Fixing the Power Management Controls Problem

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ABSTRACT

The ordinary person’s connection to an energy-using device is through an “interface.” An interface consists of elements such as terms, symbols, switches, and indicators. If the interface is clear and consistent, users can use the device more efficiently. Power management of office equipment already saves significant energy—over $2 billion/year in the U.S. alone. However, over a third of potential savings are presently lost when power management is disabled, or never enabled in the first place. One reason for the high rate of disabling is the awkward, confusing, and inconsistent user interfaces found on many products. Improving the power interface for future products offers a low-cost way to increase energy savings.

We seek to increase the use of power management by developing consistent and more clear interface elements. Thus, the core of the project addresses terms, symbols, switches, indicators, and the underlying “metaphors” used on office equipment and consumer electronics, rather than energy measurements. Our research suggests that several international symbols related to power control should be changed to better match the most common usage on current products. In addition, we recommend using “sleep” as the universal metaphor for low-power modes, and propose a standard method for indicator lights to communicate power status. A unique aspect of this energy-saving endeavor is that energy technology itself is peripheral, and disciplines such as human factors and product design are at the core.

Introduction

This paper describes an emerging voluntary standard for the user interface elements of power controls. The standard is intended to reduce energy use of office equipment and consumer electronics. The paper begins with the origin of the standards project1, the context within which it exists, and the process by which it is occurring. The core of the paper is an overview of the standard itself. This process may hold important lessons for other energy efficiency opportunities in the realm of user controls.

The electronics industry is notable for its rapid pace of change. Energy efficiency of digital electronics—and office equipment specifically—is no exception to this. About ten years after the general introduction of the personal computer, an efficiency program with wide industry support was launched, namely ENERGY STAR® (Johnson & Zoi 1992). It took much longer for other energy-using devices (e.g. refrigerators, water heaters) to mature to the point where such an effort could be made. Additionally, rather than focus on energy used during operation, office equipment energy efficiency began with the consumption of the

1 All project information is available at:  http://eetd.LBL.gov/Controls
device while it is not being actively used. From an energy perspective, digital electronics was clearly a new type of end use.

The next peculiarity of electronics is the degree to which usage patterns affect annual energy consumption. Thermostat settings affect heating and cooling energy, and door opening changes refrigerator consumption, but the variation in typical consumption is modest. By contrast, user choices about when office equipment is turned on and off, and whether power management capabilities are used have a huge effect on annual consumption.

Another notable aspect of office equipment energy use is economic. The lifetime electricity cost of a computer is usually a small fraction of its purchase price, whereas for a refrigerator it often exceeds the purchase price. This helps explain why for computers, relative efficiency is almost never a purchasing criterion beyond ENERGY STAR labeling.

All of this suggests that we shouldn't expect the major opportunities and obstacles for energy savings in office equipment to resemble those of more traditional energy uses, and experience to date shows that they do not. Our work with power management controls bears this out.

A few definitions will help readers better understand this paper. Except where noted, this paper is concerned only with user interfaces—not mechanisms internal to products that accomplish power management. The “power status” of a device is its basic operating mode, usually on, off, or asleep. “Power management” includes mechanisms that reduce power use through automatic transitions to lower power states. The term “power controls” applies to the user interface, as well as a larger set of operations than just power management, including manual and automatic controls for putting a device to sleep, waking it up, turning it on or off. User interface “elements” are items such as individual symbols, terms, and indicators. “Electronic devices” is the combination of office equipment (e.g. computers, monitors, and printers) and consumer electronics (e.g. audio, video, and telephony equipment).

**Background**

The rationale for the voluntary standard derives from two facts: low “enabling” rates and confusing user interfaces. The disappointingly low use of power management on computers is partly due to factors other than the interface, such as computers that go to sleep but don't wake up and persistent myths about power state changes reducing hardware life. However, a significant portion is still attributable to the user interface problem.

The rate at which power management operates is a combination of whether it is enabled and whether it functions. Enabling can be defeated by operating systems which make it difficult to even have the opportunity to enable (e.g. Windows NT® and most versions of Linux) and conditions which keep a machine awake (such as some network contexts). Our best estimate (Nordman et al. 2000) is that only about 25% of PC systems are

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2 A low-priced monitor left on all the time could use more in electricity than its purchase price. A key point is that the range of annual energy use for computers and monitors is huge, mostly dependent on usage patterns.

