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Greening State Capitols

Securing a Clean Energy Future Initiative

ARKANSAS CAPITOL BUILDINGS

(Office / Legislative Chambers and One Capitol Mall, "Big MAC")

Little Rock, AR

Wal-Mart and the National Governors Association
In addition to Wal-Mart's grassroots efforts to increase awareness among our customers and suppliers about sustainable products, we're working with political leaders to share our experience in regards to energy efficiency within our facilities. This year and next, Wal-Mart is conducting energy audits on 19 state capitol complexes through a new partnership with the National Governors Association (NGA) called Greening State Capitols. The goal: to help states cut their energy use through cost-effective improvements.

As 2008 chair of the NGA, Minnesota Governor Tim Pawlenty made "Securing a Clean Energy Future" his key initiative, with a focus on energy efficiency. The energy audits conducted at state complexes mirror Wal-Mart's existing Supplier Energy Efficiency Program, or SEEP, which is an effort of Wal-Mart's Energy Division. Through SEEP, Wal-Mart shares knowledge with suppliers, helping them to cut costs and reduce emissions. Systems used in Wal-Mart's energy-efficient facilities are applied to the distribution and manufacturing centers throughout the supply chain. SEEP has helped participating suppliers decrease energy use by 20 to 50 percent. Through this NGA partnership, these same principles are applied to state government complexes.

The NGA selected 19 participants based on energy usage and cost data provided by the states. It will be up to each state to determine what, if any, improvements are implemented as a result of the audits. Each state has agreed to submit a report to the NGA's Center for Best Practices to describe any changes made and details of their savings as a result. This information will be distributed to other states in an effort to make these opportunities available to state governments across the country.

The State of Arkansas Capitol Buildings
The audit of the Arkansas capitol buildings took place during one week in September 2008. A team of engineers examined the complex's lighting, HVAC (heating, ventilation, and air conditioning), and building envelope. The audit engineers are employed by P.E. Energy, Inc, a Florida-based company located in the city of Jacksonville, and accompanied by Wal-Mart associates from the company's Energy Department. The audit consists primarily of recommendations for improvements and estimated costs. Most important, we have provided a sense of how much energy can be saved, amount of emissions that can be reduced, and how much money can be saved by implementing the recommendations.

We recognize that state governments have competing annual budget priorities. It is not uncommon to see capital expenditures deferred, forcing facilities staff to prioritize the resources provided to them. In the case of Arkansas's capitol buildings, it is evident that many improvements have been made during renovations or when equipment has reached the end of its useful life. However, Arkansas can recognize substantial energy savings and reduce emissions by implementing these recommendations.

This report summarizes several of the energy-saving opportunities available to Arkansas at the Office / Legislative Chambers within the State Capitol and One Capitol Mall, also known as "Big Mac". Here forward, we will refer to these buildings as "The Complex". This report contains an overview of the major energy reduction opportunities, followed by a project summary that includes the project cost, savings and payback.

Opportunities Identified

- Plug Load
- Lighting & Lighting Controls
- Building Envelope Reinforcements
- HVAC Upgrades
- Water Conservation

Overview

The Complex has excellent energy-saving opportunities. While several opportunities exist, and each has individual merit, all buildings will realize the greatest benefit from a careful and well-planned implementation schedule. The schedule for implementing the following recommendations should first focus on reducing the base energy load, then reducing the cooling load and finally replacing HVAC equipment that has reached the end of its useful life. The new equipment components and system design should support the new, lower cooling load along with forecasted future cooling load estimates.

The quickest way to reduce energy consumption and base load is to address plug load. Plug load refers to any items plugged into outlets. Much of the plug load consists of personal appliances installed in individual work spaces (i.e. space heaters, radios, etc.). While individual appliances have almost negligible power consumption, the aggregate power draw is significant. These appliances hurt energy efficiency in two ways: the electric power they directly consume and the additional cooling load placed on the HVAC equipment resulting from heat associated with the appliances. **Recommendation 1: The State should review and consider improving the enforcement of their policy to reduce plug load. A policy that is backed by Executive leadership can potentially reduce this power draw by 50% or more.**

The next step should be an upgrade to energy efficient lighting. Lighting upgrades are relatively inexpensive and tend to offer a faster payback on capital investment. As discussed with plug load above, old and inefficient lighting causes a double penalty of excessive power draw and requires greater HVAC load. **Recommendation 2: The Complex should initiate an energy efficient lighting project that focuses on eliminating T12 and incandescent lamps, while implementing lighting controls, and daylight harvesting.**

