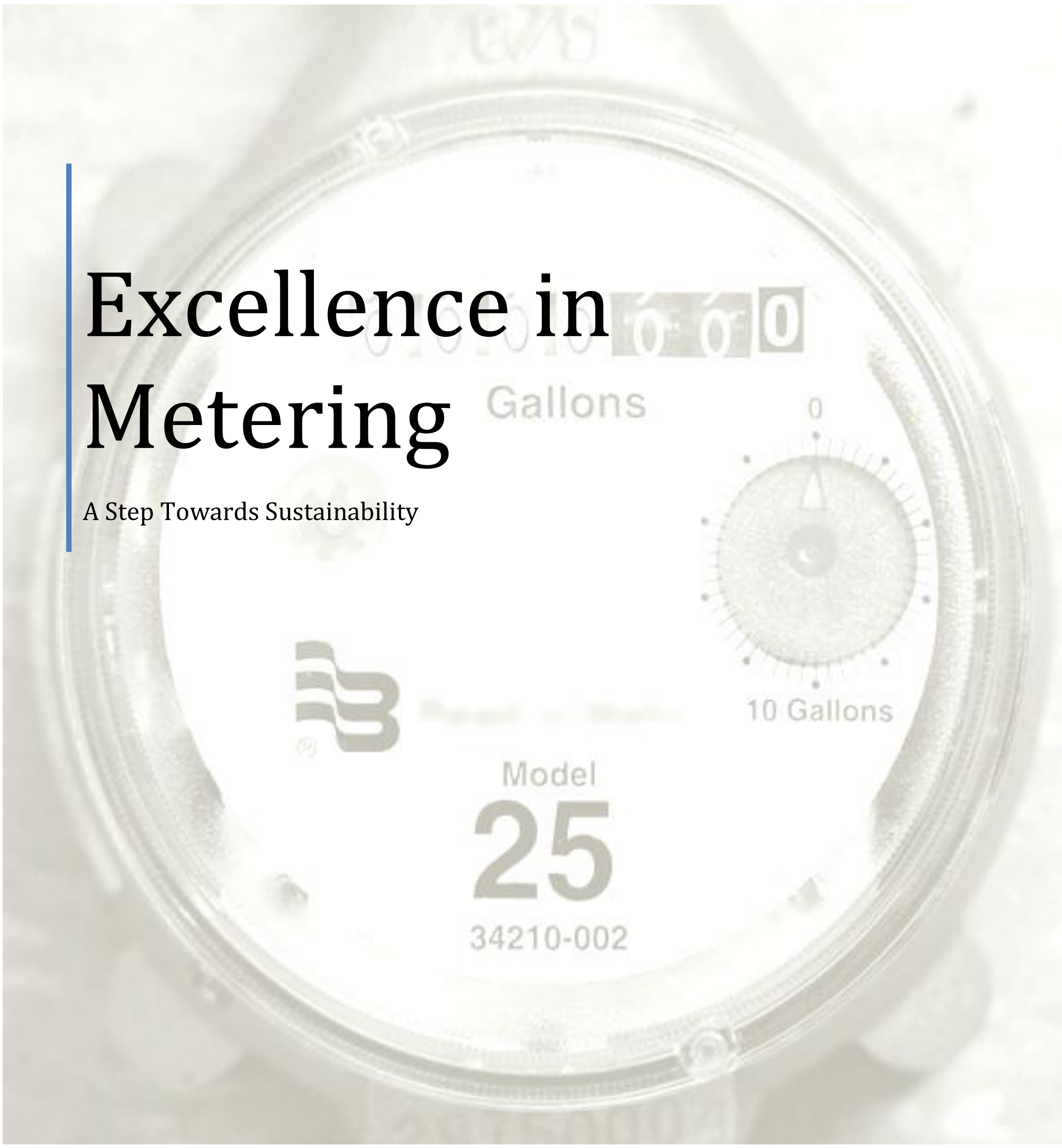
Excellence in Metering

A Step Towards Sustainability



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1.0 Introduction

The emergence of strong campus energy conservation and sustainability initiatives across the country are leading universities to implement utility sub-metering programs. 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 collection, and subsequent analysis, of robust utility metering data provides information that can drive significant green house gas reductions, and cost savings on campus. Specifically, a well executed utility metering program can support: the analysis of campus water and energy use, optimization of system and building performance, leak identification and building audits, identification of high return retrofit and conservation projects; and evaluation of investments in energy and water management and conservation programs.

This report seeks to help IU achieve excellence in utility metering. In general, the report is guided by three fundamental perspectives: 1) utility metering is a critical component of data driven sustainability initiatives, 2) increased awareness amongst the university community (either through billing and/or public data displays) will reduce energy and water use on campus; and 3) providing higher resolution data to the utilities staff will enable better identification of inefficiencies, malfunctions, energy/water waste, and opportunities for savings[1]. Overall, the analysis contained below indicates that IU is well positioned to develop a strong utility metering program that can provide critical support to emerging sustainability efforts on campus.

Section 2 of this report provides a detailed analysis of the current state of utility metering on the IUB campus. Section 3 looks outward to examine what other universities are doing with respect to utility metering. Here, careful attention is paid to how universities are using collecting, aggregating, and leveraging metering data to both improve operational efficiency and support sustainability efforts on campus. Section 4 provides both short term and long term recommendations to help IU achieve excellence in utility metering (*See p. 16 for a summary of recommendations*.) Finally, Section 5 offers concluding remarks.

2.0 Utility Metering at IUB

Spanning more than 1,900 acres, the Bloomington campus consists of more than 400 buildings that serve faculty, staff, and students. The campus is served by numerous utilities to power, heat, cool, and provide water and sanitation services to the IUB buildings. Utilities used on campus include: electricity, domestic water and sewer, natural gas, steam, and chilled water. While electricity, domestic water and sewer, and natural gas are purchased from external utility companies, steam and chilled water are produced on the IUB campus. During the FY 2005-2006 the Bloomington campus used 667,460,000 gallons, 1,803,075 therms, and 21,817,955 kWh of

[1] USEPA. 2002. *Sub-Metering Energy Use in Colleges and Universities: Incentives and Challenges: A Resource Document for Energy, Facility, and Financial Managers*. Washington, DC.

water, gas, and electricity respectively. In total, the Bloomington campus spent approximately $22 million on utilities, utility maintenance and management in 2006-2007. This section examines the current state of utility meter on the IUB campus and highlights the breadth and depth of currently available utility metering data.

2.1 Utility Metering: Roles and Responsibilities

Given the variety of utilities on campus, meter purchasing, installation, maintenance, calibration and reading is a collaborative effort between a number of internal and external stakeholders. Table 1 highlights the entities with primary responsibility for different aspects of the metering life cycle. As might be expected, a diverse set of actors are responsible for metering installation, maintenance, and calibration. Depending on the utility, external contractors, IU trade shops, private utility companies, or the UIG install, maintain and repair the metering infrastructure.

