Enabling Green Computing in the Enterprise

How to Maximize the Impact of Effective Power Management with Windows 7

By Andrew J Hacker

Abstract

Optimizing desktop power management is one of the simplest yet effective ways to reduce power consumption in the enterprise. Windows 7 provides an arsenal of power management features, controls and under-the-hood enhancements to both reduce desktop infrastructure energy usage and improve manageability of power policy. Mindteck's Smart Energy Lab conducted extensive research to study Windows 7 power consumption levels running on various hardware platforms under a range of simulated user work patterns to provide insight to CIOs and IT managers on leveraging Windows 7 to implement a comprehensive power management strategy.

Mindteck

Mindteck

Introduction

The motivations for going Green are many. Whether organizations are looking to save on operating expenses, gain competitive advantage by marketing socially responsible initiatives, improve public opinion, or reduce exposure to fluctuating energy prices, Green initiatives are among the top focus areas in more and more corporate IT roadmaps. With Information and Communication Technologies (ICT) labeled the fastest growing segment affecting carbon emissions, implementing energy management strategies and technologies can greatly reduce energy consumption waste.

In 2009, Mindteck's Advanced Smart Energy Lab released a study comparing Windows 7 power management features to Windows XP and found compelling results indicating that upgrading to Windows 7 can help organizations save on energy costs[1]. In an effort to build upon the original research, Mindteck expanded the study this time focusing on the role of Windows 7 in an organization's power management strategy and how different hardware platforms and usage patterns affect power consumption.

What we did

Mindteck Smart Energy analysts quantified power consumption on five basic hardware platforms: a high-end desktop such as those used in engineering design or media processing, both a business desktop and business laptop, a Pentium 4 class business desktop to investigate prior-generation hardware, and a netbook (See Appendix for full methodology and test specifications). To explore the effect of different types of daily work activities on power draw, test designers crafted four usage profile simulations; idle, consisting of no user input and allowing the system to reach steady state after background worker processes complete tasks, low-usage, simulating light work such as typing an email or Internet browsing, high-usage, consisting of more CPU taxing activities such as watching video or other graphical operations, and S3 sleep.

[1] Visit http://www.mindteck.com for original study

Desktop Power Management

Desktop power management is a critical piece of any Green IT strategy. The client PC infrastructure of a 5,000 desktop enterprise, assuming PCs and LCD monitors left in idle state, consumes power at a rate equivalent to the emission of over 4.65 million lbs of CO2 per year*. Manufacturers of PC hardware (chipsets and processors) and core software (operating systems) continually enhance their designs and coding to increase power efficiency and provide customizable profiles to help organizations balance employee productivity and power reduction realizations.

One important component of PC power management is the Advanced Configuration and Power Interface (ACPI) specification. Released in 1996, ACPI defines common interfaces for hardware/device recognition, configuration, power management and monitoring. In addition to device and processor power states, ACPI defines several global states such as the G0 state, or "working", and the G1 state, "sleeping". The two most common G1 sub-states are S3, referred to as "sleep", and S4, "hibernation". Operating Systems such as Windows 7 leverage ACPI controls as well as additional advanced hardware power management functionality to reduce overall power consumption.

* Average business desktop consumes 717.44 kWh at 1.297 lbs CO2 per kWh emitted as a result of electricity generation multiplied by 5,000 PCs.

Mindteck

After collecting baseline power readings, analysts customized power management profiles to achieve several workday power management objectives. User-state percentages were selected to be representative of real world corporate usage patterns based on metrics from Intel's study on Energy-Efficient Performance[2] . Figure 1 illustrates resulting workday profile objectives including: No Workday S3 Sleep, Limited, Average and Aggressive S3, and the assumptions for annual workday versus off-hours breakdown[3]. Analysts also tested a baseline profile that consisted of "Idle" in off-hours and "Idle-Low-High" profile for workday hours.

