Controlling Energy Costs With Best Energy Reduction Tools (BERT)

Executive Summary:

As companies, consumers and the country look for ways to save energy and reduce pollution, increased attention will be focused on new ways of controlling the energy use of the legion of smaller electrical loads which now represent the major source of growth in total energy use. While energy managers have been quick to identify and automate large sources of energy use (like HVAC), controlling many smaller devices spread throughout a building is difficult to do. The promotion of 'good habits' like turning off lights and computers may have short term impacts, but sustaining these types of activities over time has proven to be difficult. This paper describes a new approach to facility energy management that leverages a building's existing WiFi network to control end uses throughout a building. By connecting 'smart plugs' to a web-based software interface, energy managers can program schedules by end-use that control energy consumption during times when facilities are not being used. Case studies of university, office, restaurant and residential applications illustrate a range of ways in which the technology can be used. The end uses described in these cases average a 6 month payback. If widely adopted, the control of 'small use' devices could save approximately 461 million kWh and 632 million pounds of carbon annually.

Section 1: Introduction

As energy prices increase and companies and organizations place increased focus on the environment, facility energy managers are challenged to find ways of controlling the energy use of an ever-widening variety of electronic devices. While most managers have made significant strides increasing the efficiency and control of major end uses like HVAC, a large portion of each facility's bill is spent on 'the little stuff'—computers, lights, and other relatively new electronic devices. This paper describes and documents a new patented technology that utilizes the existing WiFi infrastructure to control devices throughout a facility. Section 2 describes the explosion of electronic devices, which represents both a significant growth area for energy demand as well as a new, untapped opportunity for savings. Section

3 provides an overview of past attempts to control diffuse devices over networks, and provides a glimpse into the future of 'smart' appliances. Section 4 describes a new technology called "BERT", for Best Energy Reduction Technologies. Particular focus is placed on how the software interface allows for the individual control of virtually any device. Section 5 describes how the technology can operate within a university, office, restaurants and in residential applications. Section 6 concludes by documenting the savings potential of the technology in several key sectors, and illustrates the potential for this type of technology to transform how energy use is managed in homes and businesses.

Section 2: The Electronics Explosion: Growth and Savings Opportunity

Despite the increased efficiency of a wide variety of many electronic devices, efficiency gains for many facilities have been countered by a proliferation of new devices. Spending on PCs continues to be strong, growing 22.7% in 2010 according to iSuppli, a company that tracks technology sales. According to the Department of Energy's Building Data Book, total energy use for computers rose 43% between 2006 and 2010. Even more startling is the growth in uncategorized uses, which jumped 663% during the period[1]. The increasing number of peripheral devices, from iPhones, to video conferencing equipment and large format LED and plasma displays all add up. Energy use at work is clearly on the rise, despite the increased efficiency of new equipment. Similar growth is taking place residentially. According to the Nielsen Television Audience Report[2], the number of TV's per household is now 2.86, jumping 43% since 1990. In addition, 88% of homes have a DVD, over 80% of homes have a computer, and of those homes 92% had internet access[3].

A byproduct of the proliferation of devices is phantom load. Phantom load refers to energy that is used when a device is off. This includes energy used by TV's when they're in standby mode (i.e. when they can be turned on with a remote), and energy used by chargers or a laptop's AC adapter. Studies estimate that phantom load now accounts for 6% of all energy use.

This increase in energy consumption has been made worse by increases in price. Recent data from the Department of Energy shows that average electricity prices have increased in all three sectors (commercial, residential, industrial) between 2009-2010[4]. The lifting of rate caps in many states has already lead to dramatic price increases. Electricity rates have already increased 39% in Maryland, 21% in Illinois, and are projected to increase 40-70% in Pennsylvania.

With the increasing number of devices, many facilities managers must rely on people to remember to turn out the lights, or unplug their printers when not in use. However this is easier said than done. A

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[1] http://buildingsdatabook.eren.doe.gov/docs/DataBooks/2009_BEDB_Updated.pdf

[2] http://blog.nielsen.com/nielsenwire/wp-content/uploads/2009/07/tva_2008_071709.pdf
[3] http://blog.nielsen.com/nielsenwire/online_mobile/home-internet-access-continuing-to-grow-but-big-differences-among-demographics/
[4] http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html

study conducted by the Alliance for Efficiency found that the impact of behaviorally-based conservation programs wanes within a year, even when education campaigns are ongoing[5].

Section 3: The Device Control Industry: Past, Present and Future

Home automation and control technologies have been around for years, and have the potential to reduce the energy used by a wide variety of devices. Pioneers such as X10 created a communications protocol that used in-home electric wiring to transmit commands to compatible devices. These technologies have advanced over the years to utilize wireless transmission (for example, X10 now uses 310 MHz radio frequency to transmit commands to specially equipped devices within the home.) While significant effort has been put behind these technologies a host of problems have hindered widespread adoption, including unreliability due to wiring impedance, slow response time, and interference with/from other household appliances and devices. Despite the apparent allure of ubiquitous electrical wiring, X10 lacked the ease, reliability and security needed for the product segment to grow.