3 Beyond asserting that it is non-zero, we have not attempted to estimate the size of the user interface opportunity. Doing this would be challenging and not contribute to developing or marketing the standard. Even a small percentage of the power management “gap” cited below is a large amount of savings, and improved user interfaces have significant non-energy benefits for manufacturers and consumers in ease of use. Cost-effectiveness is not in question. The estimation exercise is simply not worth the effort.
successfully power managing. For monitors, copiers, and printers the rate ranges from 60 to 80%. As of 2000, U.S. office equipment annual electricity use was about 71 TWh/year ($5.7 billion at $0.08/kWh), with $1.8 billion in direct electricity savings from the use of power management, and another $1.3 billion available if 100% of these devices successfully power managed (Kawamoto et al. 2001). Figure 1 shows energy consumption, savings, and savings potentials. Over time, potential savings from power management should grow due to several factors:

- Larger stocks of devices such as PCs, monitors, and printers with power management,
- More time when these are wanted to be available, and so potentially power managing,
- Larger differences between active and low-power mode power levels, and
- More device types, particularly consumer electronics, that are likely to have power management capability.

Contemporary power-related user interfaces are problematic for a variety of reasons. On many devices, power management controls are hidden or difficult to find, and sometimes “protected” by a password. Some PC power controls are found in the Basic Input Output System (BIOS) and so difficult to access and intimidating to many users (these are fewer in recent computers, but some remain). Controls can be “absent,” such as PCs that do not indicate that they are in a low-power mode. Interface problems have been observed in other energy contexts. For example, residential programmable thermostats are for many people too complicated for them to use as currently designed (Nevius & Pigg 2000).

The biggest problem with power controls is user confusion, with a prime example the term “Standby.” In many copiers, “standby” is the power mode in which the machine is fully powered up and ready to copy, but not actively doing so. On computers, it can be anything from a small to a large reduction in power use from fully on. “Standby” is also used for the power consumption of devices in their lowest power state—often their off mode. Many user interface elements vary in meaning from device to device. Figure 3 shows some of the many symbols used for power controls on electronic devices. The result is that individuals cannot

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4 A more recent study (Webber et al. 2001) shows power management functioning rates slightly lower for monitors and higher for printers, but did not assess it for PCs due to user interface inconsistency.
rely on past experience to guide understanding of power controls and so would need to study user manuals to be confident about their usage—something most people avoid doing.

**Figure 3. Power-Related Symbols Found on Current Electronic Devices**

![Power-Related Symbols](image)

**Standard Controls in Today’s Appliances**

Modern society relies on standard user controls in many contexts. One example is the telephone number pad: AT&T was able to dictate the number arrangement and inclusion of the * and # buttons through its market power. However, the company was prohibited by law from specifying particular meanings for these buttons, and this remains unstandardized to this day. This is why voicemail systems are more difficult than necessary to use as the assignment of meaning to buttons varies from system to system. Automobile gear shifts and traffic lights are not identical from model to model, but are built on standard conventions for labeling and positioning that make their interpretation and use so easy as to not require conscious thought.

The goal of the power control interface standard is not rigid uniformity, but simply enough similarity to make figuring out the controls a simple and painless matter. Controls will vary, but be built from a common vocabulary and concepts. Peculiarities of individual devices can be learned by exception.

**The User Interface Context**

The interface problem, and the potential for standardizing power-related controls, became apparent in the course of studying energy consumption of electronic devices. It may be that no one would have noticed or cared enough about it in any other context, particularly across device types and brands. Manufacturers pay little attention to power controls, as evidenced by the variety of designs across the product lines of many single companies. Power controls generally do not raise safety concerns—a common compelling motivation for standardization and clarity. Concern for accessibility (for the disabled) is growing, but has not led to any standards for power controls. The academic literature on controls and interfaces is large and rich, but seems not to include studies on mundane power controls. To be fair, prior to electronics, most devices were only on or off, and obviously so.

A peculiar aspect of power controls is that they are independent of the function of electronic devices, which is usually to process or manage information. By contrast, for most energy-using devices, such as lights, the functional controls drive the power status directly.
Power controls are present in nearly all electronic devices (watches excepted), whether they are powered from batteries, regular AC power, or both.

