to wipe them appropriately, server hard drives are shipped to IUPUI who then sends them back to vendors to be destroyed, reducing the worth of the remaining server parts and generating a great deal of e-waste.

Exact statistics on the amount, possibly tons, of electronic equipment that move through the Surplus Store is not available. For many years IU required that all items worth over \$1000 were tracked with inventory system tags. This included almost all computers on campus. At that time, strict records were kept regarding the disposal of such equipment. However, decreases in the cost of the average computer slowly led to fewer and fewer computers being tagged. In addition, the inventory policy later changed, requiring only equipment worth \$5000 or more to be inventoried. At this time there are no formal policies requiring proof of where individual computers end up. Estimations from sale receipts indicate that roughly 1500 to 1800 working systems (monitor and CPU) were sold in 2007. Approximately 2 to 2.5 times that many were sold as non-working machines, often palletized and sold in bulk to the highest bidder. Companies who repair and/or remanufacture equipment to be resold have traditionally purchased these pallets. IU has never paid an organization or the county to dispose of our e-waste thanks to the sale of such items. However, interviews indicate that there is a very real potential for this to happen soon. Due to low market desire for CRT monitors, the Surplus Store currently has 25 pallets with 12 monitors each which have been put out to bid 3 times and have not sold. Such monitors represent the first wave of e-waste which may cost the university money to dispose of. Monroe County Waste<sup>34</sup> currently charges \$16 per monitor for proper disposal. At this rate, IU would pay \$4,800 for this first set of e-waste.

During interviews it was discovered that some departmental IT staff don't agree that computers should be retired after 3 years and prefer a 4-5 year lifecycle, depending on the type of machine. One interviewee stated “a 3 year box is still a great machine” and discussed the benefits of converting them to Linux for graduate students to use as test machines. The redistribution of such machines for use by students is a positive practice, as it extends their life and may even allow students unique learning environments where they can experiment without risking their personal devices. However, if the machines are stored away for the potential of future need or set up for graduate students who then never use them they are simply burning energy and losing value. Statistics on how common this practice is are not available.

The STARS<sup>35</sup> (Sustainability Tracking, Assessment & Rating System) for Colleges and Universities, a project coordinated by The Association for the Advancement of Sustainability in Higher Education<sup>36</sup>

recommends that the “Institution has a comprehensive electronic waste (e-waste) recycling and/or reuse program. The program includes collecting all institution-owned electronic products and, at least annually, electronic materials from students. All of the e-waste collected is refurbished, donated, or recycled domestically.” This program seeks to provide ratings for institutions which may later be used to inform prospective students. Our ability to develop a comprehensive e-waste plan will allow us to be competitive in this category.

**Positive practices:**

Despite the large number of machines which end up as e-waste from IU, there are numerous positive practices as well.

- GAFTAS program – As Student Technology Center machines are retired, many of them are given to the College of Arts and Sciences who refurbish them, install a common build, and sell them for a small fee to students who qualify for a program based on economic need. This helps meet university academic goals as well as extending the lifecycle of the machines for at least one additional year.
- Computers which are refurbished and sold from the Surplus Store represent almost 2000 machines which do not end up as e-waste. In addition, the surplus store is a service to the community, selling equipment to local families, IU students, local businesses, and many local schools.
- Recently the Surplus Store was asked to attempt to ensure that equipment sold on pallets is not being sent overseas where it can be easily disposed of in non-environmentally sound ways. In response, they have added a line on the bid, stating the “Bidder acknowledges that to the best of their knowledge no electronic surplus they purchase from Indiana University is sold or exported overseas to be recycled or as waste.”
- Some departments have been able to avoid e-waste on campus by working out “trade in and trade up” agreements with companies. For example, at UITS the networking switches, routers, and wireless radios are purchased from HP with the understanding that old equipment will be returned to the company as IU replaces it. HP then applies this return as a credit toward the purchase of new equipment and is able to refurbish the hardware for reuse by others. This allows IU to stay on the cutting edge without sacrificing the networking equipment budget or the environment.

**Suggestions for Improvement:**

- Departments need to send items which are beyond their 3 year lifecycle and do not have a specific use to the Surplus store while there is still financial value to be gained for the dept AND the machine is usable by members of the community. There may need for greater awareness among the IT community about the Surplus Store’s procedures, such as the wiping of hard drives and their department credit policies, to facilitate the decision to send equipment there.
- The Purchasing Department should work with IU vendors to offer equipment take back programs for equipment that cannot be sold at the Surplus Store. In addition, the vendors should allow consumers who purchase computers from the vendors via our contracts or even purchase old departmental computers from the surplus store to bring these computers back at the end of use so all IU equipment falls under the take back program (even after it leaves IU). This provides extra incentive for local residents to shop at the Surplus Store and is a service to the larger community as it reduces the strain on our municipal waste facilities.
- Reconsider the mandatory 3 year lifecycle, possibly changing to a 4 year lifecycle. This is an ongoing discussion within UITS.

- Label the Surplus Store computers and GAFTAS machines with information on proper disposal of IT. A simple sticker with the phone number of the Monroe County Solid Waste facility can serve to raise awareness that the trash is not the place for old equipment.
- Reconsider the tagging of all IU electronic equipment, perhaps going back to the model of tagging all items worth \$1000 or more. Tracking of equipment from purchase to disposal is the only way to ensure that we have accurate statistics on our e-waste. If this is deemed impractical, other attempts to obtain better statistics on the number of machines sold as working units and the amount of equipment palletized and sold as components needs to be made. The goal should be that no machines are sold for parts – all are either sold as working units or are taken back by the manufacturer for remanufacturing or recycling. We should aim for 0% of the IT equipment on campus being sold en masse on pallets to bidders we cannot track.
- The current practice of having the used servers' hard drives destroyed removes a substantial portion of the value of the equipment. Arranging trade in and trade up agreements with vendors at the time of purchase, buying only from vendors who offer equipment take back programs, or paying to have the equipment professionally wiped to allow for the sale of the intact machine would be preferable.

### **Waste associated with packaging, installation, and use of IT**

Every computer comes in its own box, often with a manual, build CDs, and occasionally with extra cables and adaptors. Boxes are usually made of the strongest double corrugated cardboard and contain Styrofoam molded in the shape of the component to ensure safe travel conditions. Interviews and personal observation have revealed that some individuals have taken it upon themselves to send unused items such as manuals and extra cables back to the company so they could be used where needed. Boxes from the STC machines are placed outside of the Operations team building, where many IU staff know they can come to pick them up. Many times all of the boxes are gone before the “packer trucks” (recycling trucks) come to pick them up. While these informal methods of reducing or reusing the waste associated with packaging are beneficial, such practices are not consistent across campus and ways of sharing ideas for lowering waste do not exist.

