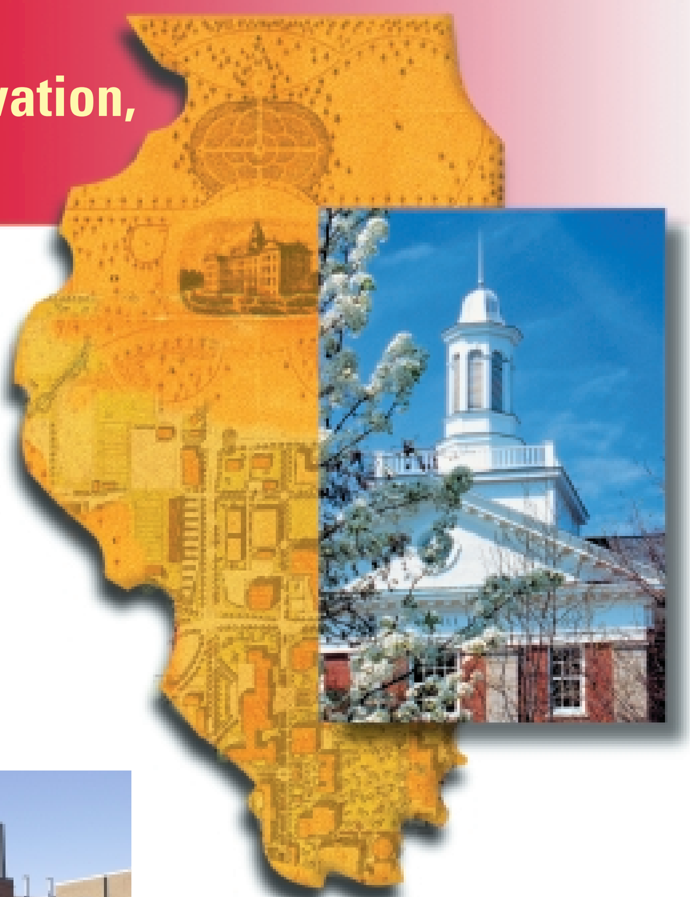
FEBRUARY 2002

The Energy Management and Utility Infrastructure Improvement Plan

Achieving Distinctiveness and Excellence in Conservation, Reliability, and Efficiency

at Illinois State University



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Energy Management and Infrastructure Improvement Team Members:

Ron Kelley	**Asst. to the VP, Facility Financial Services**	**Chairperson**
Greg Alt	**Assistant Comptroller**	
Richard Kentzler	**University Architect**	
Steve Lancaster	**Superintendent of Building Maintenance (Bond)**	
Gary Mangina	**Superintendent of Building Maintenance (General)**	
Cal Miller	**Manager, Bone Student Center**	
Chris Ratajski	**Accountant, University Housing**	
Richard Shelton	**Director of Utilities**	
Sheila Taylor	**Utilities Administrator**	

Previous Members:

Paul Graves	**Director of Utilities**
Dr. David Cain	**Assistant Director of University Housing**

Oversight Team Members:

Dr. Stephen Bragg	**Vice President Finance and Planning**
Helen Mamarchev	**Vice President Student Affairs**
Dr. Richard Runner	**Director, Facilities Planning**
Chuck Scott	**Director, Facilities Management**
Ron Jones	**Comptroller**
Chika Nnamani	**Asst. Vice President Student Affairs and Residential Life**

Executive Summary

"Energy savings provide an opportunity for investing in Facilities…."
"Invest in your Facilities, not your Utilities."*Energy Decisions*

Illinois State University has reaffirmed its commitment to energy management and infrastructure improvement through its inclusion of Actions #71 and #73 in *Educating Illinois*. The Energy/Utility Management and Infrastructure Improvement Team was established by the Vice President of Finance and Planning with the charter to draft a comprehensive plan to "*improve the University's energy management and utility infrastructure in order to increase energy conservation, reliability and efficiency*." This team has worked with the Residence Hall Infrastructure Improvement Team (RHIIT) and the Campus Master Plan steering team to ensure that all recommended actions are coordinated and consistent. The roster of team members is listed on the inside cover of this document.

The primary components of this plan are energy conservation, infrastructure improvement, energy procurement, funding, and energy management. Though each area has individually defined problem, objective, and action statements, this plan has a common focus:

> **"To reduce energy consumption and procurement costs, creating utility savings to be used to improve the reliability of university utility infrastructure systems, thereby reducing deferred maintenance, improving the campus environment, and creating additional savings for future energy management initiatives."**

Background

"Put simply, Illinois State University's facilities are aging and in need of serious improvement." "The accumulated deferred maintenance of Illinois State's general revenue facilities alone is in excess of $100 million. Facilities built with the proceeds from the sale of bonds have similar maintenance needs." ***Educating Illinois***

Illinois State University's campus was founded in its current location in 1857. The oldest existing building on the main campus was built in 1890 (Cook Hall). The bulk of the buildings were built during the expansion years of the 1960's. Only a handful of new facilities have been constructed since 1970. The majority of facilities at the ISU campus are thirty to forty years old. These facilities now require an extensive amount of work to replace/up-grade/improve mechanical, electrical, and plumbing systems. The problem is compounded by the amount of asbestos containing materials (ACM) that were used to insulate on or around many of the systems.

Additionally, the campus utilization of facilities is increasing and the demand on each facility is increasing proportionately. The addition of computers, smart classrooms, additional offices, research requirements, continuous classroom loads, and increasing enrollment is taxing the existing mechanical, electrical, and plumbing (MEP) systems.

Due to increased usage, poor MEP system capabilities, and commodity price increases, the campus is experiencing high-energy costs. Estimates indicate that 20-40 percent reductions in annual utility expenses are possible with the implementation of an energy conservation, management and infrastructure program. The FY01 utility expenses were approximately $10 million.

The development of comprehensive infrastructure improvement programs will enable Illinois State University to provide premier facilities that support premier programs. Successful implementation of this plan will address the issues of increased energy use, cost of procurement, poor MEP system reliability, and the growing deferred maintenance of our facilities. Eventually, a successful program may provide for utility savings and infrastructure improvements that will allow for reallocation of savings to other than utility needs.

Each goal and corresponding actions will be discussed in detail in respective chapters of this document. Appendices and diagrams are attached to provide supporting documentation and to record on-going activities on this subject.