Finally, the Complex can improve the building envelope by replacing all single-paned glass windows. Double-paned glass will repel heat during the cooling season and retain heat in the winter. **Recommendation 3: The State should replace the single-pane windows with double-pane windows throughout the Complex. This will further reduce the cooling and heating load.**

If executed in the manner described above, the Complex can realize a significant reduction in the HVAC load. Certain components of the existing HVAC equipment are at the end of useful life and must be replaced. A detailed analysis of the new cooling requirements along with a forecast of future load will allow procurement of properly sized replacement components.

Plug Load Reduction

- **Projected reduction in electrical plug load costs** — **53%**
- **Projected annual electrical energy cost savings** — **$19,082**
- **Projected simple payback (years)** — **Immediate**
- **Projected annual reduction in CO2 emissions (tons)** — **185.7**
- **Projected annual reduction in methane emissions (pounds)** — **4.0**
- **Projected annual reduction in nitrous oxide emissions (pounds)** — **6.5**

Annual cost savings recurs every year after the implementation of a plug load policy. The savings will fluctuate in relation to electrical energy rates.

General Observations - Plug Loads

The plug load (which includes appliances such as coffee makers, toasters, space heaters, copiers, faxes, computers, monitors, refrigerators, lamps, decorations, fans, collectibles, televisions, DVD/VCR players, etc.) is significant. It is the single largest opportunity to cut energy costs with no capital investment.

These devices individually are almost negligible in terms of power consumed, but together they add up to tens of thousands of dollars in energy costs. Plug load represents a two-fold burden: first, the electric power they directly consume and second, the additional cooling load on HVAC equipment.

There are energy conservation recommendations relative to plug load in the 2008 Minimum Standards section 2-803 Manual Controls. While this is a good start, the development of the policies is at the discretion of the building manager. A more robust plug load policy backed by Executive leadership would help to encourage energy conservation across all state-owned buildings and promote greater compliance from the building occupants. Such a policy would include considerations for the education of building managers, monitoring of energy savings and management practices that encourage less plug load usage, i.e. reduced hot/cold spots, consistent lighting quality, easy to understand signage, etc.

We estimated plug load by surveying representative floors at the Complex. Extrapolated out, this equates to approximately 137 KW of unnecessary plug load. Below is our methodology for estimating the current cost of plug load and the potential savings from a change in policy:

Plug Load	
Estimated Excess Plug Load (KW)	137
Hours Per Year	4,380
Total KWH	600,060
Rate Per KWH	$ 0.060
Total Energy Dollars	$ 36,004
Forecasted Reduction Based On Policy	53%
Estimated KWH Savings	318,032
Estimated Dollar Savings	$ 19,082

Lighting & Lighting Controls

We based the lighting assessment on the operating hours provided for each location.

- **Projected reduction in electrical lighting costs** **66%**
- **Projected annual electrical energy cost savings** **$165,481**
- **Projected simple payback (years)** **2.8**
- **Projected annual reduction in CO2 emissions (tons)** **1,464.7**
- **Projected annual reduction in methane emissions (pounds)** **32.1**
- **Projected annual reduction in nitrous oxide emissions (pounds)** **51.7**

Annual cost savings recurs every year after the project is completed. The savings will fluctuate in relation to electrical energy rates.

P.E. Energy, Inc.
Project Proposal
NGA - Arkansas

Energy Savings	
Existing Annual KWh	2,949,824
Proposed Annual KWh	996,192
Annual KWh Savings	**1,953,632**

Cost Savings		
Existing Annual Energy Cost	$	230,676
Proposed Annual Energy Cost	$	77,902
Total Annual Energy Cost Savings	**$**	**152,774**

Total Project Turn-Key Cost *	**$**	**457,928**

Additional HVAC Savings	**$**	**12,707**

Total Annual Energy Cost Savings **	**$**	**165,481**
Final Project Payback (years)		**2.8**

* Assumes use of customer dumpster for disposal of non-hazardous materials
Does not include any AR state or local sales tax
** Does not include maintenance savings

ALL LAMPS, BALLASTS, SOCKETS, ETC… REMOVED WILL BE 100% RECYLED

General Observations & Work Description – Lighting

Big Mac has already converted some of its older T12 fixtures to T8. However, the majority of the fixtures still use T12 technology. There are also many incandescent lamps in use. The Capitol Building has a similar situation, but they also utilize metal halide lighting.