We also create waste because of old habits. For example, the STCs and RTCs still use mouse pads, despite the fact that all computers in these facilities have optical mice which do not require such a surface. The UITS STEPS classes are still advertised via printed brochures (in addition to electronic advertising). While these practices generate waste, they also provide consistent information and a pleasant “mousing experience”. The STEPS class brochures advertise classes in a way that might be better at gaining the attention of students who are already bombarded by electronic messages about such opportunities. Thus, although some waste is generated, it is possible that this waste is not significant enough to warrant change when compared to the benefits provided to students.

Another source of waste associated with the use of IT is the large amount of printer paper on campus. For a full description of this practice, look to the “Printing” section of this document. Recycling bins for paper exist in most buildings on campus, all STC and RTC computer labs, and many offices. The 2008 Campus Sustainability Task Force Summer Internship Program devoted one full time intern to recycling on campus. Her report can be viewed for full details and suggestions on recycling of paper from their website<sup>37</sup>. However, it is important to note that “Manufacturing recycled paper can use up to 90% less water and 50% less energy than making it from trees.”<sup>16</sup>. Thus, any sustainable computing program should focus on ensuring that this form of waste can be recycled to minimize its impact.

Perhaps the most difficult portion of IU's e-waste stream to measure or change has to do with the disposal of personal IT devices such as cell phones, scanners, digital cameras, batteries, toner cartridges, and more. The end of lifecycle issue extends beyond departments and their operational practices. E-waste in the form of old cell phones, personal toner and ink cartridges, and used batteries easily finds its way into trash cans across campus. While recycling bins for paper, plastic, and aluminum cans are common, collection points for highly toxic e-waste are not consistent across most buildings on campus. Some residence halls and departments handle such items for their residents and staff, but there is no centralized effort. As computing becomes ubiquitous and devices such as cell phones become primary computing devices, problems associated with such e-waste need to be addressed. Exact statistics for the amount of such waste at IU are not possible to obtain, as the small size of such items makes them easy to throw directly into the trash. However, a study<sup>38</sup> of IU undergraduates and their IT beliefs and practices found that "52.8% of participants indicated they simply store old cell phones away" and that "less than 6% of people threw away their old phones." Similar findings exist in nationwide studies<sup>39</sup>. Nokia reported that 44% of individuals store their old cell phones, 4% throw them away, and only 3% recycle them. They claim a lack of awareness as the main problem, noting that 50% of their survey participants weren't even aware that old phones could be recycled. According to their study, however, "between 65 to 80 percent of a mobile phone can be recycled. The metals from mobile phones can end up in copper roofs, ski bindings or dental fillings, and other materials are ground up into chips and used as construction materials or for building roads." A lack of awareness partnered with a lack of easy opportunities to recycle used electronics, toners, and batteries might be easily rectified with an awareness campaign and the addition of collection boxes in residential halls and academic buildings.

**Positive Practices:** While some positive practices exist, the majority of these practices happen as a result of uncoordinated efforts or individual practices. The possibilities for change in the area of e-waste are abundant.

**Suggestions for Improvement:**

- Raise awareness of the benefits of recycling old electronics
- Create a centralized place on campus for used computer hardware boxes so they can all be reused rather than recycled.
- Ensure that all printed paper is being recycled properly
- Partner with RPS for pickup days
- Discuss the issue of e-waste with the RHA, IUSA, and other student groups. Ask the students what they would like and how they might be prompted to donate their old equipment rather than simply storing it or throwing it away.
- The very best practice: By PURCHASING EPEAT-certified products many of these problems will be eliminated. EPEAT requires mandatory packaging regulations, take back programs, and more.
- IU needs a consolidated take back/recycling program including an awareness campaign, extension of the recycling boxes already found in some residence halls on campus, and possibly an electronics disposal day where people can turn in their unwanted equipment for no fee. This final suggestion is already being considered by purchasing.

# IT Infrastructure – what it takes to make IT work on campus

## Energy Usage and IT

As computers, peripherals, cell phones, and PDAs have become ubiquitous their energy consumption has greatly increased. In addition to there simply being more devices on campus, the devices themselves are consuming more energy than they did in the past. Understanding the contribution of student-owned machines to energy consumption is complicated and will require future study to accurately report. However, measures of campus owned IT energy use is not much easier to measure. Many buildings on campus are not metered, so their consumption can only be vaguely estimated. Some departments supplement their IU power with energy from the local utility company, Duke Energy. IU currently offers no ways to accurately gauge IT energy consumption, incentives to lower this consumption, or instruction on ways to curb our energy habits.

However, the days of not knowing exactly how much energy we consume and the carbon emissions associated with it are coming to an end. A project is underway on campus to slowly meter all of the buildings. In addition, the Campus Sustainability Task Force is working on ways to measure our campus' carbon footprint, which will eventually bring attention to departments with higher IT-related energy usage. Indiana University may eventually join AASHE (Association for the Advancement of Sustainability in Higher Education), which has a strong focus on monitoring energy usage patterns. Finally, regulations regarding the reporting of emissions and carbon dioxide production may force IU to justify our usage and find ways to cut back when possible. Beyond saving money from energy reductions, there are potential legal justifications for making our IT usage more energy efficient. Doing so will lower our carbon dioxide emissions, which have recently become a major concern. While laws which apply to industry do not always apply to higher education institutions, there is the possibility that IU will be held to similar standards eventually. As the McKinsey<sup>40</sup> report notes:

### **“ONGOING INITIATIVES NOT WITHSTANDING, EMISSIONS WILL QUADRUPLE BY 2020 CAUSING INTENSE SCRUTINY FROM REGULATORS, ACTIVISTS AND CORPORATE BOARDS:**

- The carbon footprint has begun to attract scrutiny and legislation (e.g., US Public Law 109-431 requires EPA to submit a report on energy consumption of data centers to US Congress).
- EPA has advocated use of separate energy meters for large data centers and development of procurement standards.
- The European Union is developing a voluntary Code of Conduct for data centers proscribing energy efficiency best practices.
- Data center carbon footprint is expected to affect even the industries that are traditionally considered “clean” (e.g., telecom, media, technology)”.