Goal 1: Energy Conservation

1.1 Plan and schedule energy conservation projects identified in the facility assessment and utility audits

1.1.1 HVAC

1.1.2 Electrical

1.1.3 Plumbing

1.1.4 Building Envelope

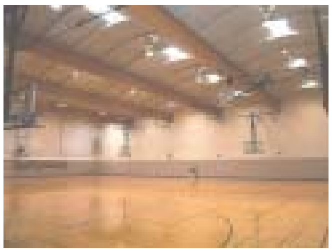
Poor Insulation

Inefficient Lighting

1.2 Conduct routine audit/assessment of all university facilities to identify conservation opportunities.

1.3 Develop Utility Conservation Policies and Procedures.

1.4 Educate the campus community.



Lights on in an unused facility.

Windows Open in Heated Facility

Inefficient Bldg Envelope

Goal 2: Utility Infrastructure Improvement

2.1 Conduct a thorough audit/assessment of all university facilities to identify use, condition, and prioritize facility infrastructure maintenance, remodeling and rehabilitation needs. (Facilities Condition Assessment)

2.2 Explore the expansion of the current power plant with one or more satellite plants.

2.3 Replace and consolidate several independent chilled water systems and complete the Historical Quad chilled water loop.

2.4 Upgrade the high voltage electrical utility systems.

2.5 Complete the Water Treatment Plan, upgrading our ability to control the chemistry of the water systems.

2.6 Develop a thermal storage capability on campus. This is a demand-side management project that improves our load profile and reduces load requirements by 20%.

2.7 Upgrade/repair building temperature control systems.

2.8 Develop long range capital infrastructure improvement projects which address current and future mechanical needs of the campus

ISU Heating Plant Cooling Tower

ISU High Voltage Electrical Station

Goal 3: Energy Procurement

3.1 Implement the ENRON and CMS Procurement and Management contracts, including:
- Natural Gas and Electrical supply planning
- Pricing strategies
- Risk management
- Optimization of storage

Note: During the time of drafting this document, ENRON Corp. filed for Chapter 11 bankruptcy and the status of Illinois State University's contract with ENRON is subject to legal proceedings.

3.2 Purchase natural gas and electricity at the best possible price.

3.3 Minimize storage, transportation and other charges.

3.4 Maintain thorough records of purchases for comparison to LDC natural gas rates and for comparison with other purchasing strategies, benchmarking and other energy evaluation purposes.

3.5 Evaluate current operations and procedures for future improvements.

3.6 Insure appropriate amount of gas and electricity is brought in daily to meet University needs.

Goal 4: Funding

4.1 Designate funds from current operating budgets that can be specifically applied to energy management and utility infrastructure projects. Specifically, continue annual commitment of facilities deferred maintenance budget to utility specific deferred maintenance initiatives.

4.2 Commit annual utility savings funds (both GR and BR) to utility conservation, management, and infrastructure improvement projects and programs.

4.3 Develop debt-financing plan to fund major energy saving initiatives. Secure long-term annual utility budget savings (of $350,000 to $500,000) to commit to annual debt service.

4.4 Seek Capital Development Board (CDB) funding of major utility projects.

4.5 Investigate grant sources for application to utility projects

4.6 Investigate cooperative opportunities with third parties (Town of Normal and ESCOs)

Goal 5: Energy Management

5.1 **Analyze all utility bills.** Utility bills contain significant data including consumption, costs, and rate information that can be analyzed to identify cost effective energy projects.

5.2 The **Acquisition and Use Energy Accounting Software** is an effective too for management in understanding and controlling their energy costs. While utility bills indicate how much energy was used and costs, they don't tell what the load profile is or what can be done to help control both energy use and costs.

5.3 **Benchmarking** is the responsibility of management to assure that all equipment operates at peak efficiency levels. Through the implementation of a benchmarking program, real-time operating information can be used to improve the decision-making process in the evaluation of potential capital projects.

5.4 **Conduct a thorough audit/assessment** of all university facilities to identify use, condition, and prioritize facility infrastructure maintenance, remodeling and rehabilitation needs.

5.5 **Sub-metering** provides a tool to aid in identifying potential energy savings projects, and to provide verification of savings. A basic metering system that can provide interval data from each utility meter is needed.

5.6 **Hire or contract qualified Energy Engineer(s)** to provide the expertise and focus needed to identify and quantify energy projects. The Energy Engineer will provide detailed energy use analysis reports, leads development of energy cost reduction projects, leads employee awareness programs, and leads conservation projects.

5.7 **Implement Projects** to reduce energy costs. The acquisition of resources for these projects requires the support of leadership from each department as part of the decision and planning process. Oversight and close management of project implementation is important to insure completion and cost controls.

5.8 **Establish guidelines and policies** that would encourage prudent usage of energy and the selection of energy efficient equipment and fixtures. Implement energy and utility conservation, infrastructure, procurement, and funding initiatives including program and project development, and detailed reporting.

Chapter One Energy Conservation

"There are good reasons why lighting and HVAC traditionally are the low-hanging fruit…because they are easy and they are obvious." *Energy Decisions*

Unprecedented high energy costs, volatile energy markets, power shortages, aging utility infrastructures, and an escalating demand for energy has created an urgent need for the development and implementation of a University wide energy conservation program. Illinois State University's consumption of electricity alone has increased 35% since FY1995. Utility consumption may increase over the next several years due to:

The Center for Performing Arts (CPA) completion
The new College of Business building
Res./Net Computer Systems for Campus Housing
Continued load growth on campus


The Center for Performing Arts

Much of the energy that is used by ISU can be conserved either by repairing or replacing current inefficient equipment and mechanical systems or by improving consumer practices on campus.

The objective is to develop energy usage guidelines, policies, and practices that encourage prudent use of energy and the wise selection of energy efficient equipment and fixtures.

- Reduce consumption of natural gas, electricity, and water.
- Improve efficiency of utility mechanical systems.
- Identify benefits to energy upgrades other than conservation:
    - Reduced maintenance
    - Reduced overhead allocations
    - Workload transferred to other deferred maintenance activities

HVAC and Lighting systems are the most obvious and easiest opportunities for energy conservation on the ISU campus. Most of the current HVAC systems are at the end of their functional life span (30 years), are single-stage, and are very inefficient (gas or electric) in comparison to modern two-stage systems. While the cost of new HVAC systems are high, the payback is relatively short. HVAC systems account for the largest variable electric load in a facility and therefore offer the highest potential for energy savings. Potential HVAC upgrades with high payback in energy conservation include:

- Repair and replacement of steam traps
- Insulation of pipes and mechanical rooms
- Replacement of single-stage chillers with two-stage chillers
- Create a portable chiller package
- Main Street condensate and High-pressure return
- Automate trunk lines


Poor Insulation in Mechanical Rooms

New energy-efficient lighting systems offer the potential of reducing lighting energy requirements by 35 to 50 percent, with additional savings being realized in reduced air conditioning costs as lower lighting system energy use translates into reduced cooling loads. Potential electrical upgrades with high payback in energy conservation include:

- Reduction in current number of lighting fixtures.
- Upgrade to T-8 or T-5 fluorescent lamps
- Upgrade to electronic ballasts
- Efficient fixture designs
- Automatic lighting controls and occupancy sensors. A properly implemented lighting control strategy will result in saving of 20 to 40 percent and will maintain occupancy comfort.

