Interactive Utility Display: Conservation through Awareness

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EXECUTIVE SUMMARY

The goal of this project is to promote resource conservation on the Indiana University Bloomington (IUB) campus by increasing access and visibility of utilities consumption information. Because campus costs are centrally accounted, individual departments currently receive little information about their utilities use. A key objective of this project is to create an interactive, web-based tool that allows building managers and staff to view the usage statistics associated with their particular department or building. This information can help guide and motivate efforts in conservation and efficiency, resulting in a reduction of overall utility usage. The potential benefits to sustainability include a reduction in campus environmental impact, reduced costs, and greater consciousness of the environmental and economic costs of resources among the campus community.

This report begins with brief introduction to the current state of campus utility information as it relates sustainability. Section 2 describes a set of interviews I conducted with various building managers to investigate the opportunities and challenges for conservation at the building level. These interviews revealed several key insights, listed in Section 3, including the need for better information flow, education and incentives. To address these needs, I present a set of interconnected design concepts and recommendations in Section 4, focusing especially on the design of an interactive website for displaying historical usage data of every metered building on campus. In Section 5, I describe the development of a prototype website which is scheduled to launch in January 2009. Finally, Section 6 offers concluding remarks.

1. BACKGROUND

Campus buildings consume great amounts of energy and water are thus key contributors to our environmental footprint. According to the United States Green Building Council (USGBC), buildings in the U.S. account for "*70% of electricity consumption, 39% of energy use, 39% of all carbon dioxide (CO2) emissions, … and 12% of potable water consumptio*n" (USGBC, 2008). Utilities use in buildings is responsible for the majority of greenhouse gas (GHG) emissions at IUB. According to the recent GHG inventory conducted by Jonathan Bell (Bell 2008), 59% of IUB's GHG emissions are attributable to purchased electricity. As Bell notes, electricity emissions are particularly high because "*the majority of the electricity Duke Energy produces*

(more than 98%) is produced by the combustion of coal". The inventory estimates that another 31% of IUB's GHG primarily results from coal combustion at the Central Heating Plant on campus.

Last year's summer internship project by David Fuente (Fuente and Robinson 2007) articulated the important role that utility metering can play in reducing the impact of IUB's buildings: *"By tracking resource use in individual buildings across campus, universities are able to make informed decisions that lead to tangible, measurable gains towards concrete sustainability objectives. Adhering to the maxim that you cannot manage what you do not measure, utility metering provides a critical foundation for effective energy and water management and conservation."* The report outlined specific recommendations for improving the collection and management of utility data for individual buildings on campus. In the past year, the Physical Plant and its Utility Information Group has been making steady progress in meeting many of these recommendations. For example, new meters are continually being purchased and installed in order to track a greater number of buildings. Also, a web database was constructed so that after utility meters are read, the data can be uploaded and aggregated in a central location. Additionally, plans are in the works to implement a new antennae system that would allow all meters to be read remotely in real-time.

As more and better utility data becomes available, it is important we utilize this information to improve decision making and bring about more sustainable use of resources on campus. As Fuente reports, "*The experience of utilities and universities across the country suggests that increased awareness of energy and water use among consumers can yield significant savings*. *Thus … the university should create a clear strategy to raise awareness of energy and water usage amongst the university community (staff, faculty, administration, and students)*". The IU Energy Challenge project, conducted in Spring of 2008, was aimed at raising awareness amongst students living in dorms (Roedl, D. 2008). This project was relatively successful in its pilot run, and is now being further developed by fellow intern James Pierce (Pierce 2008). The goal of my internship project is to further explore opportunities for raising awareness amongst faculty, staff and students across campus.

In Fuente's report, he suggested three possible initiatives for raising awareness: (i) phantom billing, (ii) a web based analysis tool, and (iii) in-building displays. Phantom billing is concept where building managers receive monthly invoices displaying actual utility consumption along with estimated cost and environmental indicators. A web-based analysis tool would provide similar information over the web, with added ability for users to query different buildings and see historical data. In-building displays would seek to "*raise user awareness of energy usage on a constant basis*" by projecting real-time utility data in a dynamic format. The Physical Plant's Utility Information Group is currently developing the phantom billing project with plans to start billing during the 2008-2009 school year. My project focuses on developing the latter two concepts following a user-centered design process.

2. INTERVIEW STUDY

In designing a strategic awareness campaign, it is important to consider the wide range of roles and responsibilities among members of the campus community. Individuals have various interests with regard to utility information. They may also have different attitudes towards sustainability as well as different opportunities to conserve resources in their daily lives. For example, the Director of Facilities at the Indiana Memorial Union probably has a very different interest in utility data than the average undergraduate student. For that reason, it makes sense to identify specific groups and design targeted awareness campaigns that cater to their specific needs. Thus, I began my project by conducting a set of interviews to investigate the individual opportunities and challenges that exist for reducing utility use on the building level.