Most labeling programs such as ENERGY STAR don’t address the user interface. The Microsoft “Designed for Windows®” logo program has requirements about (non-power) user interfaces. One source of power management user interface design is the direct importing of ideas and terminology from internal implementations. While sometimes appropriate, technical terms are often poor choices for general-purpose user terms. Some interface elements come from technical standards, and others from the whim of product designers.

The Standards Development Process

A key principle of the project is that the resulting standard be voluntary, for at least three reasons. First, it is much easier to get industry interest and cooperation with voluntary programs—mandatory requirements are opposed reflexively. Second, many aspects of user interface design do not lend themselves well to rigid testing in the way that a quantitative value such as a power level does. Finally, there will be instances in which new product types or circumstances merit a non-standard interface, and such innovation should not be stifled.

For this reason, our project is guided by a Professional Advisory Committee (PAC) made up of individuals from a dozen key companies and other organizations in the office equipment and consumer electronics industries. In consultation with the PAC, we identified 22 distinct topic areas to include in our research. We began with a review of relevant “institutions” such as standards organizations, specific standards, trade associations, labeling programs, industry consortia, and key individual companies. We found several standards for graphical symbols that clearly address power controls for electronic devices, and another for indicator lights. We searched the user interface literature for studies about power controls but found none. We then reviewed the general user interface design literature to identify key principles and insights relevant to power controls. This review addressed the role of inertia in design, approaches to the problem, key principles, the appropriate role of metaphor, how to use modes, interaction and transition design, and use of indicator lights and icons.

While industry participation is critical, we do not rely on the PAC-member companies to carry out the research and development other than to provide limited outreach within their organizations and some essential references and insights. However, their part in advising is essential to the credibility of the effort and to the incorporation of the standard into future products. Since power control standardization (or lack thereof) holds little risk for companies, and is unlikely to deliver competitive advantage, it is difficult for individuals to justify much time expenditure on it. Ultimately, so long as sufficient foundation is laid for adoption of the standard by industry, these factors are not a problem.

The core research data come from a detailed evaluation of power controls on a wide variety of electronic products. While the scope originated in concern for office equipment, the distinction from consumer electronics is less clear over time, and it makes sense for the interface standard to cover both. We have done limited testing of interface elements, and expect to do more. No usability studies related to power controls have been made available.

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5 PAC members are from: Compaq, Dell, EPA (Environmental Protection Agency—ENERGY STAR), HP (Hewlett-Packard), IBM (International Business Machines), Intel ITIC (Information Technology Industry Council), Microsoft, Ricoh, Samsung, Sony, and Sun.
to us by industry, though we know that many of these are quite informal. As these standards are derived from the design of existing products, they benefit from testing done for their design.

An intriguing aspect of the effort is that it is essentially non-quantitative. Measures such as power levels and delay times are outside of our scope. While much of the project is clearly research, work with industry dominates the project. The process has been aided by Berkeley Lab’s long association with the ENERGY STAR program and role in making the energy savings estimates that underpin the project rationale.

The Power Interface Standard

The following standard covers the switches, indicators, and the terms and symbols around them. These are most often found on the outside of devices, but may also show up on software control panels. The standard emerged from our examination of the operation and design of many current products (directly in stores and from user manuals) supplemented by our review of user interface literature. The ultimate form of the standard will include core principles, design comments, and recommendations.

We released initial recommendations to industry contacts (the PAC and many others) allowing eight months for consultation and feedback. While a few manufacturers had specific concerns, the comments were overwhelmingly positive. The standard was approved by the PAC in April, 2002 and the key points are:

- Use only three power states when possible: On, Off, and Sleep.
- Use the word “Power” for terminology about power.
- Drop the $\Omega$ symbol from use and redefine $\Omega$ to mean “power”.
- Adopt the “green/amber/off” color indications for power indicators.
- Use the “sleep” metaphor for entering, being in, and coming out of low-power states; use the moon symbol – $\bigcirc$ – to mean sleep.
- Clarify that “hibernate” is off; a new term is needed.

Three Basic States

Most electronic devices have either two basic power states (on and off) or three (on, off, and a low-power mode). Devices should be limited to these three basic states (and refer to low-power modes as “sleep”), and that any additional states be variants of one of the basic states rather than a fourth state. The purpose is to have indicator colors, capability, switch operation, and overall behavior (e.g. wake events from sleep) consistent within each basic state.