During interviews, several departments noted that their server rooms require more power and cooling than the IU physical plant can provide. Backup cooling units run 24 hours a day, 7 days a week. One department was proactive in measuring the energy needs of the servers they have, in order to establish their backup needs. However, looking at energy specifications before purchasing such high end machines was admittedly not a part of their process. As IU begins to meter all buildings we may be astonished to find what some of these department server rooms are using.

Electricity at IU is generated by our on-site coal plant. Additional energy is provided by Duke Energy Company. While it is logical to think that Duke might profit from the energy hungry IT on campus,

evidence<sup>41</sup> suggests that energy companies are actually more interested in helping curb these habits. In Silicon Valley, energy companies funded almost 100% of the experiments companies engaged in to try to quantify and lower energy usage. They “offer incentives to companies for investments that can cut their energy usage”. One PG&E energy company representative stated “As a facility manager my incentive isn't to sell you more electricity, but to give you the tools to be more efficient”. Looking into partnerships with Duke should be a top priority for sustainable computing at IU. As mentioned earlier Stanford partnered with their local energy company and receives money every time someone downloads their energy saving client called “BigFix”<sup>20</sup>.

Partnering with local utilities companies is only a portion of the solution. In fact, working to improve communication and cooperation between departments and the Physical Plant on campus is perhaps even more important. Interviews found that power for departments’ machines was rarely a major problem. When new equipment was purchased for a server room, they would simply request additional electrical hardware and circuits to accommodate it and their requests were filled. Cooling the rooms, however, was a serious problem. This had more to do with campus conservation efforts. Numerous departments noted that they must be vigilant regarding the cooling of their server rooms and computer labs due to Physical Plant summer procedures. Even though they have contacted the Physical Plant to let them know that some rooms are full of computers and MUST be kept cool, this is complicated due to the cooling cycles (called “shedding”), where the plant distributes cold water to buildings on campus in a pattern, such as two hours on then two hours off. This practice has led to support issues and dangerously high temperatures in some IT facilities. This, coupled with the massive heat generated by server rooms has led some departments to purchase additional cooling units and partner with local power companies to ensure the proper conditions for their machines. Such add-on AC units are often not energy efficient. In addition, the inconsistency of the Physical Plant’s ability to provide cooling leads some departments to keep their server rooms much colder than recommended, so there is time to react if cooling is suddenly lost. One such room was 67.8 degrees at the time of interview, over 6 degrees cooler than considered safe by the recent McKinsey report<sup>40</sup>. Working to facilitate better communication and safeguards regarding campus provided cooling is one possible solution. According to the McKinsey study, increasing the cold aisle temperature, eliminating “duelling” cooling units, and increasing the chilled water temperature can increase efficiency by 10-15%.

In addition to the server rooms on campus, departments are also responsible for thousands of end user machines, from faculty and staff workstations to computer labs and email stations. While these machines may be highly used during a portion of the day, many are locked away in offices or closed labs in the evenings. As mentioned in the “Hardware” section of this document, interviews with departmental representatives indicate that simply shutting down these machines does not work well within our current IT support models on campus. In order to prevent service slowdowns and interruptions, upgrades, security patches, and back-up routines are run in the evenings, when the computers sit unused. While this is a valid concern, technologies do exist which can make this process reliable as well as energy efficient. Cornell researchers put together a guide<sup>14</sup> outlining exactly how to do this on university-owned computers. Yale was spotlighted by the EPA Energy Star program<sup>42</sup> for its efforts to find creative solutions to the need for nightly backups and security patches by individual computers on campus. In a pilot of 105 computers, they found they were able to save \$40 per machine, for a total of \$4,700 per year by securely shutting down machines and waking them for their nightly build. If IU were to do this with most of its 15,000 faculty and staff machines, the savings could amount to well over half a million dollars in energy costs.

Enacting energy saving shutdowns in the STCs and RTCs across campus involves additional levels of complexity. Many of these facilities are open 24 hours a day and usage statistics show that students regularly fill some locations, such as the Information Commons, well beyond 2:00 and 3:00 in the morning. In addition, some locations serve as technology classrooms and instructors of 8:00 am classes expect to find all of the computers on and ready to go first thing in the morning. Finally, as noted in the “Hardware” section of this document, the STC machines are part of a research program called Condor, where the computer’s processing cycles are made available to faculty and graduate students needing higher end computing. Thus, the energy used to keep them on is not entirely wasted. Finding creative solutions to lower the energy usage of the computer labs on campus will involve a combination of shutting some machines down, purchasing more energy efficient equipment, working with IT staff to create reliable wake-up routines, and testing to ensure that the labs are still able to meet the needs of the students on campus. The University of Wisconsin<sup>43</sup> recently worked to do this in their computer labs, using sleep mode and saving \$20 per machine, or \$9,000 annually.

**Positive practices:** Reducing energy consumption appears to be a low priority for most IT professionals on campus and there is much room for improvement in this area.

**Suggestions for Improvement:**

- Strongly encourage the metering of all buildings on campus.
  - Consider ways to prioritize computer lab locations, closing the least used during the summer while continuing to support the high-usage locations.
  - Encourage departments with server room energy and cooling problems to move their equipment to the new data center, where energy usage will be the most efficient.
  - Work with Duke to fund research on ways IU can reduce its IT energy consumption.
  - Consider purchasing clean energy or carbon offset credits to lower the impact of our current IT energy consumption.
  - Form a task force to create ways to safely shut most IU computers down at night while still receiving upgrades, security patches, and going through back-up routines.
  - Prompt vendors to provide energy consumption specifications in the IU purchasing system.
  - Encourage departments to consider energy consumption when purchasing new IT equipment.
  - Provide ways for departments to measure their current energy usage, either by partnering with the physical plant or using a commercial tool.
  - Provide a personal computer energy saving tool for students, faculty, and staff to install on their personal machines, perhaps partnering with Duke to fund future energy saving programs.
  - Look into providing departments with incentives for reducing their energy consumption.
- Interviews reveal that such a model has worked at the University of Michigan.

**Facilities – we have a physical footprint too!**

Studying the environmental impact of the facilities needed to house campus computing is beyond the scope of this initial project. Such facilities include the Student Technology Centers, Residential Technology Centers, IT Classrooms, Teaching and Learning Centers, Wrubel Computing Center and the “E” buildings, departmental computer labs and server rooms, departmental IT offices, and networking closets. Complications associated with a lack of building energy monitoring, differing support models across departments and buildings, and the wide variety of the types of technology employed in each of these facilities make this portion of campus computing too difficult for current measurement techniques. However, it can be noted that changes in hardware purchasing and use patterns as well as server efficiency procedures will greatly affect the energy consumption and cooling needs of these

facilities. In addition, campus-wide efforts to change recycling habits, use efficient lighting, build and/or remodel buildings to be LEED certified, and other such initiatives will impact computing facilities as well.