Inefficient Lighting in classrooms

The energy savings realized by upgrading lighting from T12 fluorescent lamps with magnetic ballasts to T8 lamps with electronic ballasts is about 50 percent. The new lamps and ballasts are efficient and the right combination of the two allow facilities to use dimming as an energy-saving technique while compromising little in lighting quality. **See Appendices 1-2 and 1-2.**

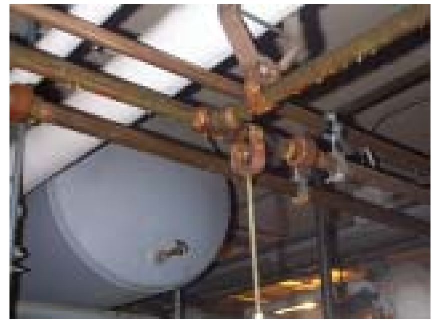
"Water is the oil of the 21st century. Everybody's going to fight for it." Water currently costs just \$3 to \$4 per 1000 gallons, in some areas the prices have steadily increased to as much as \$11. Water upgrades are cost effective and have a payback period of 2-4 years. Potential plumbing upgrades with high payback in water conservation include:

- Meters on cooling tower for tax abatement
- Toilet upgrade kits and maintenance
- Efficient showerheads (2.5 g/min)
- Irrigation management
- Laundry water recycling program
- Water Treatment Plan

A non-metered Cooling Tower

Opportunities to improve Illinois State University's energy efficiency are present in every electro-mechanical and controls device located on the property. Some areas of maintenance that impact energy savings include variable-speed motors, windows, insulation, weather stripping, door sweeps, and air curtains.

- **An insulation program** can save energy costs immediately. At ISU, insulation has been stripped off of pipes carrying steam or water for use in HVAC systems due to recent abatement activity and not replaced due to costs of material and labor. As a result the system's heat escapes into the air rather that being used for its intended purpose. In addition, a system that lacks insulation can cause long-term damage to a facility by allowing excess moisture. Most appraisers estimate that the payback of revamping a facility's insulation is 3 to 12 months.

Examples of loss of energy due to poor insulation on HVAC systems

- **Windows** are thermal holes. An average facility may lose 30 percent of its heat or air conditioning through its windows. The payback period for performing a window upgrade project ranges form two to ten years. In new construction their higher initial cost can be offset because smaller, less expensive heating and cooling systems can be afforded. More durable windows may cost less in the long run because of lowered maintenance and replacement costs. Occupancy comfort rates will be high reducing complaints and increasing employee productivity.

Loss of energy due to inefficient use of windows

Loss of Energy due to need for Window Upgrades

Note: Prioritized project lists for HVAC, electrical, plumbing, and building maintenance are maintained at the Office of Facility Management and are available upon request.

Actions.

Plan and schedule energy conservation projects identified in the facility assessment and utility audits. These installations consist of new high efficiency lighting, high efficiency motors, transformers, DDC/automation enhancements, insulation, night setbacks, and occupancy sensors.

Example. Lighting Standards and Controls. It is essential to establish light types, foot-candle requirements, and efficiency ratings. Typically, lighting accounts for 30% of the total electrical load on campus. We would develop written lighting standards for new construction and remodeling as well as for lighting upgrades. **The FY02 and consolidated Energy Conservation Projects are listed in Appendix 1-1 and 1-2 respectively.**

Conduct routine audit/assessment of all university facilities to identify conservation opportunities: Energy usage, lighting efficiencies, window leakage, insulation factors, occupancy levels, usage patterns, and infrastructure state-of-repair are typical assessment areas of interest. The facilities audit is the activity that would allow us to capture energy saving opportunities in our planning process rather than reacting to events as they occur.

Develop Utility Conservation Policies and Procedures. These are dynamic implementation policies and procedures that describe specific activities that result in energy conservation. One such policy would establish space temperatures for winter heating and summer cooling. Facility coordinators would be advised of advantages and savings actualized by the implementation of these policies and procedures. **See References 1-1 and 1-2 available at Facilities Management and Heating Plant.**

Inform and Educate the Campus Community. We will seek to consult all campus constituents to find ways to conserve energy without disrupting campus life or inhibiting the educational process.

Impact Statement. It has been estimated that 20 to 40 percent of the funds spent on utility bills at Illinois State University could be saved through mechanical systems upgrades. This equates to two to four million dollars, which could be made available for other purposes. The funds initially to be invested in these upgrades would significantly reduce the $120 million deferred maintenance accumulation. The environmental, programmatic, and fiscal impact of such a program clearly supports the University's goal of Excellence and Distinctiveness.

Horton Field House and North Gymnasium

Notes:

- Use of inefficient lighting systems
- Full use of lights during low occupancy periods
- Vehicle entrance left open when not in use

APPENDIX 1-2 CONSOLIDATED ENERGY CONSERVATION PROJECTS

Note: This list represents projects identified during routine facility audits conducted by Facility Management and Heating Plant personnel in FY 01/02 and is not meant to be comprehensive in nature. These projects are not listed in priority order. Priorities are determined upon approval of funds.

Abbreviated Project Description	Approx. Cost
• DeGarmo steam station replacement located in basement	
• Turner Hall replace air-handlers	
• Main street condensate return system (engineering study)	
• Science Lab Bldg install micro filter on closed loop system	
• Boiler economizers need repairing	$150,000
• Stevenson Hall chiller replacement	$500,000
• Centennial East complete fancoil unit repiping	
• Centennial West repipe and replace fancoil units	
• CVA repair/replace or connect chilled water to loop	$200,000
• DeGarmo Hall absorber (next 6-years) replace	$450,000
• Repair Bone Student Center steam expansion joint	$ 20,000
• Automation/upgrade main trunk to fiber optics	$ 75,000
• SCU automation upgrade to MBC (24 panels)	$ 65,000
• Edwards/Cook remove old steam absorber	$ 20,000
• Bone chilled water piping: reconfigure/engineering study	$ 80,000
• Generator for central chiller plant	$450,000
• Williams Hall chiller 50 ton replace	$ 90,000
• Horton basement condensate pump piping replacement	$ 20,000