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6 This project has many interesting parallels to the structure and origin of ENERGY STAR® (Johnson & Zoi 1992). That program stresses its voluntary nature and “the flexibility necessary to pursue technological innovation in a rapidly changing industry”. Johnson and Zoi refer to low-power modes as “sleep” and that within the electronics industry, the leadership of a small number of manufacturers can create “a de facto standard”. ENERGY STAR also “Maximize[s] manufacturer input; … [is] applicable to next-generation computers not yet designed; … the framework [is] transferable to other types of office equipment” and notably “easy for computers to understand”. A final design feature of ENERGY STAR is the narrow focus on one topic.

7 We use the words “state” and “mode” interchangeably and assume no difference in their meaning.
The Term “Power”

For terminology about power controls, manufacturers should use the term “power”—“power button” (or power switch), “power indicator”, a “power” control panel, etc. With the new “power” symbol – ⚡ – the word need not be used on the hard interface itself as is often the case today. A standard translation should be identified for each language. “Power” in English may merit becoming an international standard word.

Power Symbols

The most common and prominent power control is an on/off switch with a power indicator nearby. The most common labeling of this at present is the ⚔ symbol, and there seems to be a shift away from the ⚔ symbol. A problem for designers is that the standards lack guidance on how the symbols should be deployed on products. The official definitions are presented in Table 1.

Table 1. IEC Symbol Definitions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
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<tbody>
<tr>
<td>⚔</td>
<td>Stand-by: To identify the switch or switch position by means of which part of the equipment is switched on in order to bring it into the stand-by condition.</td>
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<tr>
<td>⚔</td>
<td>“ON”/“OFF” (push-push): To indicate connection to or disconnection from the mains switches or their positions, and all of those cases where safety is involved. Each position, “ON”, or “OFF” is a stable position.</td>
</tr>
<tr>
<td>⚔</td>
<td>“ON” (power): To indicate connection to the mains, at least for mains switches or their positions, and all those cases where safety is involved.</td>
</tr>
<tr>
<td>⚔</td>
<td>“OFF” (power): To indicate disconnection to the mains, at least for mains switches or their positions, and all those cases where safety is involved.</td>
</tr>
<tr>
<td>⚔</td>
<td>Ready: To indicate the machine is ready for operation.</td>
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<tr>
<td>⚔</td>
<td>Pause; interruption: To identify the control device by means of which the run (e.g. of a tape) is interrupted by means of a break mechanism and mechanical disconnection from the driving mechanism which continues to run.</td>
</tr>
<tr>
<td>⚔</td>
<td>Electric Energy: To signify any source of electric energy, for example on devices starting or stopping the production or use of energy.</td>
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We speculate that designers find ⚔ more visually appealing, and it strikes us personally as more connotive of change (◯ seems more static). Another reason for the increasing use of ⚔ is the fact that most office equipment and many electronic devices are still using electricity even when nominally off, and safety standards are generally interpreted to mean that ⚔ applies to this situation. While some devices (copiers) can draw tens of watts of power when nominally off, most devices draw much less. Some devices make this

8 Consumer electronics are typically customized for the country or region of their intended sale, and often use words. By contrast, office equipment is more often marketed internationally and so usually uses symbols.

9 For example, the Exelon corporation chose the ⚔ symbol for its corporate logo when created in an October 2000 U.S. energy utility merger. A FAQ page off the corporate home page (http://www.exeloncorp.com/) states that “It is the international symbol for ‘power on’.”
explicit by using “\(\bigcirc\)” to show toggling between on and a not-entirely-off mode. Several equipment designers have told us that \(\bigcirc\) was used simply because it was most common around their office when the decision was made. \(\bigodot\) is often seen as implying zero W of consumption in off such that the product is safe to disassemble.

The confusion between \(\bigcirc\) and \(\bigodot\) is compounded by two further facts. The symbols are often used interchangeably with respect to their meaning, particularly with both being used for on/off switches. Secondly, the way they are printed often blurs the distinction, with the vertical bar on \(\bigcirc\) sometimes lowered, the one on \(\bigodot\) lengthened, and the circle on \(\bigodot\) nearly closed.

Dropping \(\bigodot\) and redefining \(\bigcirc\) requires changing the ISO/IEC symbol standards (IEC 1998; IEC & ISO 2000; ISO 1989) but is most consistent with current usage on products. The existing symbols were placed in the standards in 1973 (and may have been developed even earlier), before electronic devices commonly had multiple power states.