	Order	Purchase	Installation	Maint./Repair	Calibration	Read
Steam	UIG	UIG	Utilities	Utilities	n.a.	UIG
Domestic H_2O	UIG	UIG	Plumbing/UIG	UIG	UIG/Contractor	UIG/CBU
Chilled H_2O	UIG	UIG	Contractor/Electronics	Electronics	Electronics	UIG
Electric	UIG/Engineering	UIG/Engineering	Contractor/UIG/Electronics	UIG/Contractor	UIG/Contractor	UIG
Gas	Vectren/UIG	UIG	Vectren/UIG	Vectren/UIG	Vectren/Contractor	UIG

Table 1. Utility metering roles and responsibilities.

Table 1 indicates that the Utility Information Group (UIG)[2] plays a central role in all aspects of utility metering on campus (*see* Box 1). With the exception of electric meters, meter ordering and purchasing is conducted solely by the UIG. Similarly, the UIG has primary responsibility for meter reading on campus.

2.2 Metering Coverage

All utilities are currently metered on campus. However, the majority of metering coverage is limited to master meters, or point of distribution meters, that provide an aggregate view of resource use for sections of campus. (For example, the water consumption for Franklin Hall is read as an aggregate from one master meter located on Kirkwood Avenue.) While master meters provide a clear picture of bulk resource use on campus, the aggregate data do not provide an adequate level of detail to facilitate leak detection, identify inefficiencies, system optimization, or support energy and water conservation efforts. As a result, this report focuses specifically on building-level utility metering – i.e. sub-metering.

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[2] Formed in 2001, the UIG has 6 full time employees who support the Physical Plant Utilities in its efforts to provide safe, reliable, and cost effective utilities to the University community. Specifically, the UIG is responsible for utility documentation, supporting utility metering on campus, and providing locating and protection for all utilities on the IUB campus.

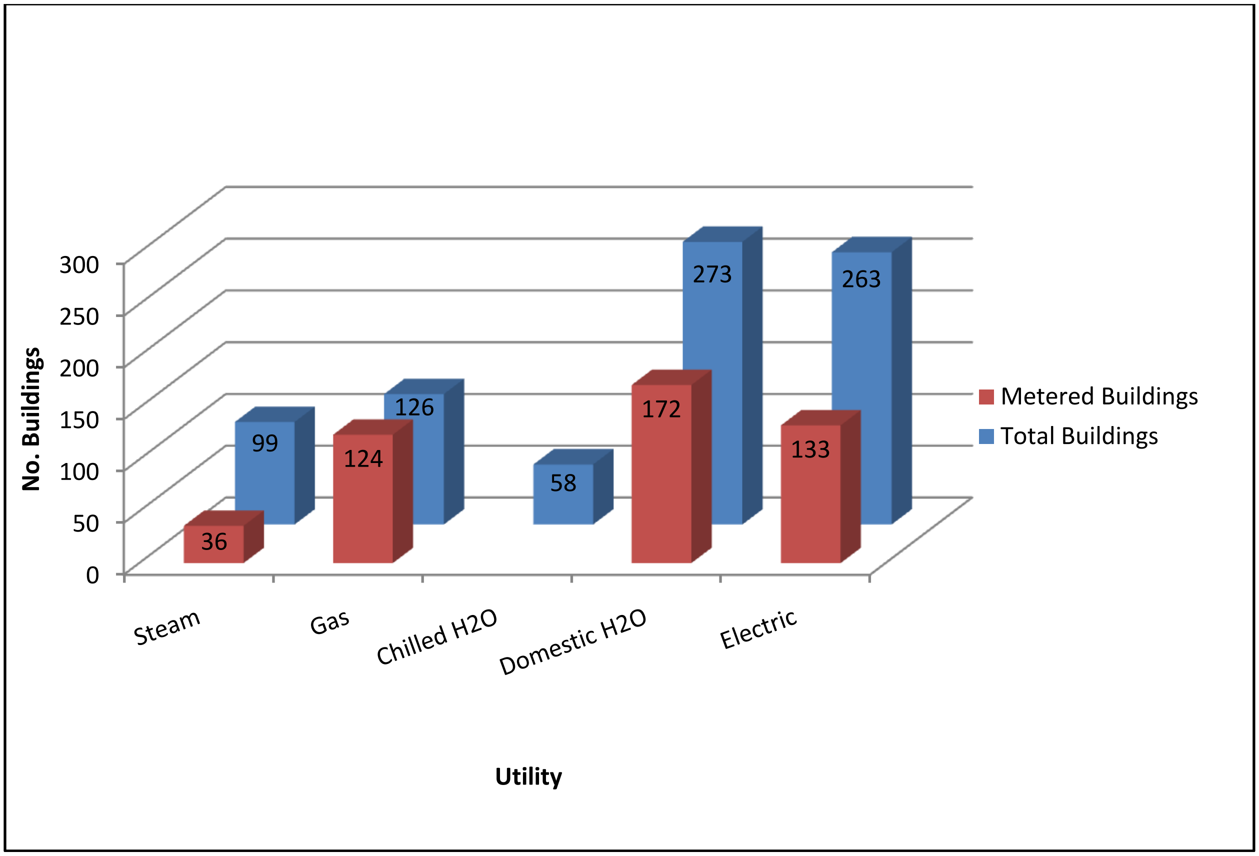

Figure 1. Utility metering coverage on the IUB campus.

IUB Metering Coverage

	Tot. Bldngs	Mtr'd Bldngs	Percent
Steam	99	36	36%
Gas	126	124	98%
Chilled H2O	58	0	0%
Domestic H2O	273	172	63%
Electric	263	133	51%

Table 2. Percent metering coverage on IUB campus

Since 2002, the Physical Plant Utilities division has worked to improve utility sub-metering on campus. As part of this study, the interns and UIG staff compiled a metering inventory for all utilities on the IUB campus. To provide an accurate picture of the state of utility metering on campus only buildings with functioning meters were considered metered; buildings that either are not currently metered or do not have a functional meter were not considered metered. Figure 1 and Table 2 summarize the state of utility sub-metering on the IUB campus[3].

[3] Here, it should be noted that total buildings refers to total number of buildings that are served by a particular utility.

Metering on Central Campus

	Tot. Bldngs	Mtr'd Bldngs	% Metered
Steam	95	36	38%
Gas	38	36	95%
Chilled H2O	58	0%	0%
Domestic H2O	163	68	42%
Electric	163	39	24%

Table 3. Metering coverage on the central IUB campus.

Overall, 35% of the buildings on the IUB campus are fully metered – i.e. all utilities currently serving a building are metered at the building level[4]. Currently, natural gas has the highest metering coverage (98%) of all utilities on campus[5]. The two utilities that are owned and operated by IUB have the lowest degree of building level metering of all utilities. Currently, 36% of the buildings on campus that are connected to the steam loop are metered for condensate. None of the buildings on the campus chilled water loop are currently metered[6]. The relatively low degree of building level metering for utilities produced on campus is likely due to the fact that campus units are not currently charged for utilities based on building level consumption.