I spoke with the appointed "building representative'" from 6 different campus buildings. The building representative is usually a facilities staff person, although in academic buildings, the responsibility sometimes resides with a faculty member or administrative assistant. I tried to cover a mixture of building types including large and small, academic, residential and recreation. The following individuals were kind enough to meet with me and answer my questions:

- Steve Akers – RPS
- Gary Chrzatowski – IMU
- Allan Headley – Kelley School of Business
- Rob Henderson – Lindley Hall
- Jim Opiat - Rawles Hall
- Linda Barchet – Student Building

My overall goal with these interviews was to figure out what kinds of conservation behaviors should be promoted within buildings. For example, there might be strategic measures that can be enacted in facilities management, such as replacing light bulbs with CFL's, adjusting thermostats based seasonal building usage, etc. Some routine actions might also be taken by special building staff, such as custodians, e.g. shutting down lights and appliances in unused areas on a daily basis. Other responsibilities lie with average building users such as students, faculty, and staff. Specifically, my interviews often included the following questions: *What information do you currently receive about your utilities use? How is conservation currently being enacted? What challenges to see getting in the way of conservation efforts? What information about utilities would you like to have? What opportunities do you see for better efficiency and conservation?*

3. INTERVIEW FINDINGS

The interviews revealed a variety of circumstances at different buildings. For example, large institutions such as the Indiana Memorial Union tend to have their own facilities and custodial

staff and thus have much more internal control over basic building operation. In contrast, the staffs of smaller academic buildings, such as Rawles Hall, tend to be much less involved with building facilities and operation. Nonetheless, the interviews did reveal a number of consistent findings that led to the following four insights.

First, most buildings reps are genuinely **curious in seeing their usage data** and agree it would be useful to make the information public. Most are also open to promoting simple conservation methods amongst their department. They generally have a positive attitude towards conservation and believe that others in their department are open to it as well.

> ***Insight 1: Show the data***
> *Facilities management can be improved by providing historical data of usage to building managers. Building managers can be expected to look at the data, use it to inform their work, and promote conservation throughout the department.*

However, most building reps **feel that they have little control** over the majority of utility usage. Some of the factors they mentioned as beyond their control include heating and cooling, computer maintenance schedules, and overall building infrastructure. Even when it comes to more basic measures, most reps indicated there was a lack of knowledge on best practices, e.g how to best manage a thermostat or whether to turn florescent lights on and off.

> ***Insight 2: Offer guidance***
> *Utility information will be of little use if building managers and occupants do not know how to act upon it. Thus, if building managers were supplied with helpful information about conservation actions, it will allow them to be much more effective in their efforts.*

Also, while buildings representatives appreciate the value of conservation in concept, **they do not have any strong incentives to go out of their way**. For example, the representatives who work in facilities are interested in efficient technologies such as CFL's, motion-sensing lights, and low-flow faucets and have even implemented them from time-to-time. However, because utility costs are centrally accounted, they have little incentive to research these technologies or spend extra money on them.

> ***Insight 3: Provide incentives***
> *Even with perfect information and education, building managers cannot be expected to go out of their way to conserve. However, if some kind of compelling incentive were offered to building managers, it would greatly increase their motivation.*

Finally, most reps indicated that even if conservation becomes a priority of building management, individual **faculty and students still have a big role to play**. Educational

programs are needed to change behavior. Also, several buildings have public flat-panel displays that could be used for educational material about conservation.

> ***Insight 4: Educate users***
> *Educational material targeted at average building users can result in significant utility savings.*

4. DESIGN CONCEPTS AND RECOMMENDATIONS

Based on these insights, I recommend that four interrelated initiatives be implemented to promote utility conservation. Together, these concepts can provide the education, incentives, and feedback necessary to begin to change behavior amongst faculty, students and staff. While the remainder of my project will focus only on the development of a single initiative, the interactive website, it is important that all four concepts be implemented in concert in order to be truly effective. I recommend that the latter three concepts be implemented by the Sustainability Task Force in the near future and may serve as projects for future Student Internships.

4.1 Interactive Utility Data Website

This application will serve to supplement the monthly phantom-billing program. It will display historical usage statistics for every metered building on campus in a simple graphical form. It will also report the associated monetary cost and pollutant emissions for each utility. The website is primarily targeted at building managers and others who have a general interest in seeing utility data, although the site should be publicly accessible.