### **Data Center**

Perhaps one of the least visible but most important aspects of sustainable computing is the impact of the data center on energy usage and carbon dioxide emissions at IU. According to the McKinsey report<sup>40</sup> the “Average data center consumes energy equivalent to 25,000 households” and “Worldwide energy consumption of [Data Centers] doubled between 2000 and 2006”. Another report<sup>44</sup> cites “The energy used by a typical rack of state-of-the art servers, drawing 20 kilowatts of power at 10 cents per kWh, uses more than \$17,000 per year in electricity. Given that data centers can hold hundreds of such racks, they constitute a very energy-intensive building type. Clearly, efforts to improve energy efficiency in data centers can pay big dividends.”

Exact energy usage data is not available for the current data center located within the Wrubel Computing Center (WCC). Energy is supplied both from IU’s coal plant as well as Duke Energy Company. While Duke meters the electricity it provides, IU does not. However, it is logical to assume that the UITS data center consumes vast amounts of electricity to power the machines as well as cool them. Interviews reveal that cooling systems have become a major concern, with a combination of floor vents, ceiling blowers, and individual rack cooling doors all being used to maintain proper operating temperatures. Increases in our enterprise systems as well as the installation of Big Red, the research super computer, make IU a leader in higher education computing. Our involvement in the TeraGrid project, our housing of the state’s data backup systems, and our massive data processing ability due to Big Red ensure that our data center plays a central role in keeping IU competitive for national grants from organizations such as the National Science Foundation. However, this also means that we must carefully plan for future energy use.

A new data center is currently under construction. At the time the new UITS data center was being designed the large environmental and financial impacts of such centers were not being widely publicized. While it is difficult to make changes now that construction is well under way, there are possible improvements which can be made. The building is designed to be structurally sound enough for a “green roof”, which might help keep temperatures lower. However, funding for the roof has not been approved. The cooling systems currently planned will not take advantage of air economizers, which make use of the cold Indiana air during the winter, due to humidity and static concerns. In addition, while the old data center, housed within the WCC building, provided heat for the offices of the UITS employees, the new data center, housed in a separate building, will not. Thus, heat pumps will be reinstalled in WCC and the heat from the data center will be lost as a potential recycled heat source. Many of these plans are well into the construction phase and are not possible to change without significant cost. However, the data center is built as a series of bays or pods, with room for future expansion. It is possible to investigate how the addition of a green roof, the installation of alternative cooling systems, and the recycling of heat from future bays might be possible. Researching these possibilities now might give the architects time to make design modifications for future impacts.

While the physical building may contribute greatly to its energy efficiency, practices within the structure are of greater concern. The current data center in WCC houses thousands of servers, back-up servers, UPS (Uninterruptible Power Supply), and generators. Many of the machines in the data center are owned and managed by departments across campus. Procedures for adding or updating servers are strictly monitored by UITS staff. Energy concerns and the classification of critical versus non-critical services and equipment must be taken into consideration in the planning of any changes to the machine

room. The complicated process of prioritization, maintenance schedules, and ensuring continuous services to the thousands of students, staff, faculty, and researchers who rely on these machines makes the concept of monitoring energy consumption at the individual device level or even the rack level seem impossible. However, such measures are vitally important if the data center is to become more efficient. The McKinsey<sup>40</sup> report cites three primary drivers of poor energy efficiency:

- **“Poor demand and capacity planning within and across functions (business, IT, facilities).**
- **Significant failings in asset management (6% average server utilization, 56% facility utilization).**
- **Boards, CEOs, and CFOs are not holding CIOs accountable for critical data center facilities CapEx and data center operational efficiency”.**

Steps are already being taken to enact changes. UITS recently began the process of “actively deactivating” over 300 servers as they move toward virtualization. Removing dead servers is estimated to improve efficiency by 10-25%<sup>40</sup>. Virtualization is estimated to increase efficiency by 25-30%<sup>40</sup>. This will also greatly increase their server utilization statistics, making the best use of IU’s resources. They are encouraging departments who house their equipment within the data center to explore virtualization as well. Other improvements such as purchasing greener and more power efficient servers (saving 10-20%)<sup>40</sup> and changing several cooling methods (saving 10-30% collectively)<sup>40</sup> may be more difficult to enact. As Christina Belady, the principal power and cooling architect at Microsoft says “While there are plenty of technology solutions for improving data-center energy efficiency, not many companies are using them. It boils down to a behavioral problem, not necessarily a technology problem”<sup>41</sup>. Many of these behavioral problems came to light during interview conducted this summer. One LSP stated “Server sprawl is a huge issue. But, people wanted different servers for different applications and backups for each. That model was comfortable.” Another interviewee indicated “Virtualization is good but there are organizational mindsets that will need to be overcome.” Many LSPs want physical access to their servers. Centralizing and virtualizing all servers in the UITS data center involves a level of trust and a confidence in the system that will take time to build.

Measuring the current energy usage and carbon footprint is another complication in making our data center more sustainable, as is indicating changes as positive practices are enacted. Fortunately, many tools are being developed to meet these challenges. A recent Gartner report<sup>45</sup> notes “Users must establish models for gaining a granular view of their energy costs, floor space and infrastructure topologies. As a result, users will understand where the power is going (servers, cooling, and uninterruptible power supplies or power distribution) and how much it costs. This must be performed as a primary task in data centers, and then it should be rolled out to the appropriate office locations.” Carbon Footprint Ltd.<sup>46</sup> provides an online calculator geared toward personal carbon use, but the company also provides commercial services for businesses. The Department of Energy has released a data center energy tool called “DC Pro tool”<sup>47</sup> and Accenture<sup>48</sup> also provides tools to ‘green’ all aspects of IT, including data centers. Many other companies and consulting firms are now offering tools and services to help measure data center costs. Potential gains from changing energy consumption practices at data centers may be the single largest contribution a “Sustainable Computing” focus can make. According to the Rocky Mountain Institute<sup>49</sup>, “From past and current client experience, RMI has found that the same computing services can be provided with 95 to 99 percent less power than standard practice. And these gains are achievable with off-the-shelf technology.”