With respect to water, 63% of the buildings on campus receiving domestic water services are currently metered at the building level. Similarly, 51% of the buildings on campus are sub-metered for electricity[7]. Of the 172 buildings that are currently sub-metered for electricity, 23 contain smart meters that are connected to a central system maintained by the Energy Management Systems Group.

While it appears the campus has a relatively high degree of sub-metering coverage, especially with respect to water and electricity, the metering data includes the individual houses on the perimeter of campus. These houses are de facto individually metered and therefore contribute to a slightly skewed picture of utility metering on campus. As can be seen in Table 3, sub-metering on central campus[8], which includes the core academic and administration buildings, is less well developed, especially with respect to electricity and water.

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[4] This inventory only examined the 277 buildings on campus for which Physical Plant has responsibility. This does not include office space and buildings that IUB currently leases or the buildings owned and operated by IU real estate.

[5] The high percentage of gas metering coverage is due to the fact that all of the natural gas meters are currently owned and maintained by Vectren, a natural gas utility company.

[6] Here, it should be noted that the Utilities Division is presently developing a proposal to meter all buildings currently served by chilled water.

[7] Many buildings on campus have multiple electric meters. The 172 buildings noted in Figured in 2, however, reflect the number of metered buildings rather than the total number of electric meters on campus.

[8] Appendix 1 contains a list of buildings considered "central campus" in this analysis.

2.3 Meter Reading

As noted in Section 2.1, the UIG has primary responsibility for meter reading on campus. Currently, the UIG has the capacity to dedicate 50% of one FTE to utility meter reading. Meter reading is conducted by one UIG employee via eleven set metering routes that have been developed for specific purposes. Table 4 contains the names of the current metering routes. Appendix 2 documents the buildings that make up the respective meter reading routes.

Meter readings are taken once per month and on an as needed basis. For example, in the past UIG has taken daily and hourly meter readings from specific buildings while trying to identify leaks or the cause of a spike in resource use. Similarly, UIG is currently reading the water meters on the housing route weekly to gain higher resolution data on water use in residential buildings.

Route Name	Buildings	Meters
Athletics	17	33
Auditorium	1	8
Condensate	36	36
Cooling Tower	34	67
Housing (weekly)	22	48
Housing (monthly)	41	148
Irrigation	n.a.	27
Research Grant	45	186
Service Building	1	4
Water Conservation	7	19

Table 4. Metering routes currently read by the UIG.

With the exception of electricity and water, all meter reading on campus is done manually. Of the 172 buildings that are currently sub-metered for electricity, 71 contain smart meters that have the capacity to report data to the energy management system. Currently, only 23 smart meters are being read remotely. Similarly, in 2002 the UIG invested in the same meter and radio read technology used by CBU to enable both IU and CBU to read one another's meters. As a result, a large proportion of water meters are read with a hand held radio read unit that subsequently downloads data to Excel spread sheets.

Figure 2 and Table 5 summarize the state of meter reading on the IUB campus. With the exception of natural gas[9], the UIG collects utility usage data on 65% or more of buildings that are currently metered. Overall, in light of the person hours that are currently dedicated to meter reading the UIG reads an impressive number of meters on campus. However, the current efforts cover less than approximately 40% of the total buildings on campus with respect to any given utility.

[9] Although the percent of natural gas meters the UIG reads is low compared to the other utilities, monthly data on natural gas usage per building can be gleaned directly from the Vectren bills.

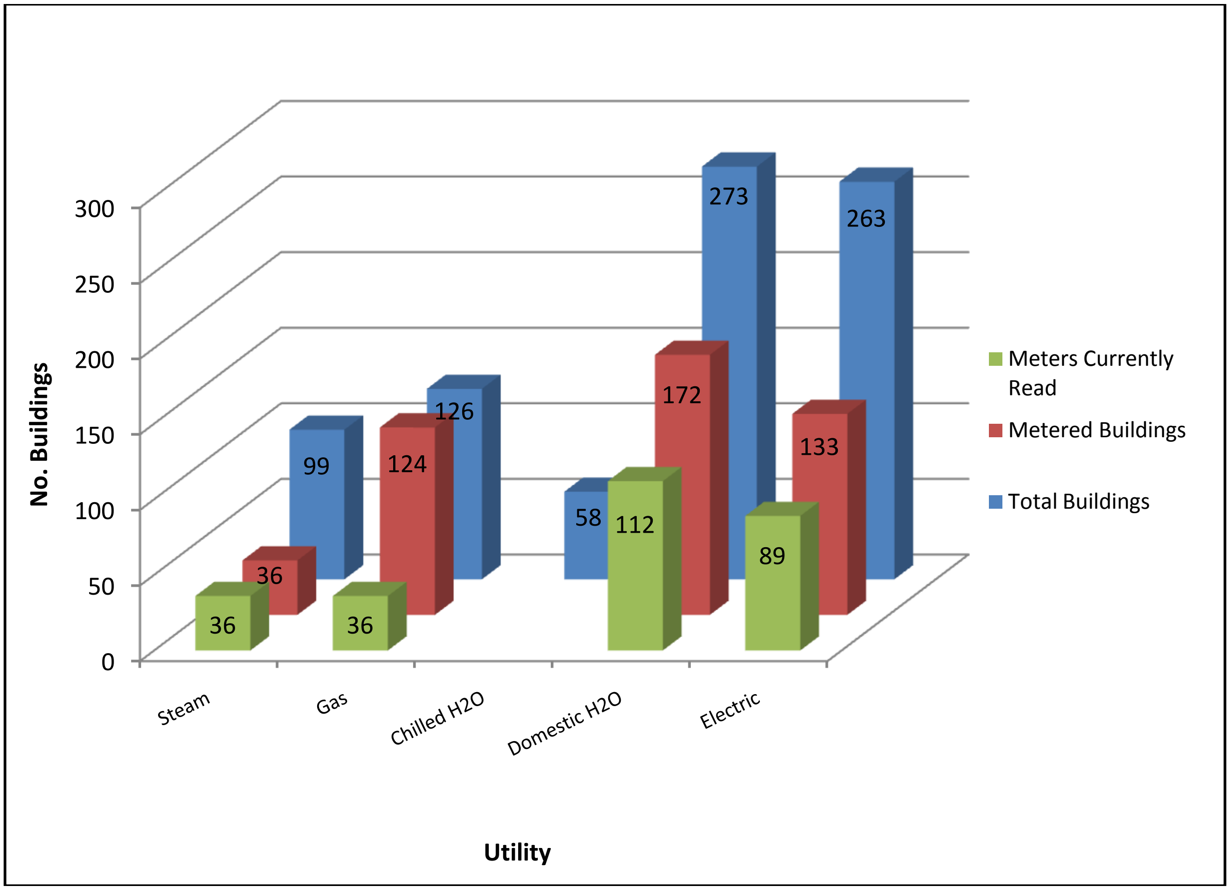

Figure 2. Utility meter coverage and reading on the IUB campus.