4.2 Guide to Utility Conservation Best Practices

The STF should develop a thorough list of recommended behaviors for conserving utilities on the IU campus. These best practices should be specified to the roles of responsibilities of different actors, such as facilities staff, faculty and staff who occupy offices, and students and faculty who make use of classrooms and other common areas. The recommendations should take into consideration the specific building infrastructure and technology found in IU buildings. Developing this guide will require substantial research into building and utility technology, as well as input and feedback from building managers.

4.3 Green Leadership Rewards Program

Public accounting of historical utility usage makes it possible to recognize those building communities that achieve significant reductions over time. I propose that the university establish a rewards program to recognize conservation efforts by building managers, similar to teaching awards that exist for faculty. For instance, the building manager whose building reduces utility usage by the greatest percentage over the year could be given a monetary award and public commemoration.

4.4 Public Educational Displays or "Green Screens"

Many buildings on campus have large LCD screens installed in high-traffic areas. These displays provide a great opportunity to raise awareness and educate the community about resource consumption. The STF should design some dynamic and engaging content about utility use and conservation to be displayed on these screens. Animated visualization of real-time utility data would be an ideal way to draw viewers in. The animation could also feature educational facts about environmental effects and tips for conservation. This content could be integrated with other information about recycling, or other sustainability issues on campus. Students from the new media departments of Fine Arts, Telecom, and Informatics would be well-equipped to work on this project. Gary Chrzatowski of the IMU has indicated in interest in allowing sustainability content on their public LCD screens.

5. WEBSITE PROTOTYPE

5.1 Interface Design

The design of the interactive utility website is illustrated in *figure 1*. The application allows access to all utility consumption data that is measured on campus. A user can choose to view data from any metered building by selecting it from the drop-down menu at the top right. The tab navigation is then populated with each of the utility types for which data is available (e.g. electricity, water, gas, etc.) When a given utility tab is selected, a time-series bar chart is displayed representing the current year's history of monthly consumption readings. Overlaid on the chart, the orange data line represents the previous year's usage for quick comparison. A date-selector tool at the top right allows a user to specify a particular date-range to be shown on the chart. Each monthly reading for a building is broken down into the consumption measured by individual utility meters which are indicated by a color coding. Checkboxes to the left of the chart allow users to show or hide consumption for each particular meter.

Below the chart, actual consumption amounts are listed in terms of measuring unit (e.g. kWh of electricity, gallons of water, etc.) as well as in equivalent dollar cost and pounds of contributed carbon dioxide emissions. Below the numeric values, a pie chart illustrates the relative consumption measured by each utility meter. The difference is usage compared to the previous year is also represented. By default, these numbers describe the aggregate amounts of consumption for the entire date range that is selected. When a user clicks on the bar for a particular month, the aggregate amounts for that particular month are shown. Every view of the application will have a unique URL address, which allows it to be bookmarked or sent as link in an email.

Being a prototype version, the site has been designed to show only the most basic and essential information. Future iterations of the application could include additional features for analyzing data such as comparing consumption change across multiple years or with respect to other factors such as weather.