- Horton steam trap replacement $ 50,000
- McCormick Hall automation in locker room $ 25,000
- Quad loop install bridge to central chiller loop $100,000
- Alternative boiler fuel study and installation
- Lighting projects and grants: DeGarmo, McCormick, etc.. $ 350,000
- Load reduction at Arena, Resnet, Watterson
- Install and reset VF drives – campus
- Repair Turner glycol heat recovery system
- Install heat recovery unit on Metcalf pool
- Campus install and increase setback – run times on system
- Milner library – engineer and install separate zones for each floor
- Student Services VFD zone dampers need to be re-engineered
  And relocated to proper locations
- Schedules for occupancy need to be evaluated across campus
- Old Main look at time and program scheduling and zone control set-ups
- Conduct routine energy walkthrough audits
- Install motion sensors throughout campus
- Install insulation on pipes, valves, ducts campus wide
- Watterson – replace domestic hot water with instantaneous heater
- Increase water treatment program
- Install chiller and tower at Vrooman
- Install speed drives on cooling tower at Watterson
- Watterson – lighting upgrades

- Watterson – replace absorbers with high efficiency chillers
- Vrooman electrical upgrade to high efficiency transformers, and Install new generator
- Vrooman automate the six air-handlers
- Vrooman replace elevator shaft air-conditioning and automate
- Vrooman automate second heat exchanger
- Atkins/Colby upgrade electrical, transformer, generator, lighting
- Atkins, automate fans and hot water heating
- Atkins, Colby, Ham, Whitten, all upper and lower equipment rooms need upgrading, condensate repair, PRV, shutoffs to heat exchangers
- Ham/Whit/Atkin/Colby first floor apartments, lobbies, and student rooms need upgrading of valves, traps, and coils.
- Ham/Whit/Atkins/Colby replace heat exchangers, repair baseboard radiation, fittings and shutoffs.
- Ham/Whit/Atkins/Colby need chilled water re-piped to dorm rooms
- Wilkins, Wright, Hanie need to repair or replace pumps, valves, piping for hot water. Replace transformers, wiring, and generators. Install automation on fans, air-handlers, steam-coils need replacement.
- Walker Hall needs domestic hot water for kitchen and dorms. Automate control valves, zone controls. Install new valves, traps, coils, to dorm rooms and install new emergency generator.
- Barton Hall upgrade the mechanical equipment rooms: replace the hot water heater, pumps, and controls.

Chapter Two Infrastructure Improvement.

"Reliability is more important than economics." **Energy Decisions**

Many of the University facilities were built 30 to 35 years ago and most have not had major upgrades to the mechanical and electrical systems. As a result, Illinois State University is in need of a comprehensive infrastructure improvement program**.** The bulk of the problems with the infrastructure systems are in the facilities themselves. The various air handling units, pumps, condensers, etc., are in most cases beyond their useful life and can no longer adequately serve their respective buildings.

The objective is to ensure system reliability so that the facility infrastructure and mechanical systems create an environment consistent with excellent academic programmatic requirements. The deferred maintenance in utility mechanical systems must be reduced and eventually eliminated.

The infrastructure of the university utility system includes primarily the power plant, the distribution system (steam and chilled water tunnels, electrical, and plumbing), and independent building mechanical systems. Each of these infrastructure components is discussed below including the current status, plans for short and long term improvement, and desired end state. Future projects include replacing and consolidating several independent chilled water systems, completion of the central quad chilled water loop, and expansion of the current power plant. Expansion will be utilized to house future auxiliary mechanical systems such as electrical generators, central air receivers, and heat recovery systems. Steam system efficiency and/or capacity will be increased through a combination of re-powering and/or replacing of one or more boilers. Other improvements include installing back-up fuel burners, and the replacement and/or upgrading of plant auxiliary equipment as necessary to support campus expansion and improvements. The intent of this work is to implement a modernization program that will adapt to future changes and load growth and maximize efficiencies.

The Power Plant. The centralized power plant contains four boilers and one 1050-ton steam absorption (cooling) unit, with plans to add an additional 1050 tons of cooling capacity as part of the upcoming College of Business project. The plant has been in continuous operation since its construction in 1925. The present power plant is land locked limiting the amount of expansion that can occur at its present site. This space limitation impacts the potential for application of technical innovations such as thermal storage, heat recovery, and generating electricity. Continuing to add equipment and expanding the present structure, will ultimately make it difficult and costly to replace the existing boilers when the need arises.

Illinois State University Power Plant

Future work will involve construction of a satellite steam and chilled water plant. The satellite plants are proposed as part of The Master Plan and are to serve the proposed west campus expansion.

- **Satellite plant on West Campus.** It includes the building of a stand-alone structure that will be controlled from the main power plant. The equipment includes installing boilers, chillers, piping, pumps, tunnel, as needed, auxiliary equipment, automation, and controls. The intent of this plant is to avoid costly expansion to an already land locked power plant; the possible need to increase steam pipe sizes from the plant to west campus, and to reduce the distance that chilled water and steam has to travel. If this phase is approved, then the plan to increase capacity at the existing power plant will be changed to upgrading and replacement. West campus remote power plant will also house central chillers. The chiller piping will require additional tunnels, even though existing tunnels will be utilized as much as possible. With the upgrade of the west campus high voltage electrical system it is now possible to set a transformer to provide power for a new plant. Preliminary studies of the long-range master plan indicate that a satellite plant will be more effective in providing utility services to west campus.

- **South Campus Chiller Plant.** In order to provide firm cooling capacity for campus buildings a chiller plant needs be constructing near the south end of campus. The remote plant will provide for the additional cooling that will be required for the central quad and any future development of a south quad loop (district cooling system). The remote plant will require adding tunnel and increasing electrical capacity. It will include capacity for XX tons of cooling.

The mechanical distribution systems (steam, water, chilled water) running across campus are, in general, in very good to excellent condition as many lines have been replaced over the past number of years. There are only a handful of short runs that have yet to be addressed. There does continue to be a need to extend these systems to certain areas of campus so these services can be provided for all facilities. While the condition of the system is good, the *capacity* of the system is in need of expansion. There is also a need to expand the system in order to create the desired “loop” service. . This work would include upgrading the power plant, boilers, chillers, and piping within the plant, and improve the mechanical spaces in individual buildings. Utility systems in tunnel extensions would also be considered part of any work.

Steam Lines (See Diagram 2-1)

Steam distribution capacity needs to be increased going to central campus. New and larger pipes will have to be installed to accomplish this. The main steam line coming from the power plant providing steam to central campus will be sized for increased capacity capable of providing adequate pressure and flow to the existing facilities and meeting steam requirements for any future additions or enhancements. Pipe sizing will have to start at the power plant. As a result of the proposed East Campus chiller plan (see below) current steam capacity to East Campus is adequate.