	Meters Currently Read	% of Metered Buildings	% of Total
Steam	36	100%	36%
Gas	36	29%	29%
Chilled H2O	0	0%	0%
Domestic H2O	112	65%	41%
Electric	89	67%	34%

Table 5. Summary of meter reading on the IUB campus.

2.4 Metering Data: Depth and Resolution

While the University is not presently collecting utility usage data for the majority of buildings on campus, the UIG has amassed an impressive store of utility data for the buildings that are on designated metering routes. To provide a sense of the nature, scope and depth of these data, this section presents water data and examines water usage on the Housing metering route[10]. Similar data is available for all of the current metering routes.

Figure 3 displays the annual water use on the IUB campus for the past three fiscal years. In FY 2006-2007 IUB used approximately 650,000,000 gallons of domestic water, which represented a 7% decrease in usage from FY 2004-2005[11]. According to UIG's data, buildings on the Housing, Research Grant, and Irrigation metering routes consumed 36%, 14%, and 3% of the total water used on campus, respectively (see Figure 4). Figure 4 provides useful insight into the current distribution of water use on campus and highlights types of buildings to target for potential conservation. However, it also highlights that nearly 50% of the water use on campus is not metered at the building level[12].

Current UIG data provide additional insight into water use for individual building categories. Figure 5 presents data on water use in buildings on the Housing route from FY 2004-2005 to FY 2006-2007. Much like the rest of campus, the buildings on the Housing route reduced water consumption from 2004 to 2007, witnessing a 12% decrease in water consumption. Figure 6 drills deeper into the water use data to examine monthly water use patterns on the Housing route.

As one might expect, the data reveals that water usage in residential facilities ebbs and flows with the student body's presence on campus. Data at this resolution presents the opportunity to interrogate resource use on campus. For example, what caused the sharp spike in water use in October 2005? What, if anything was done to remedy the sharp increase in usage? Similarly, what was the cause of the high level of water usage in February 2005 and what was done in subsequent years to reduce consumption? Finally, Figure 6 indicates that water use spikes when students arrive on campus and then steadily decreases until the students leave for a respective break. This suggests that targeted water campaigns in late August/early September and January could generate maximum reductions.

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[10] It should be noted that water data is used in the following examples in part because the water data are most comprehensive and readily available.

[11] Incidentally, the UIG maintains the marked reduction in water use is a direct result of increased metering efforts.

[12] In general, other universities have found that research buildings are major consumers of both electricity and water. Thus, the apparent discrepancy in water use between residential and research buildings is likely due to the fact that many research buildings are not currently metered.

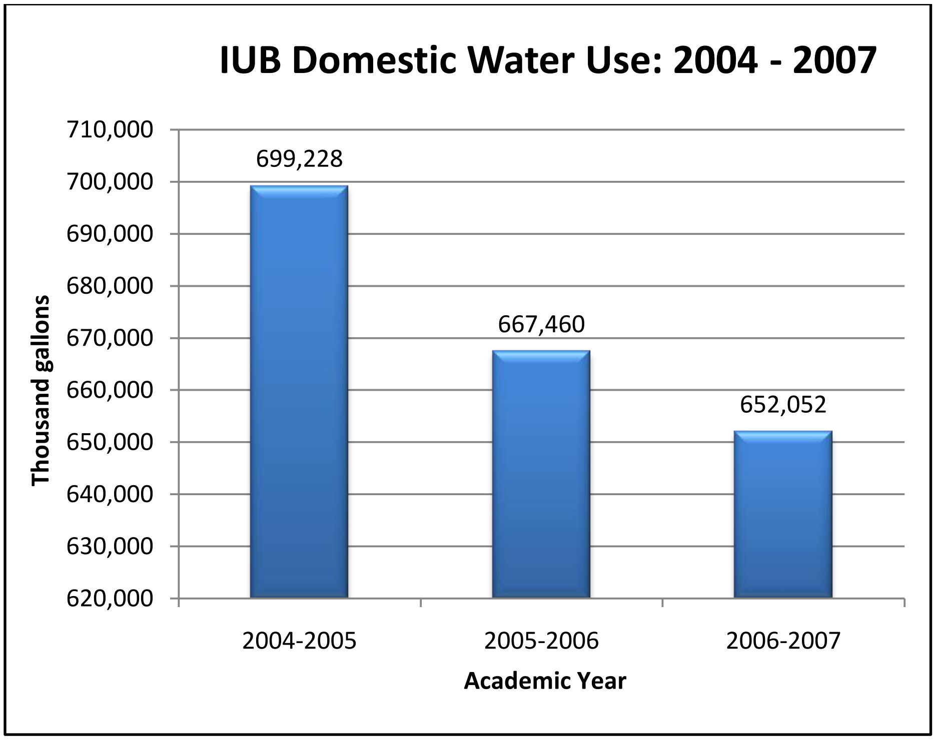

Figure 3. IUB domestic water use from FY 2004-2005 to FY 2006-2007.

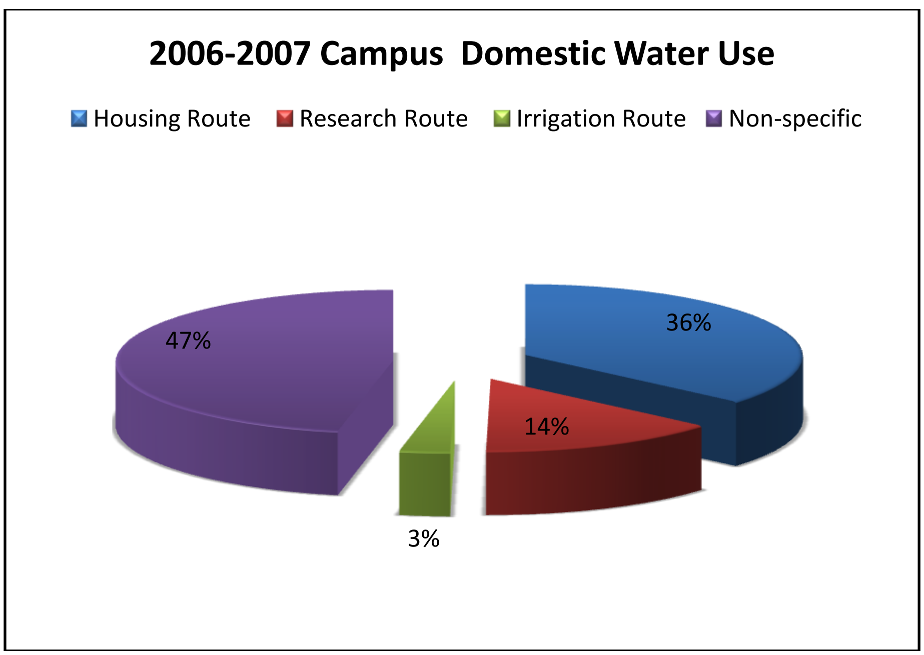

Figure 4. Distribution of domestic water use in FY 2006-2007.