#### **Positive Practices:**

- The “active deactivation” of approximately 300 servers in the current data center.
- Strict procedures regarding the addition of equipment into the existing machine room.

- Inclusion of hot and cool aisle layout in the data center makes more efficient use of cooling systems.
- The new data center design allows for a green roof, but it is not in the current plan (is not funded).

#### **Suggestions for Improvement:**

- The third pod of the data center is unfinished to allow for growth. In this area it is possible that more sustainable options might be utilized. For instance, we might look into “air economizers” for cooling these new data center areas.
- UITS should quickly look to ways to accurately measure energy consumption, including server usage, cooling, etc. This will include a comprehensive search for the commercial products and/or consultant possibilities. A strategic plan with yearly goals should be developed.
- UITS should charge for data center space not by the foot but also by the amount of energy needed. This will prompt departments to virtualize, purchase energy efficient equipment, and to justify their server needs. Microsoft is already doing this in their data centers<sup>41</sup>.
- Partner with our local energy company (Duke) to work to lower data center power consumption. In one report<sup>41</sup> energy companies are becoming involved in helping lower energy consumption of data centers and that “many of the implementations were 100 percent funded by utilities, which often offer incentives to companies for investments that can cut their energy usage.”
- Consider purchasing green power from Duke to power the new data center, which would help offset our carbon emissions.
- UITS should provide support for these changing trends by hosting virtualization workshops/LSP courses, providing space and hardware for departments to run tests to determine which of their services can easily be virtualized, and perhaps even allowing departments to partner with UITS in a pilot program to explore the service issues associated with moving servers beyond the physical reach of the departmental LSPs.

#### **Network**

Another nearly invisible portion of sustainable computing is the network infrastructure necessary for service provision. IU has been acknowledged as one of the “most wired”<sup>50</sup> and “most wireless” campuses, two achievements which help increase the visibility of our school and exemplify our commitment to technology to potential students<sup>51</sup>. In order to maintain these titles, IU Bloomington alone has over 65,000 data jacks, 17 routers in the core network, 717 networking closets, and an immeasurable amount of wiring spread across campus. Networking equipment is in a constant state of upgrade, and the networking group submits a 5 year plan as opposed to a 10 year plan in order to remain flexible to changes in technology. Keeping these high standards comes at a high cost. According to interviews, the “wiring upgrade is the biggest expense in the plan by far”, with a price tag estimated to be well over \$30 million dollars. The majority of this cost is incurred rewiring the residence halls, allowing students hard wired connections directly into the university network as well as enabling the eventual transition from analog television to IPTV in the future.

In addition to keeping the wired network up to date, the wireless presence on campus is growing as well. This year 4200 new Wireless Access Points (WAPs) will be installed, upgrading to the higher bandwidth 320 Meg radios. These numbers equate to one WAP for every 4 students living in the residence halls. One might logically ask why we need the redundancy of an expensive and eventually outdated hard-wired network in a location with such high wireless coverage. Interviews with Network Engineers reveal that even the newest technology wireless networks will not be able to meet all of the

audio, video, application, and processing needs of the students living in the halls. Until major changes in the technology happen, providing both wired as well as wireless access points is necessary to ensure that students are having all of their academic needs met.

Finding ways for the network at IU to be less resource intensive is difficult to do without opening a discussion about the potential tradeoffs involved. Indiana University has a strong commitment to its current students, faculty, and research partners to provide the highest level of services possible regarding IT. We are an integral link in national research alliances, such as the TeraGrid project, we house the State of Indiana's backup servers which rely on accurate and timely data transmission, and we try to ensure that students are able to stay connected from anywhere on campus. Major changes to this structure might have legal, funding, and enrollment consequences. On an operational level, however, some sustainable practices are already in place. The UITS Finance Office has partnered with Hewlett-Packard to trade in all of our networking equipment as it is replaced, lowering the cost of new equipment and avoiding e-waste all together. Networking crews maintain a standard of pre-wiring all jacks in network closets, allowing them to activate jacks remotely as requests come in. This saves time as well as trips to campus in networking vans. Individuals on the networking crew have even taken personal steps to reduce waste by working directly with Cisco to send extra cables back to the company so they could be re-used instead of thrown away.

In addition to consuming resources in the form of wires, equipment, floor space, man-hours, and maintenance trips, the network also serves as the backbone which facilitates many types of sustainable practices, such as telecommuting, video conferencing, and more. This is discussed at length in the section of this paper titled "IT as a Sustainable Alternative".

**Positive practices:**

- Network staff working hard to create opportunities for sustainable practices – telecommuting, video conferences, OCS.
- Already have a trade in / trade up agreement with Hewlett Packard on major networking equipment.
- Flexibility in planning process, which will allow for the inclusion of more sustainable practices as they become feasible.
- Already work with Cisco to send back extra cables.

**Suggestions for Improvement:**

- Continue to look for ways to work with our vendors to cut back on waste in the form of packaging and extra cables
- Look into the possibility of recycling old cables after they are pulled from buildings
- Remain flexible in the planning process, consider hard wiring only a subset of facilities which have the highest need for high-bandwidth

## IT Workforce

Counting the staff at UITS, departmental LSPs and IT Directors, RITS staff, STC consultants, and others there are well over 1000 IT professionals on the Bloomington campus alone. Most of these employees must be given work space and their own computers to do their job well. Their footprint and practices are intimately connected to all other aspects of campus computing and must be part of the equation. In addition, due to the distributed support model on campus, the roughly 350 Local Support Providers

(LSPs) and departmental IT Directors are extremely influential in helping shape IT habits and practices on campus. There are many ways to actively involve the IT professionals on campus in efforts to make computing more sustainable. Such involvement may be the most important suggestion in this document, as it is the IT workers who set the energy settings, enforce the policies on campus, make the support models work, and come up with the most creative solutions to some of the biggest IT challenges we face. At the 2004 Workshop of ICT and Climate Change hosted by Bell Canada this sentiment was echoed. According to the formal Global e-Sustainability Initiative (GESI) report<sup>52</sup> “A common theme that emerged was the need to actively involve employees in all processes aimed at minimizing environmental impacts, and for ICT companies to put words into action by providing new or improved services with reduced carbon emissions.”