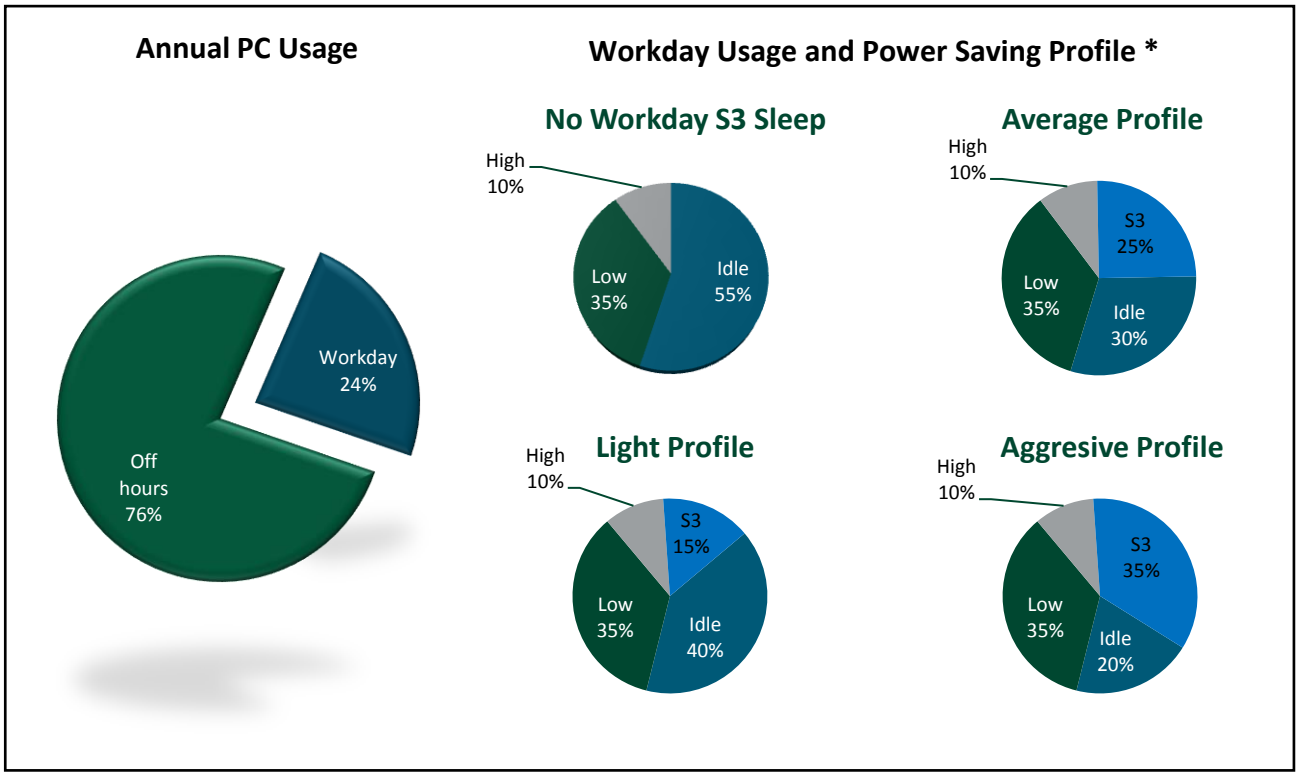


Figure 1: Average Workday Usage Profiles, *All non- baseline workday usage includes active S3 Sleep for off-hours.

What we found

A recent Forrester Research survey indicated that only 13% of organizations surveyed had an enterprise-wide power management program, while another 18% had begun implementing a program but it was

[2] http://www.intelcapabilitiesforum.net/EEP-page_all/ (See figure titled EPP 2.0 Workday)
[3] Workday percentage is 52 weeks at 40 hours/week subtracting 64 hours for holidays and 40 hours for vacation.

not intended for all PCs[4]. Mindteck tests clearly demonstrate the value of an organization-wide power management strategy.

Results show that dramatic cost savings of up to $40.44 (84.46% reduction) per client per year, not including LCD consumption, can be realized by ensuring that desktop PCs or laptops automatically enter sleep states during working hours and at the end of the day if the user forgets to manually "turn off" their PC. Annual electricity cost savings are even more dramatic when taking into consideration the approximately 35W used by our desktop test monitor[5] and can reach $67.72 in savings (82.77% reduction) on older hardware and $58.59 and 82.33%, respectively, on newer desktops (see figure 2).