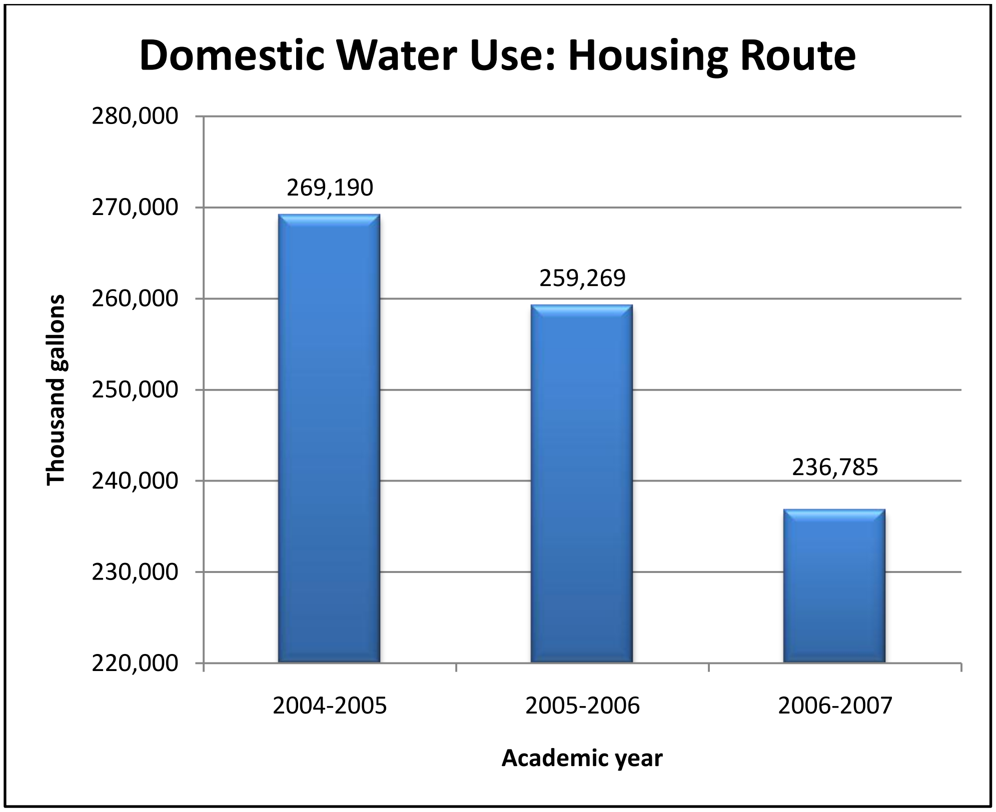

Figure 5. Yearly domestic water use on the Housing route from FY 2004-2005 to FY 2006-2007.

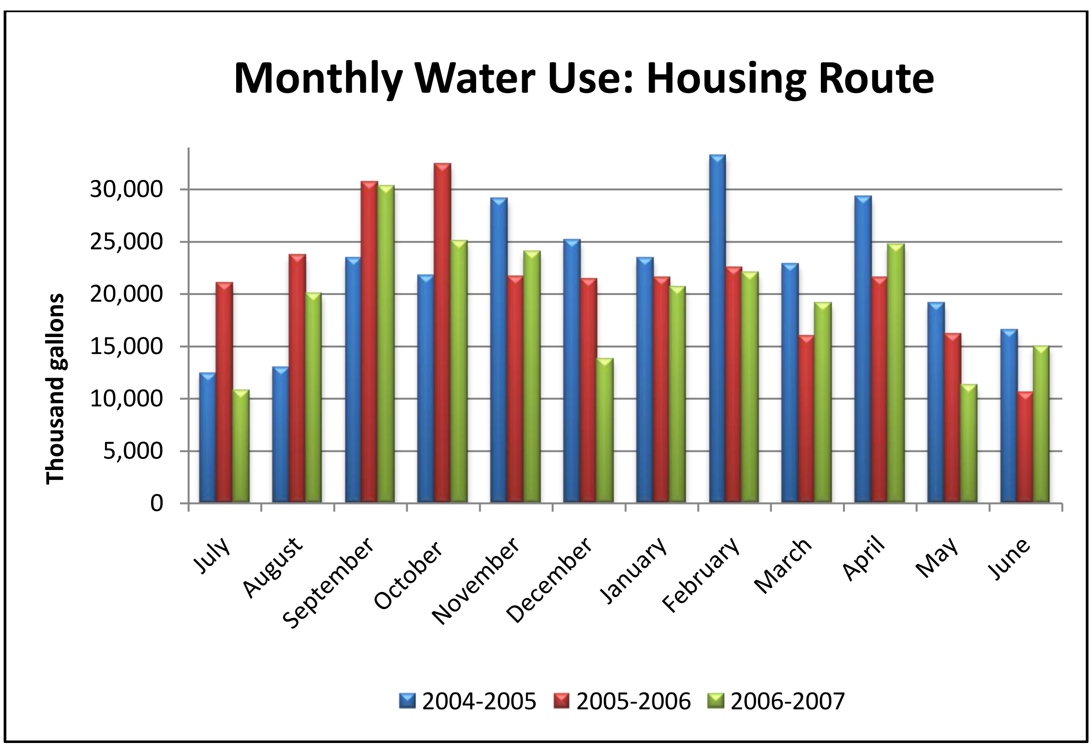

Figure 6. Monthly domestic water use on the Housing route from FY 2004-2005 to FY 2006-2007.

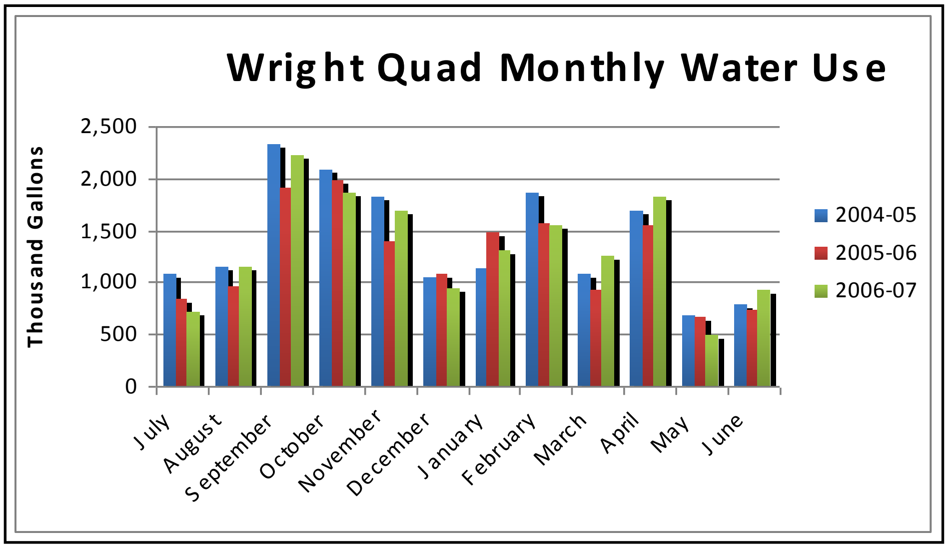

Figure 7. Monthly water use in Wright Quad from FY 2004-05 to FY 2006-07.