Chilled Water Systems (See Diagrams 2-1, 2-2)

The University's primary focus for chilled water is the completion of the Historical Quad district cooling system. District cooling consists of a central chiller plant, tunnels, piping, and controls. Each facility along the system connects to it much the same way a residence connects to city water. Given the right conditions and circumstances district cooling systems operate more efficiently, allow for diversity, greater load management, and the adaptation to new technologies such as combined cycle turbines, heat recovery systems, and thermo storage. A quad loop chilled water system will improve conservation and facilitate effective energy management. There are also maintenance and material cost savings associated with the elimination of individual building chillers.

The Historical Quad district cooling system is currently served by a 1050 ton, two-stage, steam absorption unit located in the power plant. Upon completion of the Schroeder renovation and the College of Business building the capacity will be increased to 3,300 tons. Completing the Quad loop system will require extending the tunnel from the College of Business around McCormick Hall, down the Fell Hall tunnel to DeGarmo, from there the piping will pass through the DeGarmo basement. From DeGarmo a shallow tunnel will have to be constructed leading to the power plant. **(See Diagram 2-1)**

The Central Chiller Plant is located below ground next to Felmley Hall. The plant consists of five electric chillers totaling 778 tons of cooling. The plant provides chilled water to Felmley Hall/Felmley annex, Moulton Hall, and Julian Hall. It also can provide supplemental cooling to the Science Lab Building (SLB).

The Central Chiller Plan is to create a hybrid district cooling system. The central chiller loop will be connected to the quad chiller loop. This connection will enable the Central chillers to provide both backup and supplemental cooling to the Quad loop. In addition it will provide demand limiting, load shifting, and off-peak cooling capabilities. The Central chiller will also increase operating efficiency during the cooling season "collar" months (early Spring and late Fall). Each of the five electric chillers can individually be activated for either (or both) the Central or Quad chiller loops. The chillers will be programmed to operate in their most efficient range and start up individually as the load increases, taking advantage of the most efficient operating curves.

In order to couple the Central and Quad chiller loops, a connecting underground piping system will be installed. An engineering firm was contracted to evaluate the feasibility of this plan and has confirmed that the plan is viable and the following costs and savings are reasonable.

East campus is the location of the highest risk of air conditioning failure on campus. This reliability issue is the result of chiller failures that occurred in 1998. The solution was to provide chilled water service to the East Campus residence halls (Hewett, Manchester, and Vrooman) using the new Science Lab chillers. As a result the Science Lab chiller system is running at full capacity. This chiller system is also the only available backup system for Stevenson Hall. The Stevenson Hall chiller is a 32 year old, inefficient single stage system that could fail at any time.

If it should fail, the SLB could supply chilled water to either Stevenson or the Residence Halls, but not both.

The current plan is to:

1. Install two 450-ton electric chillers, automated controls, cooling tower, and pumps into the East Campus residence hall complex (Hewett, Manchester, and Vrooman). The existing pipe section blocking the tunnel to SLB will be removed eliminating the confined space condition created when the residence halls were connected to SLB. This action also eliminates the need for the $100,000 tunnel-widening project that was being considered with other options. The tunnel between SLB and the East Campus residence halls will remain in place for emergency backup if needed.

2. Build an above ground structure housing two absorbers (two-stage chillers) and one electric chiller large enough to provide primary and backup chilled water to both Watterson Towers and Stevenson hall. The electric chiller will also be operated at night to take advantage of off peak electric rates and credits. Eventually, the electric chiller will provide thermo storage capabilities.

   Savings: This project is an opportunity to achieve considerable energy savings with high efficiency chiller systems. Preliminary annual cost savings as a result of converting to two stage chillers for East Campus is $230,000 per year. Additional savings can be achieved by load sharing between the two facilities and the implementation of technologies such as thermo storage, peak shaving, and time of day operations. Funding opportunities may exist that allow both bond Revenue and general Revenue to partner in the purchase and installation of these chillers.

ISU Power Plant Cooling Tower

CVA Cooling Tower

High Voltage Electrical System (See Diagrams 2-3a and 2-3b)

Osage Street Substation

The University electrical distribution system is being supplied from two 34,500 volts (34.5KV) sources provided by Illinois Power Company at the Osage Street substation. From the 34,000 volts located at the substation are the two underground distribution systems powering the campus: 4,160 volts and 12,470 volts. The power plant substation is the 4,160 volt system, which is broken down into twelve feeders organized into six feeder loops that serve the central and northwest areas of campus. The second transforming distribution is the 12,460 volt located at the Osage street substation. It provides power to the UHS Office building, CVA, Fell Hall, DeGarmo Hall, Student services, BSC, Milner Library, Science Lab, Watterson towers, South University Parking deck, and the Center of Performing Arts. In order to evaluate the present condition of the entire campus electrical system, several electrical studies have been completed along with system audits and evaluations. From these studies an electrical distribution map identifying system condition and reliability has been developed (Diagram 2-4). It is from this site plan that an electrical upgrade and repair plan has been developed. Facilities that are at a high risk of failure are colored in RED and those with a marginal risk of failure are colored in YELLOW.

East Campus High Voltage Conversion. Circuits 2A & 2B

<u>Scope.</u> This project is the final phase of the three-year high voltage, electrical project. The high voltage runs from the 4160 power plant substation through the center of campus. When completed, all of the below ground high voltage link boxes will be replaced with above ground switches and Vrooman, Manchester, Hewett, Julian Hall, and Stevenson Hall will be converted to 12.5 KV. The switches will be located next to Hewett, Manchester, Julian, and Stevenson Halls. Removing the link boxes will eliminate a below ground hazardous environment. It also reduces outage time from 28-32 hours to 2-6 hours.

Included in this project is the installation of a new 12.5 KV duct bank from Watterson (north) to the west side of Vrooman. A Vista switch and transformer will be installed at dining commons.

Once the conversion is complete, the east campus electrical load will be removed from the power plant substation's 4160 load and added to the Osage sub station.

<u>Benefits.</u> Dividing the load provides several benefits:

- Reduces the risk of 4160 Volt overload
- Provides a second power source to the campus
- Increases reliability
- Improved troubleshooting capabilities
- Facilitates long range planning

Metcalf/Fairchild wiring upgrade

Scope. Remove existing electrical switchgear and 480/208/120 volt transformers (2) and replace. Secondary wiring, remove and install new motor control center, switches, risers, and sub panels. Install tertiary wiring to all spaces (classrooms, offices). Evaluate and replace or upgrade emergency generator and automatic switchgear (upgrade for clean power).