Individual manufacturers, such as Lutron, have created proprietary high-end home control products intended to provide high levels of control, allowing the programming of lighting 'schemes', and the integrated control of equipment throughout the home. These high cost end-to-end solutions provide an interesting niche product for high end or specialty customers, but do not appeal to the mass market. At the other end of the market, products like Belkin's Conserve[6] Surge With Timer builds a timer into standard surge strip allowing an individual user to set the strip to turn off during select hours.

More recently, the Zigbee suite of proprietary communications protocols has made an appearance in the home control market. Under the Smart Energy 2.0 initiative, Zigbee proponents have created a data standard that they hope will be adopted by a potentially large AMI and Smart Metering industry. While the potential of this utility-driven segment is large, its success will rely on the installations of millions of Zigbee enabled electric meters and related devices.

Section 4: What Makes BERT different?

BERT provides a deceptively simple solution to the device control dilemma. First, BERT was built on a large, reliable, existing networking technology- WIFI. Building the control platform on the existing network has several key benefits:

1. Ubiquity: Virtually all homes and businesses are wifi-enabled. This means that any building that has wi-fi can easily utilize a "Plug and Play" BERT device.

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[5] http://www.allianceforwaterefficiency.org/public_education.aspx
[6] http://www.belkin.com/energy/conserve/default.aspx

2. Reliability: WiFi networks have achieved an amazingly high degree of reliability and security. This reliability meaning that the problems of cross-device interference and the lack of security are no longer issues.

3. Cost: Because the wifi network already exists, no special equipment needs to be purchased as would be with proprietary or other standards such as ZigBee. This allows for the lowest total cost solution in the marketplace.

4. Ease of installation and use: The computer-based control software allows devices to be easily programmed or controlled through any computer-enabled device. BERT does not rely on proprietary physical control panels, or specially-wired consoles. Instead BERT takes commands through common MAC, PC or Smart Phone devices consumers and businesses already use.

Figure 4-1 shows how the BERT device works. The Enterprise Application Program (EAP) is installed on one computer on the network, and is used to set schedules, group devices, and monitor activity. On/Off requests are sent through the existing network router using WiFi. Each BERT plug contains a microchip and antenna that communicates with the EAP on a periodic basis. The BERT EAP uses SNMP (Simple Network Management Protocol) to monitor the activity of connected devices (plugs). When a BERT plug receives an “off” command, the module turns off all power supplied to the plug.

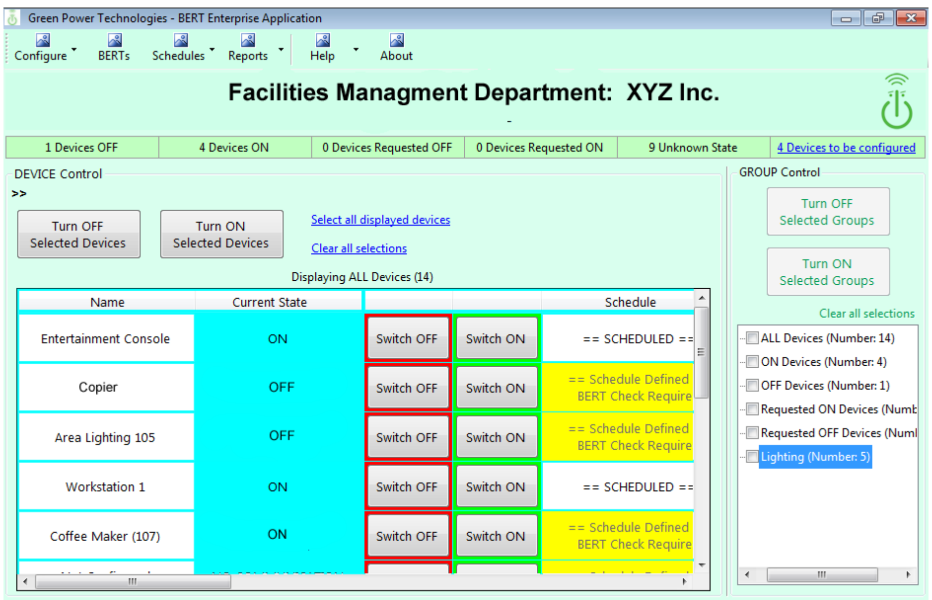
Figure 4-1: BERT System Schematic

The BERT EAP provides a set of tools to configure, schedule and monitor connected BERT devices. The windows based program is installed on a computer within the network (e.g. a facilities manager’s workstation). BERT plug contains a microchip and obtains an IP address from your network. Each BERT device appears on the interface, and individual schedules can be set with multiple on/off periods over a seven day schedule. For example, hallway TV monitors can be programmed to go off at midnight, and on again at 6 am. Multiple TV's can be grouped together to make control and reporting easier. The EAP tracks and reports the status of all devices on the system.

The energy use of each device can also be programmed into the EAP. For example, if the LCD hallway monitor consumes 225 watts of power, then BERT can use this information to track cumulative energy and dollar savings. The BERT reporting interface allows reports for individual devices, groups, or the entire portfolio of devices.