In addition to aggregate data for an individual route, the UIG data also provides insight into building level utility usage. Figure 7 shows three years of water usage in Wright Quad, one of the buildings on the Housing route. During the 2006-2007 academic year, Wright used 15,855,000 gallons of water, nearly 7% of the water used by all buildings on the Housing route and 2.4% of the total domestic water used on campus. From 2004 to 2007 Wright witness a 5% decrease in annual water usage. Interestingly, however, the data reveals that water usage in March and April during the 2006-2007 academic year was higher than the two previous years. Whereas the increased usage over March and April is not indicative of the general trend in water usage observed throughout the rest of the year, the utility metering data provide an opportunity to explore the cause of the increased usage during March and April in Wright Quad.

The above examples provide a glimpse into the breadth and depth of the data UIG currently collects. The utility usage data presented above can be used to examine patterns of resource use on campus, identify leaks or inefficiencies in utility distribution systems, and track progress towards energy and water conservation goals. Whereas these data only exist for a limited set of buildings on campus, the above examples also highlight a subset of the analyses that could be conducted for each building on campus with a more robust metering program.

2.5 Data Usage

As suggested in the above case, high quality utility usage data can provide critical insight into patterns of resource use on campus. In addition to illuminating usage trends, utility data can play an important role in identifying inefficiencies in buildings and utility distribution systems. The UIG and the utilities department regularly use the limited data they have to promote efficient utility distribution and use on campus. Two examples of how the UIG has used metering data to promote efficient of campus resources are presented below.

Box 1: *Cost Avoidance Generated by Utility Metering*

- Verification of Water Bills: $260,000
- Leak Detection: $214,000 per year
- Irrigation Rate Negotiation: $68,000 per year

2.51 Leak Report

Currently, the UIG uses water usage data from the metering routes to identify water leaks and wastage. Since 2004, the UIG has identified more than 10 water leaks on campus. (Appendix 3 contains a table outlining the leaks identified by the UIG over this time period.) In most cases, the UIG has identified and addressed leaks within one month by comparing the current month's usage to the previous month. If not noticed and addressed, the thirteen leaks identified by the UIG would have resulted in 66,367,335 gallons of wasted water and an additional $214,170 in water charges annually.

2.52 Water Bill Verification and Rate Negotiation

IUB currently pays more than $3,000,000 a year for water and wastewater services. In response to escalating water bills, the Business Office asked the UIG to review the water bills to examine water use on campus in 2001. Initially, the UIG worked with the City of Bloomington Utilities (CBU) to construct a detailed water bill that listed individual meters, meter addresses[13], and charges for individual meters. Once CBU provided the UIG a detailed water bill, the UIG was able to review the water bill regularly to identify billing errors. During the first year alone, the UIG generated approximately $260,000 in rebates from CBU due to billing mistakes or irregularities.

Subsequently, the UIG has aligned its water metering strategy to mirror CBU metering practices. As noted above, since 2002 the UIG has purchased the same meters and meter reading technology used by CBU. This enables the UIG to read CBU meters and vice versa. While this was initially done to facilitate UIG's review of water charges, the metering initiative has helped UIG negotiate better rates on water that does not return to the sewer system. For example, in collaboration with CBU, UIG lead a program to sub-meter all irrigation on campus. As a result, the UIG was able to negotiate a reduced rate for irrigation water that has resulted in savings of approximately $3.55 per 1000 gallons of irrigation water. In 2006-2007 alone, the negotiated irrigation rate saved IUB approximately $68,000. Similarly, the UIG and CBU partnered to meter water used to fill the chilled water system's cooling towers. As a result, IUB currently saves approximately $3.35 per thousand gallons of water used in the cooling towers.

[13] When the UIG began to examine the water bill, all meters were associated with the Physical Plant, the billing address. As a result, there was no clear way to link a metering reading to a discrete service address on campus.

3.0 Utility Metering Benchmarking

The combination of rising energy costs, tighter university budgets, and the imperative for universities to become increasingly sustainable has prompted universities across the country to closely examine their energy and water use. Recognizing that you cannot effectively manage what you do not measure, universities are beginning to explore utility sub-metering to drive energy management and conservation efforts on campus. Drawing upon extensive web research and in depth phone interviews with managers at six universities, this section presents a brief overview of utility metering on university campuses. In particular, this section highlights five trends that emerged from our research: web-based display of energy and water usage; facilitation of building audits and identification of high value retrofit projects; supporting, monitoring, and evaluation of conservation programs; phantom and real billing for utility usage; and utility rate negotiation and energy purchasing. Appendix 4 contains a contact list of individuals at peer institutions who are responsible for utility metering and/or energy management at their respective campus.

3.1 Web-based display of utility usage data

A number of universities display energy and water use data on their websites. Most often, energy and water use information is posted on either the utilities or energy management sections of the university's website. When universities have prominent sustainability initiatives, the energy usage information is often explicitly linked from the sustainability section of the web page.

Currently, there is a wide range in the level of detail universities present on the web with respect to their energy and water usage. Approaches range from static web pages composed of text and in some cases graphs (e.g. OSU, UNH, etc.) to dynamic web pages that allow users to query usage data for individual buildings or groups of buildings on campus (e.g. UC Boulder and Yale). In very few instances, some small colleges provide access to real time usage data on select buildings (e.g. Oberlin). Appendix 5 contains examples of how universities are communicating energy and water use data to internal and external constituents via the web.

3.2 Facilitation of building audits and identification of high value retrofit projects

In addition to using the web to display utility usage data via the web, a number of universities use sub-metering data to facilitate building audits and identify high value retrofit projects. Equipped with an accurate picture of a building level energy and water use, universities are able to identify high use or underperforming buildings. This provides an opportunity for staff to conduct audits on individual buildings with the potential for high returns to identify specific measures to improve energy and water use efficiency. Once improvement or retrofit measures are identified, accurate usage data allows staff to estimate use reductions and better calculate pay-back periods and net present value of cost avoidance/savings. This provides administrators and energy managers high quality data to inform decision making with respect to conservation and retrofit projects. According to Aparna Dial, Director of Energy Services and Sustainability at

OSU, 12 conservation and retrofit projects identified in FY 2006 in conjunction with building audits have resulted in over $750,000 net present value savings[14].

3.3 Support, monitoring, and evaluation of conservation programs

A number of universities use utility metering data to support, monitor and evaluate energy and water conservation programs. Here, accurate metering data plays a critical role in defining baseline consumption levels, enabling accurate estimates of energy, water and cost savings, and providing feedback on program progress and performance. Examples of where metering data has been used to support, monitor and evaluate conservation programs include: student and staff conservation contests, compact fluorescent light replacement programs, and building automation adjustments. Examples of energy conservation programs are presented below.