Project Summary:

- Phase I — Install new switchgear and transformers
- Phase II. — Install new motor control center, risers and Sub panels.
- Phase III — Install new tertiary wiring (2-years)
- Phase IV — Complete tertiary wiring (final year)
- Phase V — Install new emergency generator
- Asbestos — No estimate provided

Upgrade and improve reliability of Edwards Hall electrical system.

Scope. Install a new high voltage 4,160 Volt transformer at Edwards. Install a new above ground switch. Relocate Cook Hall high voltage circuit located in Edwards mechanical room to above ground switch at Cook Hall. Install new high voltage lines and switch. Install new secondary panels on 2nd and 3rd floors. Wire into existing distribution panels. Install tertiary wiring when renovating areas. * Asbestos is an issue (no estimate provided)

Hovey Hall Electrical Upgrade Phase I.

Scope. Secondary wiring replacement. Remove existing secondary transformers, stacks, and wiring. Install new 208/120 building transformers, and new electrical feeds from the transformers to the electrical distribution center and connect to the floor sub panels. This project will need to be done in one phase.

Stevenson Hall electrical upgrade – primary

Scope. The intent is to both upgrade the primary electrical service to Stevenson Hall and to remove it from the high voltage 4,160 volt circuits. This will be done by connecting it to the 12.5 KV circuits 303 & 304, which are already installed from the Osage Street substation to Watterson Towers. Provisions to connect Stevenson Hall to the 12.5 KV circuits have already been made.

Phase I involves installing a new above ground 12.5 KV switch and installing a new underground duct bank and wiring. Replace the existing 4,160 volt transformer located in the basement with a 12.5 KV transformer. Install transformer and connect to the main switch gear.

This project is part of a multiyear project, which will ultimately upgrade all of the Stevenson Hall wiring systems.

ISU High voltage substations

Osage Street Substation

Power Plant Substation

Water Treatment Plan (See Diagram 2-4 and Reference 2-1)

The intent of this proposal is to upgrade our ability to control the water chemistry of the Cooling Towers, Chill and Hot water systems. The benefits of an effective treatment program are:

- Extended life of equipment.
- Less down time due to equipment failure.
- Control of Biogrowth (Algae, Bacteria, Mold)
- Direct cost savings in the amount of chemicals used.
- Cost savings in the amount of city water purchased.
- Reduced maintenance cost due to plugged coils, condensers pipe failure and pump seal failure.

CVA Cooling Tower

This can be accomplished by reducing causes of corrosion by adding chemicals to reduce corrosives and oxygen (Susceptible material, water & oxygen). Most of our chill-hot water systems are either chill or hot water systems depending on the time of the year so we treat the water in these systems year round. In the areas where the chill water system is separate we treat during the summer months and add chemicals to coat the pipes for the non-use times.

Cooling towers are maintained in a non-corrosive scale and bacteria free environment by inducing chemicals. The chemicals are kept within recommended control ranges to extend equipment life, insure that we are not growing bacteria and increase efficiency of heat transfer thereby reducing campus costs. We can operate within a narrower margin by replacing antiquated equipment and upgrading to a constant computer monitored control through Apogee.

Required Upgrades:

Automation. This upgrade would automatically start the cooling tower pump and enable chemical pumps to inject selected chemicals into the cooling tower circulating line.

Brominator. A brominator is used to introduce bromine into the cooling tower circulating line to help control the Bio-growth, and gives us better control of the chemical concentration. We are currently using a method called floaters where the bromine tablets are placed in a container that floats in the tower water and allow the tablets to melt into the system.

Corrosion Coupons. These measure the iron and copper depletion in the water system and are used to assess the effectiveness of the chemical treatment.

Monitoring Station. This station consists of three chemical pumps, automated blow down, and conductivity meter. The pumps are activated by the plant automation system, the conductivity meter activates the blow-down valve and a value is sent to the power plant. The operators would receive a status report and notified when a tower goes into high conductivity.

Cooling Tower Meters. Install makeup water meters on all cooling towers. All meters will be in compliance with the Town of Normal requirement for evaporation metering. ISU will receive evaporation credits for water not being treated at the McLean County Water Reclamation District.

Long Range Capital Projects:

The Utility Distribution System Upgrade is a project that addresses both the present and future mechanical needs of the campus including the power plant, distribution system, and mechanical spaces within facilities.

- **Thermal storage** is a demand-side management project that improves our load profile, reduces load requirements by 20%. For example, on the quad we have 3,700 tons of cooling loads, which would reduce the daytime load by 740 tons/hour and is equivalent to reducing our electric load by .6 megawatts. Currently our nighttime electric rate is below $0.02/kW, which is ideal for operating a thermo storage unit. Another area that would benefit from this type of unit is Watterson Towers and West Campus.

- **Campus Generation.** In the future there may be opportunities to benefit from on-site generation of electricity. There are several means of generating energy and which will be beneficial or practical depends upon the status of deregulation, energy supplies, contracts, and world energy markets. Some of the options include:

    - **Peak Shaving units.** Peak shaving units are financially beneficial if power companies provide incentives for load reduction during peak generation periods. Reducing loads during these periods reduces “demand” and “guaranteed energy” charges by the power company.

    - **Co-Generation.** Two potential scenarios for co-generating power are providing power for the entire 4.16KV system at the current power plant, and co-generating power on the 12.5KV system from a new power plant on south campus. Reclaimed heat from co-generation will be used to create steam and power both the heating and cooling systems on campus.

    - **Distributed generation using micro-turbines.** Micro-turbines can operate off of flow pressure steam and may prove to be well suited for a campus setting.

    - **Combined heat and power (CHP).** Combined cycle turbine technology installation is one alternative that has proven to be a cost effective operation and is environmentally friendly.

  Note: Proposed changes in U.S.E.P.A. guidelines requiring site permits and emissions testing/certification for on-site generation could increase operating costs and complexities. Proposals for such projects must be reviewed carefully.

- **Upgrade/repair building temperature control systems**: Buildings such as DeGarmo Hall, CVA, Centennial East/West, Turner Hall, and Stevenson Hall are high-energy users due to poor operating systems.

Actions.

Conduct a thorough audit/assessment of all university facilities to identify use, condition, and prioritize facility infrastructure maintenance, remodeling and rehabilitation needs.

Replace and consolidate several independent chilled water systems and complete the central and historical quad chilled water loops.

Upgrade electrical utility systems. Critically needed replacement of high voltage electric lines is already underway.