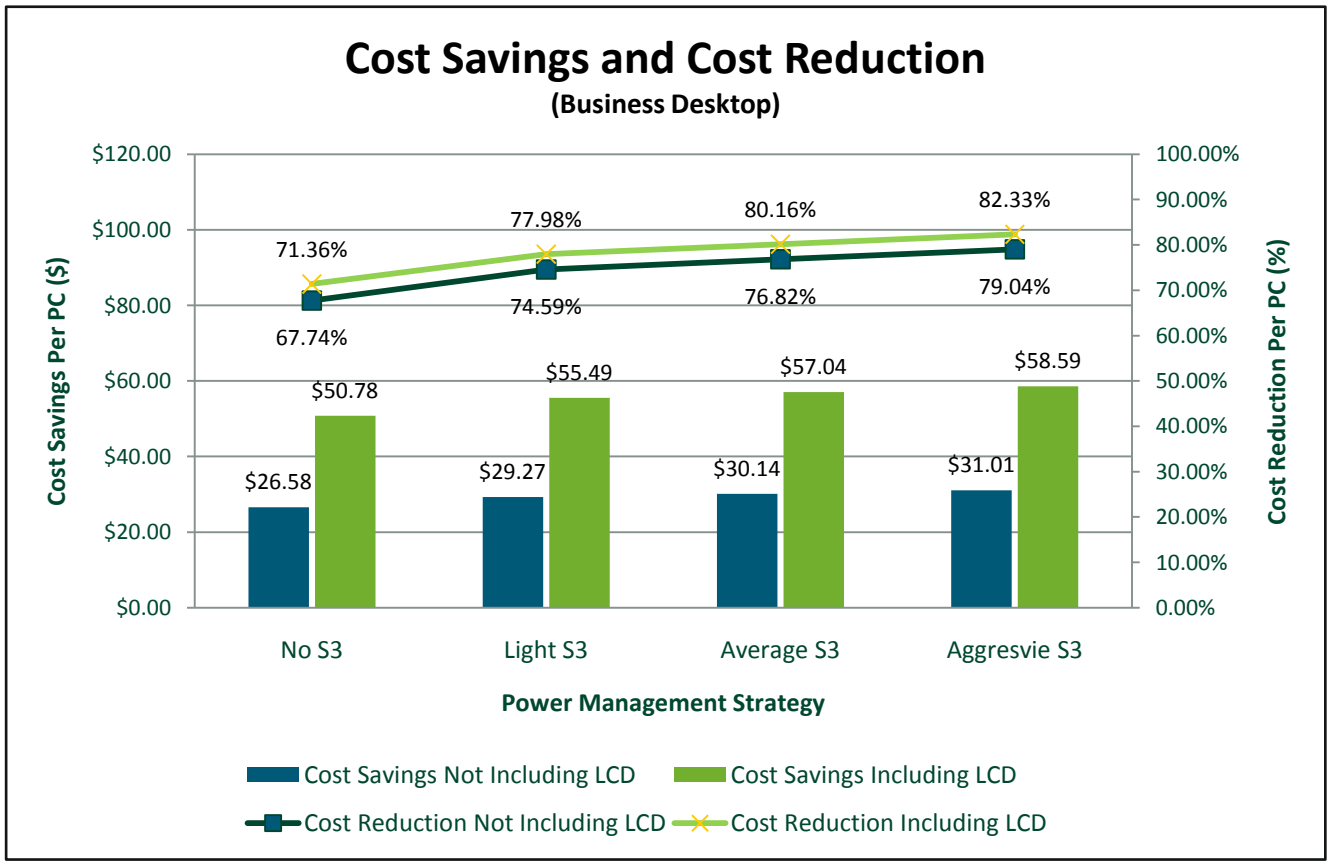


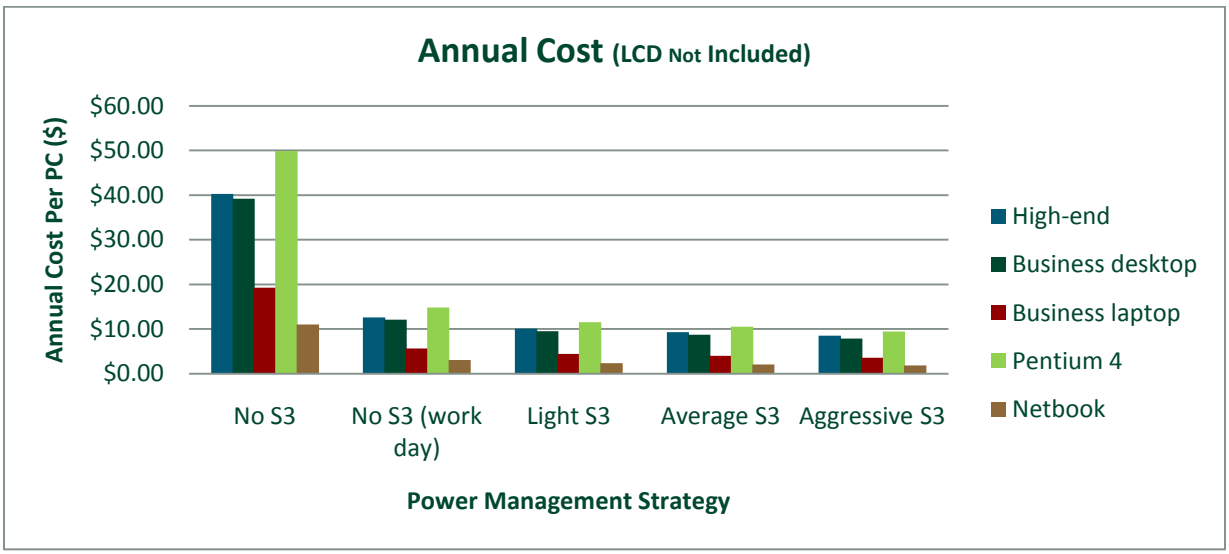
Figure 2: Per PC Cost Savings and Cost Reduction

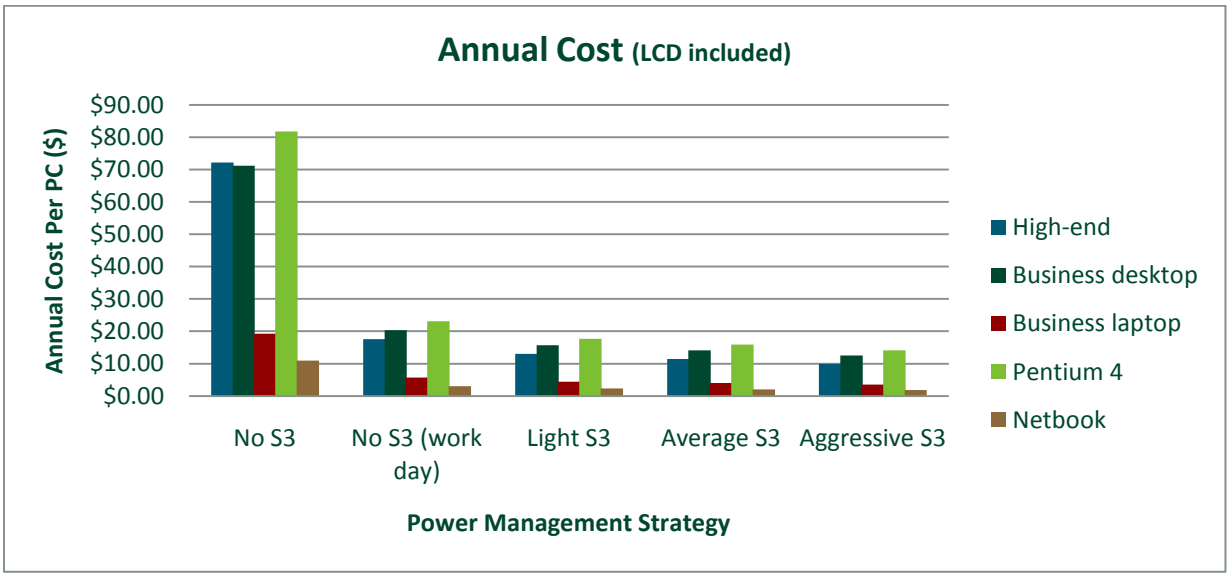
[4] http://www.computerworld.com/s/article/9132338/Forrester_PC_power_management_still_not_widespread_in_IT_despite_recession

[5] LCD power consumption does not apply to laptop and netbook as built-in LCD power is included.