The process of greening IT workers starts with training. While many of the people interviewed for this report had ideas about ways to make computing sustainable on campus, most admitted that they had not become fully educated about the topic and lacked the time to do so on their own. One reported “I’m swamped and don’t have time to be proactive. It would be nice to have someone do the legwork/research on things you could do now. We need a group that provides a list of feasible things to do”. Such a ‘list’ might be sent out in the form of emails, posted in the Knowledge Base, made part of a workshop or speaker series, or included in a much larger training series. UITS currently offers ongoing training opportunities for the LSPs on campus. The creation of a course or series of course on becoming a “Green LSP” could include information about measuring server utilization, virtualization, Condor, energy settings, purchasing practices, changing habits, best practices at other universities, virtual conferences, telecommuting, e-waste, and more.

After training, IU must strive to empower its IT workers to serve as green examples and ambassadors. The IT workforce on campus can serve as volunteer testers for sustainable employee initiatives. Obvious examples include increased telecommuting or partial telecommuting and shared office space. UITS has already been testing the Office Communicator Suite, which enables employees to work more effectively from home. Another example is the increased use of video conferencing as an alternative to traveling to meetings. See more information about these examples in the “IT as a Sustainable Alternative” section of this paper. As the IT workers on campus make more use of these services they can improve them and then help roll them out to other IU employees. The IT workforce might also be empowered to behave more sustainably beyond their technology habits. For instance, UITS could purchase hybrid fleet vehicles and/or gators (for use on campus), both of which use less gasoline than conventional fleet vehicles. UITS could install more or better bicycle racks, include recycling bins for plastic and glass in all buildings (in addition to the paper recycling already in place), replace all light bulbs with compact fluorescents, use motion detectors to turn lights on and off in non-critical areas, and implement other sustainable practices as a part of making the transition to sustainable computing. Examples in the corporate IT world abound, such as Microsoft’s practice<sup>53</sup> of providing shuttle-buses to reduce total commuter miles by 30,000 per day, solar-power at some facilities, a hydro-powered data center and biodiesel in its facility’s trucks. Sun Microsystems<sup>54</sup> instituted a project “to determine how much energy is consumed while working in a Sun office, while working at home, and during commuting to and from a Sun office.” Their findings suggest that “Average Employee Saves 2.5 Workweeks Per Year in Commute Time, More than \$1,700 in Gas and Wear and Tear on Vehicle, and 5,400 Kilowatt Hours/Year Working Flexibly”. The environmental footprint of the IT managers and UITS employees on campus is greatly increased due to the shared management model, where individual managers are in charge of employees on both the IUB and IUPUI campuses. This necessitates frequent trips between Bloomington and Indianapolis. UITS has been exploring the possibility of a shuttle arrangement which might greatly reduce the number of single passenger vehicles making this trip.

Beyond being well trained in green computing and engaging in sustainable behaviors, the IT professionals on campus can serve as influential leaders in sustainability. The IT Managers Council, composed of IT Directors and UITS representatives, helps establish purchasing policies, informs UITS on the needs of faculty and students, and in many ways determines university-wide IT habits. Involving these powerful IT figures in sustainable computing would allow IU to consolidate resources and knowledge and become a leader in this area.

“Greening” of the workforce and the workplace has the potential to do more than position IU as an example of sustainable computing. Such projects have the added benefits of attracting a broader employee base and improving employee relations. One poll<sup>55</sup> of 1,500 IT workers found that 37% of respondents were willing to take up to a 10% reduction in salary to telecommute full time. It also stated that “surveys suggest that offering the ability to work from home can be a good way to attract and retain talented workers.” While telecommuting comes with potential limitations and added management responsibilities, research indicates<sup>56</sup> that there are numerous benefits to the environment, society, employers and employees. Finally, recruiting the best IT professionals to jobs at IU might be influenced by our sustainable computing habits. According to a recent article, Enterprise Rent-A-Car Co. found<sup>57</sup> that “green computing is a strong selling point in attracting IT job prospects, and it wants HR to know what it’s doing in that area”. A list of the top 10 pressures urging CIOs to “go green”<sup>58</sup> included hiring concerns. The article noted that “College grads who can be selective are selecting their employers by the reputation of the company and how committed it is to environmental practices,” and that “Demographics are on the side of this issue, and IT managers who are on the front lines of hiring out of college will be seeing that.”

**Positive Practices:**

- Many departments already have flexible work practices
- UITS is currently exploring shuttle options
- Many interviewees already practice sustainable computing on an individual basis

**Suggestions for Improvement:**

- Continue exploring the possibilities of telecommuting, carefully weighing the need for employee interaction with their supervisors and peers. When telecommuting is deemed appropriate and mutually beneficial, having some people telecommute some of the time (so it has a bigger impact) and offering “telecommuting cubicles” with empty desk space similar to the laptop stations in IC2 so there aren’t offices sitting empty half of the time.
- Keep exploring transportation alternatives for IT workers.
- Offer incentives for employees to come up with green solutions, publish white papers on the topic, etc.
- Offer workshops and training on green computing – including formal LSP training but also extending into personal practice focused seminars.
- Promote UITS as a green place to work.
- Student workers (STC and RITS consultants, support center staff, etc) also provide a good opportunity. They interact with students on a daily basis and can offer ideas to them regarding their practices. In addition, they can help with jobs which require large foot traffic (posting campaigns, distributing or collecting boxes for e-waste, rebuilding labs across campus), can come up with creative ways to share information with students (Photoshop contest among consultants, facebook groups), etc.

# IT and Education

As a university, IU is in a perfect position to formally and informally educate students, staff, and even its faculty on sustainability. The creation of the Campus Sustainability Task Force has been generating interest in the topic and this summer they devoted an intern to Education and Community Outreach<sup>37</sup>. Classes on sustainability-related issues do exist at IU, but no classes with a specific focus on technology. However, at least one research group has formed in Informatics, the Sustainable Interaction Design Research Group<sup>59</sup>, with an impressive number of publications and presentations on sustainability and technology. In addition, the prominent ACM's Special Interest Group on Computer-Human Interaction (SIGCHI) will host a student competition<sup>60</sup> this year with a challenge to find design solutions to sustainability problems. The IU School of Informatics typically has numerous teams who make it to the final in this competition and have won it in the past. Thus, the amount of research coming from IU with a focus on IT and sustainability will increase greatly in the coming years.

Beyond student research and competitions, there is a real need for formal student courses covering the greening of IT or at least the inclusion of a unit on sustainable computing in existing sustainability courses. Some examples exist at other institutions which might inform the creation of classes here, such as the Environmental Informatics course at Dalhousie University's School for Resource and Environmental Studies<sup>61</sup> or the workshop course created by the Monterey Institute for International Studies and The Sustainability Academy titled "Technologies for Sustainability & New Business Opportunities In Emerging Markets (IM 671)"<sup>62</sup> and a doctoral program in Urban Affairs and Public Policy with a specialization in Technology, Environment, and Society at the University of Delaware<sup>63</sup>.