The Complex should focus on two main areas. First, eliminate all T12 fluorescent and incandescent lighting throughout the Complex. These older technologies are not energy efficient and carry incremental maintenance costs compared to newer technologies. The replacement fixtures or retrofit kits should provide the best solution (lowest energy use) that is practical for a specific area. In other words, "one size does not fit all" and each area should be analyzed and the best solution should be implemented. Second, occupancy sensors can be installed to turn lights on when someone enters a room or hallway. The simple action of adding sensors may reduce energy consumption, but the correct solution is an engineered control strategy that optimizes the combination of sensors and fixtures. An engineered solution eliminates nuisance switching and maximizes return on investment. Most areas in the Complex do not require full lighting when unoccupied. T8 fluorescent lighting systems should replace the existing T12 systems throughout the Complex. Compact fluorescent lamps should replace all incandescent lamps. Finally, all metal halide lighting should be retrofitted or replaced to use energy efficient lighting components.

A typical compact fluorescent lamp typically last five times longer than an incandescent lamp. A typical T8 lamp / ballast system lasts three times longer than a T12 system. These T12 lamps would have to be replaced at some future time. Neither the unavoidable future lamp replacement cost nor the longer lamp life (resulting in maintenance savings) has been included in the cost savings analysis.

The T12 fixtures we inspected had the original magnetic ballasts, which mean that these ballasts are approximately 10 – 20 years old.

Although these older ballasts are still functioning, they are not energy efficient, they reduce lamp life, and the lamps quickly lose their original lumen output, resulting in a "dim" look in rooms and areas that should be bright and conducive to productivity.

The United States Department of Energy has mandated that T12 ballasts may not be manufactured after June 30, 2010. Sometime in the near future, Arkansas must face the cost of replacing these lighting systems.

General Observations - Building Envelope

Windows

The windows in the Complex present an excellent energy-saving opportunity. There were some windows in the Legislative building that are double-glazed and some were not. At Big Mac, some windows were double-glazed and low-e, some were simply double-glazed, and some were single-glazed. We recommend that both buildings replace all windows that are not double-glazed and low-e.

The staff at the Complex is aware of energy efficiency issues as they relate to the windows. There is also an on-going effort to mandate the use of blinds on all windows. Specifically, during the hot months, there is a major push for all offices to leave their blinds or curtains down in an effort to reduce solar gain and reduce the cooling load. However, this effort has only been marginally successful.

During our audit (completed in September), we recorded average inside window surface temperature of over 100 degrees Fahrenheit on the south facing windows. The average temperature in the middle of the area was 73°F. We also noticed many situations where the room or area was unoccupied, the blinds were open allowing the generation of extra surface window heat, and the thermostat controlling the area was set at 65-71°F.

New windows offer better insulation to prevent cooling or heating losses. They allow visible light to come through while blocking heat during the summer and, conversely, keeping the heat inside during the winter. New windows will result in a year-round reduction in HVAC load.

The replacement of old windows with new energy efficient windows should be analyzed before heating and cooling loads are reviewed. The new windows should significantly reduce this load.

Building Envelope TOTAL: HVAC Cost Reduction		
Cost for new windows - Offices / Legislative Chambers	$	500,000
Cost for new windows - "Big MAC"	$	620,000
Total Cost - new windows, both buildings	$	1,120,000
KWH Savings from New Windows		690,000
Energy Rate	$	0.060
Estimated Dollar Savings	$	41,400
Simple Payback (years)		27.1

It should be noted that the payback we have calculated only includes energy cost savings, and therefore, the simple payback is quite lengthy. The current situation mandates action because of structural, maintenance, safety, and energy issues. Both buildings had leaks. While this often becomes much more than an energy issue, these leaks should be addressed. Leaks are often a first sign of a building envelope in need of reinforcement and re-sealing. In addition to any possible HVAC leakage, leaks cause a rise in humidity which leads to many problems, including unnecessary dehumidifier use and a general feeling of being very warm – leading to a lower HVAC setting.

HVAC Equipment

- **Projected reduction in HVAC electrical costs** **$85,000**
- **Projected annual maintenance cost savings** **$123,000**
- **Total projected annual cost savings** **$208,000**
- **Projected annual reduction in CO2 emissions (tons)** **1,169**
- **Projected annual reduction in methane emissions (pounds)** **17.6**
- **Projected annual reduction in nitrous oxide emissions (pounds)** **40.3**

Annual cost savings recurs every year after the project is completed. The savings will fluctuate in relation to electrical energy rates.