When deviations from standard building schedules occur, devices can be activated in several ways. Most simply, users approaching a BERT device that is it's off state can press a button on the side of the BERT plug and power will be restored to the device. This change of state will be recognized and recorded by the EAP. The device will remain on until the next programmed schedule change. If there are temporary schedule changes for multiple devices, for example if a building is open late for a special event, the facilities manager can turn on/off individual or groups of units remotely. The manager simply selects the designated groups, like Hallway LCD Monitors, and clicks on "Turn On Selected Groups".

Figure 4-2: The BERT EAP Interface



The microprocessors embedded in each BERT plug provide unique protection in the event of a WiFi outage, the shutdown of the management computer, or other interruption. Each BERT unit contains the programmed weekly schedule within the microchip, so if the plug loses contact with the EAP control software it will simply continue to execute its standard schedule.

Section 5: Sample Applications

BERT units can work in a wide variety of applications. This section describes how BERT can operate in university, office, restaurant and residential applications.

University Building:

Temple University's Speakman Hall is an academic building in the middle of campus, and contains a mix of classrooms, public spaces, study areas, and administrative services. The building includes a wide variety of devices that are on 24x7, including hallway announcement TVs, cooled water fountains, office equipment, vending machines, and computer monitors. The building is WiFi enabled. While the University prides itself on having a wide variety of amenities available for students, it also recognizes that many of these amenities use energy round the clock, even when the building is closed during nighttime hours.

Table 5-1: Sample BERT Installation in a University Building

Item Description	Watt Savings	Hours off per day	Number of devices	*Potential energy savings (kWh per year)*
Computer Monitors	65	8	30	5,694
Vending Machine	400	8	2	2,336
Water fountain (cooled)	60	8	24	4,205
Copier	5.26	10	2	38
LCD TV	225	10	12	9,855

Table 5-1 shows modeled energy savings for 70 BERT plugs installed in a single academic building over a 1 year period of time. This application saves 22,128 kWh and $3,983 per year.

Office

An office has 30 workstations (each with a computer, monitor, printer and cell phone charger), a water cooler, copier, and a TV screen in the company lobby. The office manager installs a BERT plug at each workstation, and various other devices. The manager schedules the BERT devices to go off for 12 hours each night, when the office is closed.

Table 5-2: Sample BERT Savings In A Small Office

Item Description	Watt Savings	Hours off per day	Number of devices	*Potential energy savings (kWh)*
Workstation	48.51	12	30	6,374

Water cooler	60	12	1	263
Copier	9.63	10	1	35
LCD TV	225	10	1	821

Table 5-2 shows modeled energy savings for 33 BERT plugs installed in a single office over a 1 year period of time. This application saves 7.493 kWh and $1,349 per year.

Restaurant:

A sports bar features a large number of flat screen TVs so that patrons can view their favorite sporting events from virtually any seat. The restaurant owner configures BERT so that the closing manager can turn off all BERT devices as part of the nightly shut down procedure. BERTS return to service when the opening manager returns in the morning.

Table 5-3: Sample BERT Applications In A Restaurant

Item Description	Watt Savings	Hours off per day	Number of devices	*Potential energy savings (kWh)*
Register Stations	48.51	14	3	744
Bar lighting	65	14	5	1,661
Vending Machines	400	14	4	8,176
LCD TV	225	14	20	22,995

Table 5-3 shows modeled energy savings for 33 BERT plugs installed in a single restaurant over a 1 year period of time. This application saves 33,882 kWh and $6,099 per year in energy.

Residential:

A homeowner buys four BERTS to control a computer workstation, entertainment center, area lighting, and kitchen appliances. The homeowner programs BERTS to be on during the times when family members are typically using the equipment; the coffee maker goes on in the morning, while the computer station is active in both morning and evening hours.

Table 5-4: Sample BERT Residential Application

Item Description	Watt Savings	Hours off per day	Number of devices	*Potential energy savings (kWh)*
Light	60	14	1	307
Entertainment Center	75	16	1	438
Workstation	48	14	1	245
Kitchen	8	20	1	58

Table 5-4 shows modeled energy savings for 4 BERT plugs installed in a single home over a 1 year period of time. This application saves 1,084 kWh and $189 per year in energy.

Section 6: Global Impacts:

The global impacts of the adoption of BERT plugs is significant. For example, one million plugs deployed in applications similar to the ones described above saves 461 million kilowatt hours and over 632 million pounds of carbon per year.

Table 6-1: Potential Energy and Environmental Savings

Number of plugs	1,000,000
Average KWH Savings	461.34
Total KWH Savings	461,335,714
Total Dollar savings	$ 83,040,428
Annual Carbon Savings:	632,029,928 pounds per year

In contrast to existing and emerging technologies described in Section 3, WiFi based devices like BERT provide an immediate opportunity to leverage an enormous existing technology infrastructure to save money, energy and the environment by turning off devices on a controlled, scheduled basis while they are not in use.