Educating the IT professionals on campus is currently handled via formal training sessions, workshops, speaker series, as well as official certification preparation and testing. LSPs can attend infoshares and presentations. Faculty, staff, and students can also attend STEPS workshops on technology topics. The potential for informing people of all types about sustainable computing at any number of these venues is great. Currently there are no workshops, classes, tutorials, or official presentations on green computing.

In addition to formal training sessions, there are also many opportunities to informally educate people on campus about sustainable computing. Providing details about ways to "green IT" for residents at the sign-in tables during Fall move-in or participating in their speaker series, posting information on LSP wikis and blogs, creating a sustainability related listserv, and hosting a booth at "Make IT Happen", the annual IT Fair for students, staff, and faculty, are just a few examples. Formal campaigns to help people understand the impact of their personal IT habits on the environment is another option. The STCs are currently working on a print reduction campaign along these lines.

Finally, there needs to be a way to provide "just in time" information in a sea of sustainability-related documents. Media coverage of sustainability in general can be confusing and can often give advice that is not appropriate to a campus environment (suggesting that people shut computers down at night when LSPs have not been notified will lead to these computers not receiving their backups and security patches and a potential for data loss). We need to have information which is detailed but easy to follow, targeted to meet the individual needs of specific audiences, and available in multiple formats. Creating podcasts, tip sheets, and self-paced tutorials are a few examples. The IU Knowledge Base already provides a few documents with a sustainable computing focus, including "How can I minimize my computer's impact on the environment?"<sup>64</sup> and "At IU, how can I conserve paper in the STCs?"<sup>65</sup>.

Knowledge base editors are already working on additional articles in an effort to help make sustainable computing on campus a reality.

**Positive Practices:**

- Knowledge base articles published on sustainability topics.
- Print reduction campaign in the STCs.

**Suggestions for Improvement:**

- Create a series of online tutorials or podcasts covering sustainable computing topics.
- Organize “Green LSP” certification classes or workshops.
- Create lists of the top ways students, faculty, staff, and IT professionals on campus can change their IT habits to make them more sustainable.
- Invite industry leaders to give talks on ways they have greened their IT operations.
- Work with faculty to add sustainable computing elements to existing sustainability courses or to create stand alone courses on the topics, perhaps through Computer Science or Informatics.
- Add more Knowledge Base articles on sustainable computing.
- Increase the number of campaigns which raise awareness about sustainable computing.
- Advertise sustainable computing at all major IT events on campus.
- Create a listserv, blog, and website to centralize information about sustainable computing at IU.

## IT as a Sustainable Alternative

Information Technology has recently become associated with very real negative impacts on the environment. However, there are also ways that IT can contribute to helping with environmental problems. It prompts us to change our work patterns, provides alternatives to resource intensive practices, and facilitates research on environmental topics enabling us to model scenarios and visualize data.

Telecommuting is one well publicized alternative with is made possible by IT. As explained in the “IT Workforce” section of this document, this alternative is beneficial to the environment as well as employers and employees. Recently UITS has been testing the new Microsoft Office Communicator Suite (OCS), running a pilot program to elicit feedback from employees on how this program might be best deployed university wide. OCS allows end users to share documents easily, works well with existing calendaring and email systems on campus, enables easy desktop video conferencing, has the ability to indicate an employee’s activity level (busy, available, unavailable, out) and instant messaging, integrates with desktop phones, and provides a much more engaging form of interaction than past telecommuting models were able to offer. Every employee who can work from home is one less employee who needs physical space on campus (which must be lit and temperature controlled) and must travel to and from work. As stated earlier, Sun found that the average employee who took part in their telecommuting program “saves 2.5 workweeks per year in commute time, more than \$1,700 in gas and wear and tear on vehicle, and 5,400 kilowatt hours/year working flexibly”<sup>54</sup>. All of this said, it is important to acknowledge that the back end servers to maintain OCS are substantial and must be calculated into any equations documenting environmental and financial savings to IU and its employees. If the OCS servers are ENERGY STAR<sup>3</sup> compliant, EPEAT<sup>4</sup> registered, virtualized when appropriate, and housed in an efficiently cooled data center, the tradeoffs will almost surely be worth the effort of promoting this as a sustainable alternative.

Another highly visible and highly used tool provided by information technology is video conferencing (VC). As stated earlier, the management model at UIITS is efficient in terms of human resources, but costly in terms of a high number of trips between Indianapolis and Bloomington as managers cover both campuses. Video conferencing allows fewer trips, enables us to meet with peers in other states and other countries, and can be used in educational contexts to allow students to engage in e-learning. IU is a leader in video conferencing, with the ability to meet the needs of everyone from individuals to large groups and classes. In addition to supporting Microsoft OCS, UIITS hosts approximately 1200 IU faculty and staff accounts for Adobe Connect Professional (formerly Breeze), XMeeting software, and PVX Polycom software which allows point-to-point or multi-point video conferences. According to Polycom, Indiana University's 300 Polycom group systems was the largest number on any campus which responded to an Internet 2 survey last year (with the second largest number being 50). The use of such systems is also increasing on campus. This year we logged 22,134 hours of videoconferencing as compared to 16,988 last year. Unfortunately, there are currently no easy ways to understand how much videoconferencing is saving the university financially and environmentally. We do not know, for instance, how many video conferences were held to avoid traveling or how many miles were saved. We also do not have statistics on the amount of electricity the systems themselves consume. For instance, the current systems stay on all the time because users become confused when they arrive to find the machines shut down. In addition, in order to provide the most realistic VC experience high definition flat panel monitors are often used, which may not be as energy efficient as their counterparts. On the positive side, our current system requires just 1 server and allows up to 40 VCs at once. Finding ways to quantify the true financial and environmental tradeoffs with video conferencing is an important issue for sustainable computing.