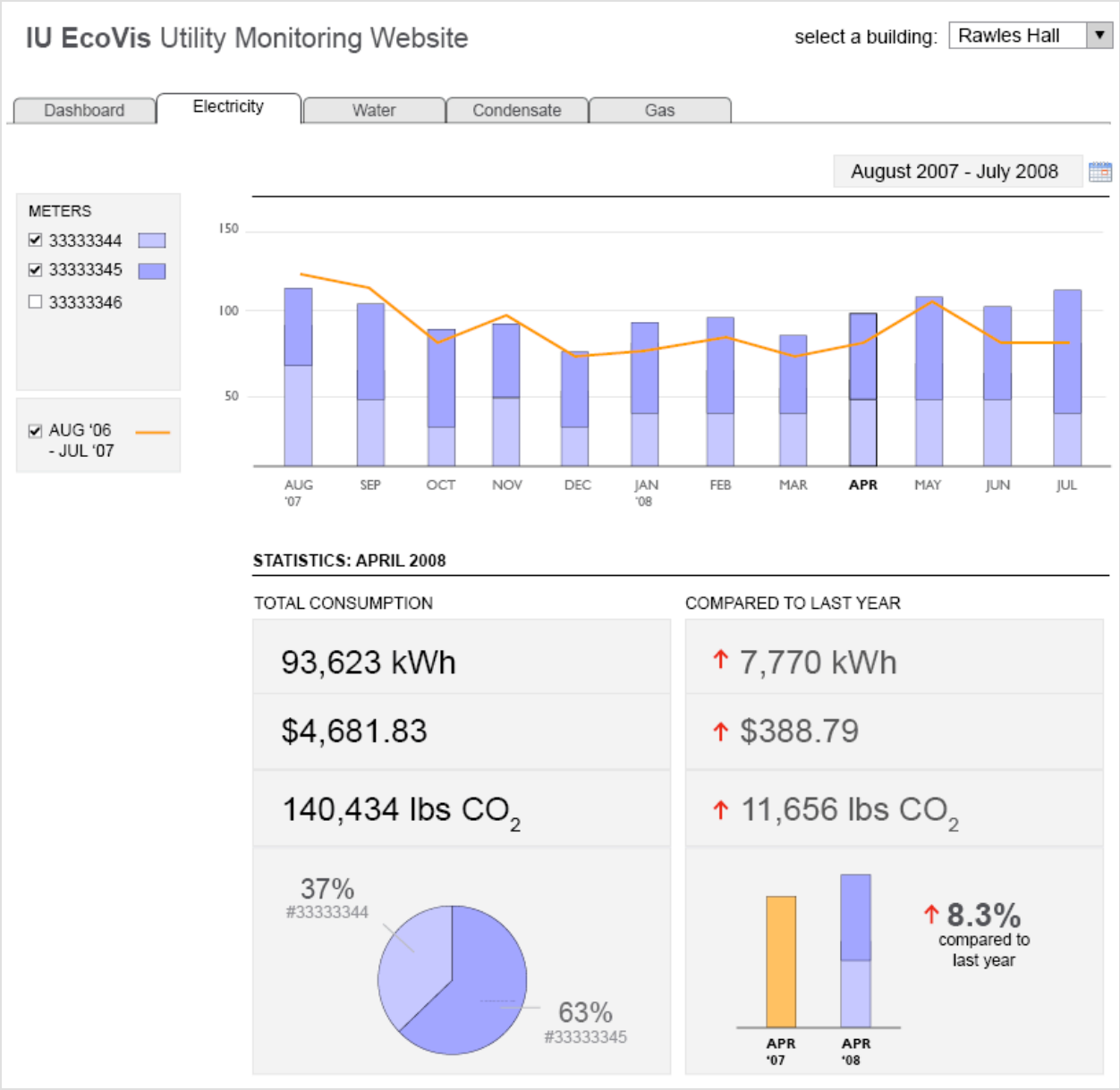

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Figure 1 – Design mock-up of the prototype utility website.

5.2 Architecture and Development

The development of this web application was made possible by the existence of a utility database that was created and is being maintained by Jeff Huang of VPAD Technology Support. Jeff has recently been collaborating with Glenn Moulton of the Physical Plant Utility Information Group (UIG) to develop a procedure for regularly importing data into the database. When meters are read on a monthly basis, the spreadsheets created by UIG will be uploaded to the server where they will be automatically imported into the database. Currently the database contains historical data from selected buildings for testing purposes. The regular import process for all metered data should go into effect in coordination with the release of the interactive

website. This system will then allow the website to automatically display the freshest utility data as soon as it is collected. After each monthly meter read and data upload, automatic emails can be sent linking to the application.

The data queries are implemented in the PHP scripting language, which is an open-source and widely used technology. These scripts return the requested consumption data in xml format, which is then processed by the front-end client application and rendered into interactive charts. This type of architecture is flexible in that it allows for multiple different front-end applications to be built utilizing the same xml data service. The front end web application is built in Adobe Flex Builder 3 software and deployed as a Flash application in a web browser. The Adobe Flex framework is available as a free and open source software development kit. The Flex Builder 3 integrated development environment has free licenses available for educational use.
I am presently developing the application and hope to have it ready for public launch by Spring semester '09. If funding is available, either through the Office of sustainability or the Physical Plant, I would strongly recommend hiring a skilled student to maintain and continue development of this website as well as the IU Energy Challenge website.

6. CONCLUSION

As we move to address the sustainability of IUB campus, utilities use represents a crucial component of our collective environmental footprint. The improved collection of utility data opens many opportunities to bring about more mindful and responsible management and consumption of resources. The interactive website described in this report is one step towards making our quantities of consumption more visible and actionable. However, it is important that we acknowledge that information alone is unlikely to create lasting behavior change. In order to significantly reduce resource consumption on campus, we need to implement a holistic awareness campaign, including educational resources and appealing incentive programs of recognition and reward. With a well-crafted combination of effective information design, education and reward structures, we can begin to build a sustainable culture of conservation at IUB.

7. REFERENCES

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