Expansion of the current power plant will house future auxiliary mechanical equipment (electrical generation, central air receivers, heat recovery systems, etc.) Steam system efficiency and/or capacity will be increased through a combination of re-powering and/or replacing of one or more boilers. Other needed improvements include installing back-up fuel burners, and the replacement and/or upgrading of plant auxiliary equipment as necessary to support campus expansion and improvements. The intent of this work is to implement a modernization program that will adapt to future changes and load growth and maximize efficiencies.

Complete the Water Treatment Plan, upgrading our ability to control the chemistry of the water systems.

Develop long-range capital infrastructure improvement projects, which address current and future mechanical needs of the campus

APPENDIX 2-1. High Priority HVAC Infrastructure Improvement Projects

1. Replace the Main Street condensate and high-pressure return system. This supplies West Campus with steam and heating. Approximate Cost: $65,000

2. Upgrade the building automation and control Siemens Apogee trunk lines from 18 gauge to 24 gauge or fiber-optic. The 18 gauge system severely limits the communication speed of the entire network. This is both a performance and safety issue as this system is used to report fire alarms to emergency units.
   Approximate cost: $100,000.

3. Repair or replace the CVA cooling tower. Approximate cost: $85,000.

4. Create a portable chiller package by using a new or used chiller taken off of a building added to the quad or central loop. Approximate cost: $160,000

5. Turner Hall: Repair or replace the air handling units, chiller, and cooling tower. This may become part of the Turner/Stevenson Hall Life Safety Capital Project if not completed prior to State approval. Approximate cost: $1,500,000

6. DeGarmo Hall: Replace and upgrade the chiller and pressure reduction valve (PRV) station and pumps. Approximate cost: $550,000.

7. Center for Visual Arts (CVA): Replace and upgrade all HVAC mechanical systems including air handlers, ductwork, controls, and coils. No chiller or cooling tower is required, as CVA will be added to the Quad chilled water loop.
   Approximate cost: $1,800,000.

8. Stevenson Hall: Determine a source of chilled water (See East Campus plan) and replace the supply air handlers. Approximate cost: $450,000.

9. Complete the CVA chilled water tunnel and loop connection. This project was part of the CVA Capital Development Board (CDB) project that has not yet been completed.
   Approximate cost: $350,000.

10. Replace the Central Chiller. Approximate cost: $500,000

Chapter Three Energy Procurement

"The key is to procure the right amount of power at the right price." ***Energy Decisions***

The business of procuring energy resources at a reasonable price has become complex, as there are many strategies and models involved for both natural gas and electricity. Those responsible must develop procurement plans that incorporate the utility needs of the university, budget limitations and goals, and acceptable risk management.

OBJECTIVES:

- Purchase natural gas and electricity at the best possible price.
- Minimize storage, transportation and other charges.
- Maintain thorough records of purchases for comparison to local distribution company (LDC) natural gas rates and for comparison with other purchasing strategies, benchmarking and other energy evaluation purposes.
- Evaluate current operations and procedures for future improvements.
- Insure appropriate amount of gas and electricity is brought in daily to meet University needs.
- ISU should be in a position to acquire lucrative follow-on contracts with Electrical and Natural Gas companies.

Electrical Procurement Summary **Note:** During the time of drafting this document, ENRON Corp. filed for Chapter 11 bankruptcy and the status of Illinois State University's contract with ENRON is subject to legal proceedings.

Current Supplier: ENRON Energy Service
Term: May 19, 2000 through May 18, 2008

Contract provides: Monthly energy costs based on IP Rate 24 with billing determinates fixed as of September of each year. **(See Reference 3-1)**

Rate 24 is a very good rate for ISU. Since converting to Rate 24 in June 2000, an electrical savings of approximately $375,000 has been realized over what would have been billed using Rate 21in FY01. There is potential for increased savings through good load management. The rate is based upon the load factor. If energy is used efficiently throughout the year, overall costs will decrease. If not, costs go up.

Rate 24 bills for both electrical energy use and demand. In addition, there is a time-of-day portion of the bill that results in lower energy costs during off-peak hours. In many ways, this parallels current market costs with incentives to:

- Reduce on-peak energy consumption/demand during summer and especially hot weather.
- Utilize energy during evening hours when utility rates are lower.

Gas Procurement Summary

Current Supplier: CMS Marketing Services

Term: June 26, 2001 through June 25, 2003 with renewal options

Contract provides: **(See Reference 3-2)**

- Supply natural gas to Nicor City Gate.
- Fixed service fee of $.042 per Dekatherm.
- Recommend and implement purchasing strategies to benefit ISU; i.e., storage utilization, forward pricing contracts and financial products, spot gas purchases, and fixed price contracts including forward basis pricing.
- Submit storage requirements to LDC based on economic analysis and communications with ISU.
- Review MDCQ to assure appropriate value has been issued by LDC.
- Review natural gas loads to assure adequate delivery and storage balances to avoid penalties.
- Provide monthly information pertaining to current market situations to Buyer and advise how forward pricing strategies will be impacted.

Water Procurement Summary

Current Supplier: Town of Normal

No Contract — Currently Purchasing is investigating contracts for all suppliers of service to ISU.

Current Charges	Water	$2.48/thousand
	BNWRD	$3.28 first 4,000 gallons
		.82/thousand all gallons > 4,000
	Sewer	$2.00 first 4,700 gallons
		.77/thousand all gallons > 4,700

Note: BNWRD is Bloomington/Normal Water Reclamation District

Actions.

- Implement the ENRON and CMS Procurement, Management contracts, including:
  - Natural Gas and Electrical supply planning
  - Pricing strategies
  - Risk management
  - Optimization of storage
  - Report analysis
- Develop a "Risk Management" strategy for the procurement of natural gas. This strategy will be the basis for determining "triggers" for the purchase of natural gas.
- Energy procurement should be a primary and integral responsibility of the energy management team.

Chapter Four Funding.

"Financing energy upgrades can cut costs and preserve an organization's financial health." But … "Energy projects that don't produce enough savings or don't recoup capital expenses quick enough are destined to fail." ***Energy Decisions***

Energy management and utility infrastructure projects are often deferred due to lack of funding resources. Long-term projects are difficult to accomplish due unreliability of funding. Improvement to the University's energy management and utility infrastructure requires the identification of new and current fund sources that can be definitively and consistently applied to utility projects; and capital expenditures for energy upgrades must be returned through energy savings within a specified timeframe. This will be accomplished by:

1) Designating funds from current operating budgets that can be specifically applied to energy conservation and utility infrastructure projects.
2) Developing a debt-financing plan to fund major utility initiatives.
3) Seeking Capital Development Board (CDB) funding of major utility projects.
4) Investigating grant sources for application to utility projects. (**See Appendix 4-1: State of Illinois Energy Grant Programs.)**
5) Investigating cooperative opportunities with third parties such as the Town of Normal and Energy Service Companies (ESCO).