The University of New Hampshire (UNH) conducts annual student energy conservation contest in the dorms on campus during the four weeks leading up to the Thanksgiving holiday and prior to spring break, traditionally high use periods. Dorms compete to reduce their per capita electricity consumption[15] and the top three winning buildings are awarded $300, $200, and $100 respectively. According to UNH, the 2006-2007 competitions reduced electricity consumption by almost 300,000 kilowatt hours and generated a net savings of $40,000 for the university[16].

Similarly, the University of Colorado Boulder holds an energy conservation competition for building proctors/managers on campus called Buff Energy Stars. Winners of the competition are awarded a one-time $1,000 cash bonus. In order to be considered for the award university staff must meet a number of criteria, which includes reducing energy consumption by 5% per square foot over the previous year and completing a building energy and water audit. During the FY 2003-2004, five buildings qualified for the competition and generated a 600,000 kilowatt hour reduction in electricity use and an estimated savings of $72,000[17].

3.4 Cost sharing for utility usage

In order to promote increased awareness of energy and water use on campus and encourage conservation, a number of universities engage in phantom or real billing of different campus units. In general, universities that use phantom bills do so to 1) to raise awareness of energy and water use amongst building occupants and 2) develop the institutional expertise necessary to execute actual billing[18]. The majority of universities interviewed and encountered through web research currently bill campus auxiliaries (e.g. hospitals, athletics, hotels, etc.) for energy and water usage. In many instances, universities also billed the entity responsible for on campus

[14] The Ohio State University Energy Management and Sustainability. 2007. FY 2007 Budget Follow-up: End of Year Report. June 17, 2007.
[15] The baseline for the competition is the average electricity usage from the previous three years over the same four week period from
[16] http://www.unh.edu/etf/challenge.html
[17] http://www.colorado.edu/news/releases/2005/287.html
[18] The University of Illinois Urbana Champagne is currently implementing a 2.5 million dollar utility metering program. With the initial set of meters coming online in August, UIUC intends to implement phantom billing by December 2007.

housing. Currently, OSU and UNH bill campus auxiliaries for utility usage. University of Iowa bills all campus units for utility use.

To support both phantom and real billing functions, universities recognize the need for both regular and accurate meter reading as well as a robust data management system. University energy and utility managers interviewed indicated that phantom and real billing prompts a high level of attention from campus constituents. As a result, all individuals interviewed stressed the importance of reliable and accurate metering to support billing functions. With respect to meter reading, universities use a variety of approaches to collect metering data including manual metering on a monthly basis, remote meter reading on a monthly basis, remote meter reading based via an aggregation of interval data. Whereas the majority of universities have limited remote read capabilities, meter reading is often carried out manually. While some utility departments dedicate a portion of utility staff time to meter reading, others, such as UNH, draw upon staff from technical departments (plumbing, etc.) one day per month to conduct metering.

In addition to meter reading, university energy and utility managers indicate that effective data management is an essential component of their billing programs. Again, universities displayed a wide range of approaches to utility data management, including manual Excel workbooks, Access databases, software developed in-house, and off the shelf utility data management software. Universities who carried out well-developed billing functions generally utilized custom access databases, custom developed software, or off the shelf utility management software[19]. Our research indicated that as universities continue to expand their metering capacity, more institutions are investing in utility data management software that integrates remotely read data from various sources and data entered from manually meter reading.

3.5 Utility Rate negotiation and strategic energy purchasing

In addition to the above trends, our research indicated that universities increasingly rely on accurate metering data to support utility rate negotiation and inform strategic energy purchasing. In response to raising natural gas and electricity prices, a number of universities use historical metering data to inform the pre-purchase of natural gas. For example, in FY 2006 OSU's pre-purchasing program resulted in over $2.75 million in cost savings over market commodity prices. Similarly, many utility data management software packages can provide access to real-time electricity prices. Leveraging this capability, universities with sophisticated energy management programs use both historical and current metering data to facilitate spot purchasing on the electricity market and promote demand management.

4.0 Recommendations

Given the current state of utility metering on the IUB campus, Indiana University has a strong foundation to develop a first class utility metering program that can support 1) the efficient operation of campus utilities, 2) effective energy and water management, 3) achievement of campus wide sustainability objectives, and 4) the educational mission of the University. In

[19] Software vendors mentioned by other university energy managers include: Cimetrics, OSISoft, Interval Data Services, Itron, and Instep EDMA. The latter is currently used by University of Michigan and OSU.

addition to having significant potential to generate cost avoidance opportunities for the university, investment in utility metering will provide the critical data necessary to evaluate progress towards concrete sustainability targets. Drawing on the observations highlighted in Section 2 and 3, this section provides recommendations intended to help IUB develop an effective utility metering program.

Recommendation 1: Develop a campus wide strategy to improve sub-metering infrastructure on campus.

Long term: To provide high level resolution utility data to energy managers and the campus community, the University should form a sub-committee to develop a strategic plan to achieve 100% sub-metering coverage of all utilities in on-campus buildings. The strategic plan should be informed by a detailed review campus metering needs, identification of critical success factors required to operate a first class utility metering program, and careful consideration of how collect, integrate, and leverage metering data to improve resource use efficiency on campus.

Additionally, the University should begin a formal process of **networking with peer institutions** that have implemented, or are currently implementing, sub-metering programs on their campuses. All energy managers contacted as part of this study indicated a willingness to hold more in-depth discussions in the future. OSU, UIUC, and the University of Michigan are key institutions who have valuable experience to share with respect to utility metering.

Short Term: In the short-term, it may not be financially prudent or possible for the university to invest in sub-metering the entire IUB campus. Thus, the university should create a phased implementation plan to achieve **100% utility sub-metering** of critical buildings on campus – i.e. buildings that are high use, high occupancy, or high profile. To accomplish this, the university must identify the buildings that meet the above criteria and prioritize buildings with respect to metering importance. Building prioritization should directly reflect the campus energy and water conservation strategies.

In order to ensure that the university implements a well coordinated and consistent utility metering program, the utility division must create **clear building standards** for all utility metering on campus. Metering standards should include the make and model of appropriate meter, installation method, accessibility requirements (height, meter location, etc.), and requirements for data communication.

At present, meter maintenance and repair is done on an ad hoc basis and is critically constrained by lack of funding and adequate person power. Thus, to extract maximum value from its investment in metering infrastructure, the university should invest in the development and execution of a regular **program of meter maintenance, repair, and calibration.** This will ensure that meters provide accurate data to inform operational practice as well as identify and evaluate high return conservation efforts on campus.