General Observations - HVAC Equipment

The Legislative offices have a relatively new boiler. Both buildings have very old chiller units and should be replaced. The air handlers are also old and in need of replacement. Most controls, thermostats, and other equipment are old. The perimeter units are also quite old. Big Mac has three old steam boilers that need replacement. Some of the larger air handler units have variable speed controls. It should be noted that the payback we have calculated is quite lengthy. However, the current situation mandates action to avoid a serious system issue that could cause extended system down time and very expensive repairs.

General Work Description

1. Replace chilling units at both locations, and the boilers at Big Mac.
2. Replace all old pneumatic controls (air-handlers) with direct digital control (DDC) equipment.
3. Replace all old thermostats with digital equipment.
4. All pump motors need variable frequency drives (VFD).
5. Replace perimeter units.

New HVAC Equipment, TOTAL HVAC Cost Reduction	
Upgrade HVAC Equipment - Offices / Legislative Chambers	$ 2,700,000
Upgrade HVAC Equipment - Big Mac	$ 3,540,000
Average Run Hours - Current Equipment - All Buildings	4,600
Average Run Hours - New Equipment - All Buildings	3,450
Run Hour Savings	1,150
KWH Savings Per Year	2,050,000
Energy Rate	$ 0.060
Estimated Cost Savings	$ 123,000
Incremental Maintenance Savings Estimate	$ 85,000
Total Cost Savings Per Year	$ 208,000
Simple Payback	30.0

At the time of the audit, the Arkansas Building Authority had already begun the planning process of building upgrades for the Big Mac.

The three central plant water chillers are to be replaced with high efficiency screw or centrifugal chillers. The plant will contain at least one chiller having a high turndown ratio or variable speed compressor to achieve maximum part load efficiencies. The ABA is also considering the inclusion of a heat recovery chiller and/or thermal storage system for peak load shaving. The pneumatic controls will be upgraded to direct digital controls. We agree with the plans for these upgrades.

The existing steam boilers in the central plant are to be replaced with new high efficiency, modulating water boilers. This will eliminate the conversion process from steam to hot water and allow for the direct generation of hot water. The hot water pumps will be replaced with more efficient pumps fitted with variable speed drives. The new heating system will be tied to a new direct digital control system. We agree with the plans for these upgrades.

Water Conservation

- **Projected reduction water usage per year (gallons)** **610,000**

- **Cost savings per year** **$5,900**

General Observations – Water

Restrooms currently use standard 1.6 gallon per flush (GPF) water closets (toilets) and 1.0 GPF urinals. Some restrooms have auto flush units, and some have manually controlled flush units. Some restrooms have automatic hand wash faucets and some do not. A 100% conversion to automatic hand wash units and a 100% conversion to low-flow flush valves using automated controls would reduce water usage and reduce utility costs.

General Work Description

1. Install dual-flush valves on the water closets and low-flow flush valves on the urinals.
2. Install automated flush controls.
3. Install auto-off faucets on all remaining manually controlled faucets.

While this project would not offer large cost savings or an attractive payback, it does offer an excellent opportunity to conserve water which has many tangible and intangible benefits. We estimate the total project cost at $165,000.

Conclusion

The State of Arkansas deserves commendation for their hard work and dedication to the maintenance of the Complex given a constrained budget. There is obviously awareness and action, showing an appreciation for energy conservation. During our site visit, we recommended that the cold water storage temperatures be lowered during night hours so as to (1) reduce peak demand energy usage and (2) take advantage of cooler conditions. Jim Comer has already implemented this recommendation.

We also recommend that all new construction and renovation projects include the mechanical and energy engineering teams that maintain the buildings during the design phase.

To garner support for the capital investment necessary for further energy retrofits, Arkansas may want to install the recommended projects incrementally, then monitor and verify the savings from each project. Reducing plug load is an immediate, no-cost project that will provide measurable results. The lighting retrofit is a low-cost project with a relatively quick payback. These two projects should provide evidence of money well-spent and encourage further energy efficiency funding. The implementation of these four building components (plug load, lighting, building envelop, and water) will help lower the HVAC load and guide the continued HVAC upgrades with proper specifications.