The most common use of the “on” – \(\bigcirc\) – and “off” – \(\bigodot\) – symbols is as a pair on rocker\(^{10}\) (and similar) switches (this is much better than their use in isolation or in combination with other symbols). We have not identified any reason to change these symbols or definitions. The symbols “ready” – \(\bigodot\) – and “pause” – \(\bigodot\) – may have reasonable use on electronic devices but should be kept distinct from power controls (pause is sometimes used on a reset button). There seems no need to use the “electric energy” symbol – \(\bigodot\) – on electronic devices.

The international standards also have an on-off symbol for “momentary on” buttons – \(\bigodot\). We have not observed this on electronic devices and would recommend against it. However, it may have good uses in other areas (e.g. heavy machinery).

The standards also have versions of the \(\bigcirc\), \(\bigodot\), and \(\bigodot\) symbols for “part of equipment” – \(\bigodot\), \(\bigodot\), and \(\bigodot\) – and symbols for “remote station” – \(\bigodot\) and \(\bigodot\). We have seen these used only rarely on consumer devices and in these applications the distinction from the basic symbols is unlikely to be noticed and hence understood by the user.

Indicators

The green/amber\(^{11}\)/off indicator scheme (for on/sleep/off) is by far the most common, with green/green-blinking/off the runner-up. There are many other indications in current products, most which involve blinking. Green/amber/off has the advantage of clear consistency with the colors used in traffic lights\(^{12}\), with green meaning ‘go’/continue, and yellow indicating caution or slowness. There is an international standard on indicators (IEC 1996) that identifies green as meaning “Normal,” yellow as “Abnormal,” and red as “Faulty” for state of equipment. While it appears that the standard is intended for industrial equipment rather than for consumer use, it is broadly consistent with our green/amber/off convention.

Blinking indications are not to be used for any long-term power state; they can be annoying and draw unwarranted attention. Some current devices use blinking for a transition

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\(^{10}\) Most rocker switches on recent electronic devices in the U.S. are oriented so that on is to the rear or up.

\(^{11}\) The actual colors used on products and terms used in manuals varies from product to product; we don’t ascribe any significance to using “yellow”, “amber”, or even “orange” and use the terms interchangeably.

\(^{12}\) Traffic signals also use position in addition to color to indicate their state. The use of green and yellow can present a problem for many color-deficient people (there are different forms of the condition) for traffic lights and power indicators. Specifying precise color spectra for each alleviates this problem.
state, e.g. “warming up” (or “waking up”) or “cooling down” (as on a projector). An exception to the non-blinking standard for basic states is needed for battery-powered products; some of these conserve power by illuminating a power LED only briefly once every few seconds.

Sleep Metaphor and Symbol

For devices in a reduced-capability, low-power state, the “sleep” metaphor is the most common and clear metaphor used, and is often used in user manuals even in cases in which other terms (e.g. standby or suspend) are used in the user interface.

The idea of “suspending” activity may conjure up a clear idea, but is problematic as some devices (e.g. a printer or copier) have a mode of activity or inactivity separate from whether the device is globally awake or asleep. There is also no obvious visual analog to suspend, nor are the verbal extensions appealing (“going into suspend”) or obvious (e.g. “resuming” from suspend). The term “standby” does not seem to reside within a single obvious metaphor, and is problematic due to its many diverse meanings.

The metaphor manifests itself as: the term “sleep” which can be used on graphic displays to show a low-power mode, and in control panels; the “moon” symbol\(^\text{13}\) for buttons that manually put the device into or out of the sleep mode (or, rarely, for a sleep indicator separate from the power indicator); and the phrases and ideas of “waking up” and “going to sleep”. The moon symbol — \(\odot\) — is the most common graphic representation of sleep. There is no similar symbol on products that it could easily be confused with, and it meets the simplicity criterion of symbol design.

Hibernate

Traditionally, computers always shut down and restarted the operating system when turning on and off. In contrast, smaller devices such as personal digital assistants retain their state through off/on cycles. As more people use mobile PCs and as operating systems become more reliable, the capability to save a computer’s state to a hard disk before turning off rather than shut down the operating system is present and used more often. The most common term for this is “hibernate” though others such as “non-volatile sleep”, “suspend to disk”, and “checkpoint” are also used.