Actions.

1) The allocation of funds from current operating budgets that can be specifically applied to energy conservation and utility infrastructure projects can be accomplished by:

   a. Continuing the annual $350,000 commitment of Facilities Deferred Maintenance budget to utility specific maintenance.

   b. Incorporating utility conservation projects as a permanent component of the University utility budget. Specifically,

      - Starting in FY 02, apply all utility savings towards utility conservation and infrastructure improvement projects. Saving should be based upon the FY01 base utility budget of 10 million dollars and includes both Bond and General revenue funds.
      - Projects will be selected based upon conservation potential, rate of return, risk of system failure, and cost and time to complete.

2) Developing a debt-financing plan to fund major energy saving initiatives can be accomplished by:

   a. Securing a long-term annual utility budget savings of $700,000 to $1,000,000 (GR – 60%, Bond Revenue 40%) to commit to annual debt service.

   b. Developing a prioritized list of utility improvement projects with highest potential for future utility savings. Each project should include an estimate of projected annual energy savings.

   c. Issuing $5M to $15M in debt Certificates of Participation (COP) to fund long-term utility conservation projects that are mutually beneficial to both GR and Bond Revenue areas. (The length of the loan term should be sufficient to generate positive cash flow from the upgrade projects.)

      - Refer to conservation and Infrastructure projects listed in Chapters 1 and 2. An example of such a project would be the construction of thermal storage to reduce daytime peak load by shifting daytime cooling to night when electrical rates are lower thus reducing rates campus wide.

      - State law allows for issuance of COPs with repayment made from state appropriated funds.

      - Utility budget savings realized from the combination of lower procurement costs and utility conservation resulting from the projects would be used to fund the debt service for the retirement of the debt.

      - Based on a term of 10 years, annual debt service is estimated at $680,000 (GR = $408,000, Bond = $272,000). See **Table 4-1** for estimated debt service costs.

      - Earmark resulting savings first for repayment of COP issue and next for funding of future energy conservation projects.

3) Seek Capital Development Board (CDB) funding of major utility projects

   a. Identify the top five highest priority projects related to energy and utility improvement to incorporate with CDB and Capital Renewal funding requests.

   b. Require that all capital improvement projects include any related utility improvement components.

4) Investigate grant sources for application to utility projects. **See Appendix 4-1: State of Illinois Energy Grant Programs.**

   a. Engage qualified consulting firm to identify grant resources applicable to energy management and utility improvement projects and assist with grant proposals.

   b. Meet with Illinois Department of Energy and Natural Resources to develop utility projects with highest potential for funding assistance from state.

5) Investigate cooperative opportunities with third parties.
   a. The Town of Normal
   b. Energy Service Performance Companies

Impact Statement. The consistent dedication of current and new fund sources specifically to utility improvement and conservation projects should provide the University the following benefits:

1. Reduce the backlog of deferred utility maintenance and infrastructure projects.
2. Enhance longer term planning and commitment to large utility capital projects that improve infrastructure and take advantage of energy conservation opportunities.
3. Create a source of new funds realized out of the lower utility costs resulting from these projects that can be applied to future energy management and utility needs.

Chapter Five Energy Management

"A well-formulated energy savings plan starts with an in-depth look at how and where facilities are using energy." ***Energy Decisions***

"You cannot **Manage** what you cannot **Measure**"
"Measured data are of little use without **Analysis**"
"It takes **Action** to get **Results**"

The University must develop a comprehensive understanding of energy procurement and use, and a coordinated plan to optimize energy consumption in the most cost effective manner.

Energy represents a significant operating cost to Illinois State University. Controlling this cost is not merely a matter of executing conservation and infrastructure projects. Energy projects must compete for financial and labor resources just as other operational projects must. A management team must exist which has the credibility to develop good solid business cases with options, reasonable implementation plans, and good presentation skills.

Energy usage guidelines, policies, and practices that encourage prudent usage of energy, the wise selection of energy efficient equipment and fixtures, and establish wise procurement practices must be developed in order to efficiently invest/leverage utility savings into utility management/conservation/infrastructure initiatives and maintain or improve environmental conditions on campus.

This will be accomplished by:

Analyzing all utility bills. Utility bills contain significant data including consumption, costs, and rate information that can be analyzed to identify cost effective energy projects.

Acquiring Energy Accounting Software as an effective tool for understanding and controlling energy costs. While utility bills indicate how much energy was used and costs, they don't tell what the load profile is or what can be done to help control both energy use and costs.

Benchmarking to assure that all equipment operates at peak efficiency levels. Through the implementation of a benchmarking program, real-time operating information can be used to improve the decision-making process in the evaluation of potential capital projects.

Conducting a thorough audit/assessment of all university facilities to identify use, condition, and prioritize facility infrastructure maintenance, remodeling and rehabilitation needs.

Sub-metering as a tool to aid in identifying potential energy savings projects, and to provide verification of savings. A basic metering system that can provide interval data from each utility meter is needed. Some the benefits of sub-metering include: Allocation of energy costs, Discover opportunities for potential energy-efficiency improvements, Measure and verify energy conservation projects, Optimize chillers and limit demand, and verify the accuracy of utility bills.

Hiring or contracting qualified Energy Engineer(s) to provide the expertise and focus needed to identify and quantify energy projects. The Energy Engineer will provide detailed energy use analysis reports, leads development of energy cost reduction projects, leads employee awareness programs, and leads conservation projects.

Implementing Projects to reduce energy costs. The acquisition of resources for these projects requires the support of leadership from each department as part of the decision and planning process. Oversight and close management of project implementation is important to insure completion and cost controls.

Establishing guidelines and policies that would encourage prudent usage of energy and the selection of energy efficient equipment and fixtures. Implement energy and utility conservation, infrastructure, procurement, and funding initiatives including program and project development, and detailed reporting.

Program Development uses measured and analyzed data to develop conservation "Shut it off when not in use" and educational "Employee Awareness" programs.

Project Development takes the top energy cost reduction ideas and turns them into detailed business cases, implementation plans, and presentations for administrative approval of resources.

Detailed Reporting provides utility bill analysis, utility use and cost trending, forecasting, energy project tracking, and analysis and recommendations.

Controls and metering systems located in the power plant and facility mechanical rooms facilitate the management of energy usage and infrastructure reliability.