Summary of Recommendations		
Theme	***Long term***	***Short term***
1. Develop a campus wide strategy to improve sub-metering infrastructure on campus	Form a metering subcommittee to create a strategic plan to achieve 100% utility metering coverage on campus	Develop a phased implementation plan to achieve 100% utility metering coverage in critical campus buildings (e.g. high use, high occupancy, or high profile buildings)
	Network with peer institutions that have implemented robust metering programs (e.g. OSU, U. Michigan, U. Iowa, UIUC, etc)	Develop clear building standards for utility meters
		Develop a program of regular meter maintenance, repair, and calibration
2. Ensure utility metering data drives decision making with respect to energy management, conservation, and effective resource use	Invest in remote read technologies to collect utility usage data	Dedicate additional resources to data analysis to better leverage existing utility usage data
	Invest in data management software	Develop a utility metering database to facilitate analytical and reporting functions
3. Raise visibility of energy and water use on campus	Initiate a program of phantom utility billing to campus units	Develop static web pages from current utility data that highlight utility usage patterns on campus
	Provide public displays of building level utility usage patterns (e.g. lobby LCD screens)	
	Develop a web-based module that allows users to query aggregate and building level energy and water usage data	

Recommendation 2: Develop a university wide strategy to ensure utility metering data drives decision making with respect to energy management, conservation, and effective resource use.

<u>Long Term</u>: In order to enable human capital to dedicate additional time to value-added data analysis and reporting, the University should invest **remote read technologies** to collect utility usage data. Where possible, the university should select remote read technologies that leverage existing metering infrastructure. For example, water meters are currently equipped with radio read technology that could be read remotely from a series of relay antennae as is currently done at UNH. Similarly, electricity, condensate, and chilled water meters could be retrofitted with communication devices that leverage the university IT backbone to communicate utility usage data. Where appropriate, the University should consider investing in remote read technologies that provide access to real-time and interval data.

In order to extract maximum value from utility usage data, the University should also invest in **data management software** that can integrate utility data and facilitate analytical and billing functions. To accomplish this, the university should explore a number of software procurement options ranging from: in-house development, integration with existing building automation systems (Siemens, Johnson, etc.), MMS, off the shelf vendor products (Cimetrics, OSISoft, etc.), or custom developed software. Critical components of a software system include: the ability to integrate a wide range of metering data (manual read, remote read, interval, etc.), building automation systems, and weather/climate data; an intuitive user interface; and centralized reporting/billing functions; etc. The price point for off the shelf software used at peer institutions is approximately $250,000. Reputable vendors for utility management software mentioned by energy managers at peer institutions include: OSISoft (currently used at Yale), Cimetrics, Itron, Instep EDMA (currently used at Michigan and OSU), and Interval Data Systems.

<u>Short Term</u>: While the University would certainly benefit from investing in remote read technologies and an integrated utility data management system, it can take immediate action to better leverage existing data. As highlighted in Section 2.4, the UIG currently collects an impressive array of utility metering data. However, due to the limited human and financial resources dedicated to utility metering, current data remains critically underutilized[20]. To extract maximum value from current metering practices, the university should **dedicate additional resources (either new or re-programmed) to meter reading and data analysis**.

Currently, utility metering data is managed in excel spreadsheets. As a result, extracting meaningful information from the utility metering data is a time consuming task. To ensure existing data can provide the maximum value to end users, the university should invest in creating a **database to integrate current utility metering data**. This would improve the accessibility of current data and facilitate streamlined analysis and reporting. Additionally, a well structured and maintained database would create a foundation for the integrated software system noted above and web-based inquiry into resource use on campus discussed below.

[20] While the data existed to perform the analysis presented in Section 2.4, the data was compiled manually and all of the analyses were done specifically for this report.

Recommendation 3: Develop an explicit strategy to raise visibility of energy and water use on campus.

<u>Long Term</u>: 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, building upon actions outlined in recommendations 1 and 2, the university should create a clear strategy to raise awareness of energy and water usage amongst the university community (staff, faculty, administration, and students). To accomplish this, the university should initiate a strategic awareness campaign that includes, but is not necessarily limited to, **phantom billing, web-based access to utility usage data, and in-building displays of energy and water usage[21].**

Equipped with robust metering data, the University can provide **phantom utility bills** to managers of various campus units (auxiliaries, administrative offices, academic units, etc.). Phantom bills could provide three types of information to building managers and occupants: 1) actual utility usage (thousand gallons, kWh, therms, cooling tons, etc.), 2) cost of utility usage, and 3) an equivalent usage sustainability indicator (GHG emissions, automobiles on the road, etc.) These indicators would provide managers insight into the amount of energy/water use as well as the financial cost and environmental impacts of the use.

Similarly, to impact the behavior of building occupants (e.g. students, staff, etc.) the university should provide **in-building displays** of utility usage in high occupancy areas such as dorms and classroom buildings. Due to the fact that buildings users – i.e. students, faculty, and staff – are often removed from the direct financial implications of energy and water usage, in-building data displays have the potential to raise user awareness of energy usage on a constant basis. Utility usage information can be displayed along with other important information (e.g. upcoming events), on LCD screens in building lobbies. Displays should include the highest resolution data available to help solidify the direct link between occupants' actions and data displayed. The university may consider investing in real time data monitoring capability for flagship buildings – e.g. MSB1 and MSB2. Examples of this can be viewed on Oberlin's website at http://www.oberlin.edu/dormenergy/.

As noted in Section 3, a number of peer institutions provide internal and external audiences access to utility usage information on their websites. Once a robust database of utility data has been created, the university should develop a **web-based module** that allows users to dynamically query utility usage information[22]. Users should have the ability to retrieve

[21] Here, careful attention must be paid to ensuring the instrument selected to promote conservation is targeted to the appropriate audience. For example, phantom or real billing to residence halls may prompt RPS to advocate for building audits and retrofit projects. However, due to the fact that students often do not directly pay for their housing, phantom or real billing will likely have little effect on occupant behavior. Thus, to promote behavior change amongst the residents of RPS buildings, tools such as student competitions and in-building usage displays may be more effective.

[22] Current examples of this can be found on the UC Boulder and Yale websites at http://www.colorado.edu/conservation/usage.html and http://www.facilities.yale.edu/Campus/Energy.asp, respectively.

aggregate data for campus as well as information on individual building usage for specific utilities.

Short term: While the University may not be able to immediately invest in developing a dynamic web-based utility data module, it could use currently available data to create static web pages to display energy and water use on campus. As highlighted in the data analysis example presented in Section 2.4, the university can use current utility metering data to provide a relatively rich picture of campus, and in some cases building-level, resource use. Once complete, this information should be prominently linked to the emerging sustainability website.

5.0 Conclusion

As the sustainable campus movement gains momentum across the country, University's are increasingly investing in utility metering programs to promote effective energy management and informed decision-making. In addition to providing utilities staff high quality data to improve operational performance, a robust metering program can raise the university community's awareness of resource use on campus, provide measurable indicators of progress towards critical sustainability objectives, and help drive decision making on campus. As the analysis above suggests, Physical Plant Utilities and the Utility Information Group have laid a firm foundation on which IUB can build a strong utility metering program. Leveraging this base, the University would be well served to invest in utility metering as it develops a vision for sustainability on the IUB campus.