Information about hibernate presented to users in the interface and documentation is often confusing. Because the system state is retained and hardware changes such as adding memory are not to be made during hibernate, users are often told that it is a form of sleep. However, the system is electrically off, responds the same as the traditional off, and generally will have no indicator lights on. So, hibernate is a form of off and needs to be communicated to users that way. Because the term “hibernate” suggests a very deep sleep, it should be phased out of usage. In time, it may be rare to restart the operating system when turning a PC off so that hibernate can simply be called “off” with a special term applied to the shutdown off.

\(^{13}\) It does not appear that the meaning of the moon within Islam makes this usage problematic in the way that, for example, using a Christian cross for sleep would. However, use of stars with the crescent moon should be done with caution, as that makes it more specifically the hilal of Islam and less an ordinary crescent moon.
Implications of the Standard for Manufacturers

The goal of the standard is to affect the design of new products—there is no need to retrofit older ones though operating system upgrades could accomplish this for some computers.

Implications for hardware. Many electronic devices already use \(\odot\) for power buttons, and nearly all refer to this as the “power” button and indicator. Most PCs with a sleep button already use \(\odot\). The standard does not address whether a sleep button should be present, but rather only its name, icon, and behavior. There should be a standard function key as a default sleep button for PCs without a separate sleep button.

Some devices will need to convert from a green-only to a bi-color (green/amber) LED, but the incremental cost for a bi-color LED is only on the order of \$0.02. Sleep indicators separate from power indicators (these are rare) may need revision of their labeling or behavior. Device should be checked to insure that they react the same way to user input in all sleep modes for consistency of experience.

Industry specifications and requirements (such as for logo programs) should be amended to implement these recommendations, with changes flowing from recommendations to requirements over time as manufacturers are able to readily implement them.

Implications for ACPI. The Advanced Configuration and Power Interface (ACPI) specifies how different parts of a PC system work together to accomplish power management and other features (Compaq et al. 2000). The advent of ACPI was a huge step forward in the internal support for aggressive PC power management, and while its construction aides standardization of the user interface, it needs slight modification. For example, the ACPI specification is ambiguous on whether the S4 state (“hibernate”, though ACPI does not use this term) is a form of sleep, of off, or a fourth basic system state. Another needed change is an optional indication for powering down (going to sleep or turning off) and to expand the “waking up” indication to include powering up from off.

Implications for future operating systems. For all operating systems, initial changes are only in terms and symbols, though forthcoming parts of the standard may extend to default settings and operating system power policies\(^{14}\). The “Power” symbol – \(\odot\) – should be used for control panel icons.

Future computers are likely to have a wide variety of power-related capabilities and potential constituent devices that affect power behavior. It will be an ongoing challenge to give users sufficient control and information to be able to configure their machines to operate as they want without making these overly complex. An increasing amount of power behavior will be adaptive to a wide variety of information about the use context and services being provided.

Implications for graphical symbol standards. The committees that determine the international standards should drop the \(\odot\) symbol from use, redefine \(\odot\) to mean “power”, and

\(^{14}\) Power policies are the decision-making rules that the device uses to determine how to behave under different conditions.
add a new moon symbol – ☽ – for sleep. They should also include a reference in the standards documents to the design guidelines we develop as part of the interface standard.

Next Steps

A further part of the standard will cover dynamic “device behavior”—ensuring that devices respond to different types of input in a way that people expect. We are preparing more detailed discussions of how to implement the standard. As companies begin to use them for their merit, usage will grow towards a critical mass whereupon manufacturers will have an incentive to use them for consistency.

Conclusions

Both the problem of poor power controls and the opportunity for improving them both exist because of unique characteristics of digital electronics. However, there are other areas that may benefit from standard controls, such as lighting, thermostats, and real-time price controls. The standards recommended here should cost very little for manufacturers to incorporate into future products. User energy savings will dwarf this by orders of magnitude, and be supplemented by benefits for both manufacturers and consumers in improved ease of use. Over time, existing non-standard products will largely disappear from common use.

Ironically, we will have succeeded if power controls become more used but less noticed than at present. The goal is to make the controls so ubiquitous and consistent that they recede into the fabric of life and do not call attention to themselves. This will allow people to better focus on actually using devices and facilitate the energy savings at the root of this effort.

Acknowledgements

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