Information Technology has also allowed us to replace many resource intensive practices, for instance by putting books, newspapers, and magazines online in lieu of printing them, downloading MP3s instead of purchasing burned CDs, and posting course schedules and materials online instead of publishing them. A recent presentation at EDUCAUSE<sup>66</sup> listed the greenhouse gas emission reductions attributed to the IT practices discussed so far:

	Annual Savings	Forecast 10-year savings
Telecommuting	134.7	568.2
E-commerce	37.5	206.3
Teleconferencing	36.3	199.8
Replacement of mail, CDs, publications with online equivalents	9.8	67.2
		(millions of tons)

**Reduction in greenhouse gases** Source: <http://net.educause.edu/ir/library/pdf/ENT08002.pdf>

These are some of the most obvious ways that IT has been effective at helping change environmental impacts. A report by Accenture<sup>67</sup> summed it up by stating "Today, IT can shape and ultimately determine where and how people work, how much they travel, and how they behave when they get

there. All of which translates not only into how much energy they consume, but also how much other costly resources they use ranging from paper to petroleum fuels.”

There are others ways in which IT helps us develop creative solutions to everyday problems on campus. For instance, automation of lighting and projection systems can greatly reduce energy consumption problems caused by human forgetfulness. Printing might be reduced by providing easy-to-use alternatives which still allow students to take notes on assigned readings, such as PDF markup software, or allow students to listen to their reading assignments such as PDF to MP3 converters. We can use IT to provide information tailored to specific people, such as providing their up-to-the-minute printing statistics or offering energy saving software for their specific computer. IT can provide real-time data that monitors heat in the data center or models various energy consumption scenarios based on the purchase of different servers. These are just a few ways that IT can be a “sustainable alternative”.

#### **Positive Practices:**

- Large scale infrastructure in place to support telecommuting and video conferencing.
- Increasing use of video conferencing on campus.
- Many IT professionals, including the OVPIT cabinet, are using technology to be as “paperless” as possible – taking notes on tablet PCs and PDAs, for instance.

#### **Suggestions for Improvement:**

- Find ways to quantify the financial and environmental savings incurred from video conferencing.
- Implement automation in settings where reminders have not been successful in changing habits (such as turning off projectors and lights).
- Work with human resources at IU to look into the benefits and drawbacks of telecommuting from a management perspective.
- Find ways to quantify the financial and environmental savings incurred from telecommuting.

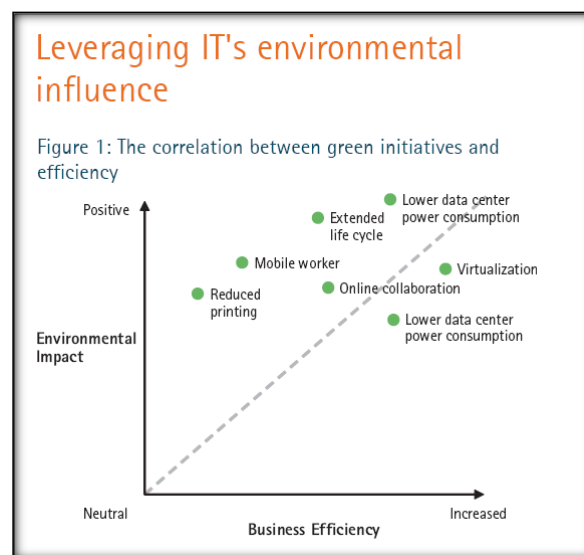
## **Conclusions**

Sustainable computing at IU is a wide reaching concept, from purchasing to disposal and will require a coordinated effort to enact significant change. We are at a turning point in terms of campus planning and worldwide efforts in this direction. The second IT Strategic Plan (ITSP2) is currently being developed and sustainability has been suggested as a topic of possible inclusion. Given the ITSP2’s long-term vision, the addition of action items regarding sustainable computing may have the largest impact of any suggestion within this document. This will require all UITS units to report on how they are meeting sustainable computing goals and encourage active problem solving which might overcome many of the institutional and habitual barriers that stand in the way of a large scale change to campus computing. In addition to the ITSP2, the suggestions for improvement included in this document need to be reviewed and organized into a plan of phased initiatives.

Sustainable computing has only recently become an area of interest to academic institutions. Cornell, Stanford, and the University of Michigan all have programs devoted to better understanding how to reduce the environmental impact of technology. Currently sustainable computing is not an official category on the College Sustainability Report Card established by the Sustainable Endowments Institute<sup>68</sup>. These categories include Administration, Climate Change & Energy, Food & Recycling, Green Building, Transportation, Endowment Transparency, Investment Priorities, and Shareholder

Engagement. In 2008 Indiana University scored an overall “C” according to these measures. Finding ways to make technology on our campus more efficient and less wasteful from purchasing to disposal will hopefully improve our scores in at least two of these categories – Climate Change & Energy, where our score was a “D” and Food & Recycling, where our score was a “C”.

Industry has been more interested in sustainable computing, from environmental, financial, and public relations perspectives. Many businesses are already realizing that the environmental benefits also provide business efficiency benefits, creating a win-win situation. This greatly lowers the barriers to implementing sustainable computing projects in the business world and at IU. One interviewee recognized this connection, stating that IU needs to “apply common sense to how we use computing on campus by improving our environmental impact, saving money, and improving services”. Consulting organizations have gone so far as to chart exactly which sustainable computing projects have the greatest environmental and business efficiency benefits.



Source: “Green IT: beyond the data center. How IT can contribute to the environmental agenda across and beyond the business”.<sup>67</sup>

Research focused on ways to make sustainable computing a reality should also be an active part of moving forward. As we involve departmental IT professionals in projects to improve computing on campus our progress should be recorded and presented in the form of conference and journal papers. Solutions to questions regarding implementing change to the vital IT services on campus in the name of sustainability will be a valuable contribution that IU can make to other academic institutions. Technical papers on software we develop, methods of configuring servers, overcoming the challenges of virtualization, and more could also serve as research endowments. There is also a need for standardizing the metrics to compare environmental data<sup>69</sup>. As we seek to make changes on our own campus, we will need to develop metrics to gauge our progress and compare ourselves to similar institutions. Our work in this area could enable us to be active partners in establishing standards which might be used well beyond our initial needs. Finally, we should focus on highlighting all of the green computing projects on campus that our IT infrastructure facilitates. Many departments on campus use the processing power and data storage housed at Wrubel Computing Center. Research computing serves a vital role in investigating environmental phenomena from deforestation of the rainforests to visualizing climate change. For instance, the PolarGrid<sup>70</sup> project seeks to “acquire and deploy the

computing infrastructure needed to investigate the urgent problems in glacial melting". It is just one example of the way IT is allowing us to better understand what is happening to our planet and perhaps better understand why there is a real need to focus on changing our habits in many areas of our lives, including our computing practices.

Through dedicated planning and sustainability-focused research IU will be positioned to be a leader in sustainable computing.

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