Mindteck

Power reduced states such as sleep and hibernation are an important part of these cost savings and reductions. Idle consumption of the various hardware platforms rages from 12.6 W (Netbook) to 94.8 W (Pentium 4) with LCD and the corresponding S3 sleep states range from less than 1 W to 4.5 Ws (see figures 3 and 4). While the importance of reduced power states to effective power management might seem obvious, what is not obvious is that sleep state usage is not a guarantee. Furthermore, there are certain conditions; both hardware and software related that can prevent a PC from entering these reduced power states. IT Managers should also keep in mind that the sleep setting on Windows XP systems is not always active by default.





Figures 3 and 4: Annual Cost per PC

Mindteck

Windows 7 not only ensures better power settings out-of-box, but also provides significantly more controls to better tailor a power management strategy to business user needs. More importantly, Windows 7 allows client-side centralized remote management and lockdown of power management settings while Windows XP does not.

Mindteck can work with an organization to verify that power management settings are at their most affective and can further tweak default settings to squeeze additional savings. A sampling of results across hardware platforms show that annual cost savings range from $7.95-$40.4, LCD not included, and $7.95-$67.72 including LCD (figures 3 and 4 on previous page). Additional power management customization can provide an additional 2-4% savings.

Projecting Annual Cost Savings

Single PC measurements are useful for comparing power states and hardware efficiencies, however, CIOs need to know how modifications at the PC level will affect overall power usage in the enterprise. Mindteck calculated projected annual cost savings for multiple numbers of PCs using consumption results with and without LCD costs. Using business desktop PCs as the baseline, cost savings range from $14,821 at 500 PCs to a significant $296,426 per year at 10,000 PCs, LCD not included. Savings, including LCD, ranged from $27,739 to $554,772 per year (see figure 5 next page). A full set of numerical results can be found in the Appendix: Test Details Section.

Implementing Centralized Policy Management Leveraging Windows 7

Having an enforced central management policy is critical to an effective power management strategy. Mindteck can work with an organization's IT department to help unsure all systems are properly configured, utilizing advanced configuration and monitoring tools provided by Windows 7 including the powercfg

Power drain: Recommendations for Older Hardware and Windows XP

Windows XP power management functionality, although sufficient at the time of its release, is substandard in today's enterprises. Full power management capability is not activated by default out of box and Mindteck discovered serious power consumption penalties (as high as 25.24% additional power draw) when proper chipset/CPU drivers were not installed on a particular platform. Furthermore, Mindteck tests show that Windows XP uses more power on older machines relative to Windows 7 due to the fact that older hardware does not have the benefit of enhanced chipset/CPU-level power management that comes standard with newer hardware. And as mentioned before, Windows XP does not natively provide remote centralized management of power settings making a full enterprise strategy difficult. (See Appendix for numerical results.)

Mindteck strongly recommends: 1) upgrading Windows XP operating systems to Windows 7 to leverage enhanced power management features at the operating system level, 2) Ensuring machines still running XP have all of the latest device drivers from the manufacturer installed, and 3) Ensuring whatever power management features are available for a particular hardware platform are enabled in the bios, especially S3 sleep.

tool to uncover hardware and software instances that may be preventing sleep states.

Windows 7 has augmented standard power management components such as hard drive spin down and monitor shutoff with a wide range of advanced features. Adaptive brightness that dynamically reduces the brightness of ACPI-aware displays, kernel features that improve the time a PC is in idle state such as Timer Coalescing, Timer Tick Distribution, and enhanced peripheral power state management, all contribute additional power consumption reductions.

When designing an effective power management strategy that utilizes S3 sleep during off hours, it is important to be able to remotely wake PCs during off hours for maintenance processes such as patch application and to provide temporary exclusions for certain projects or having an employee work late. Mindteck consultants can help an organization build an effective power management strategy and implement central management policy enforcement leveraging Microsoft System Center Configuration Manager.

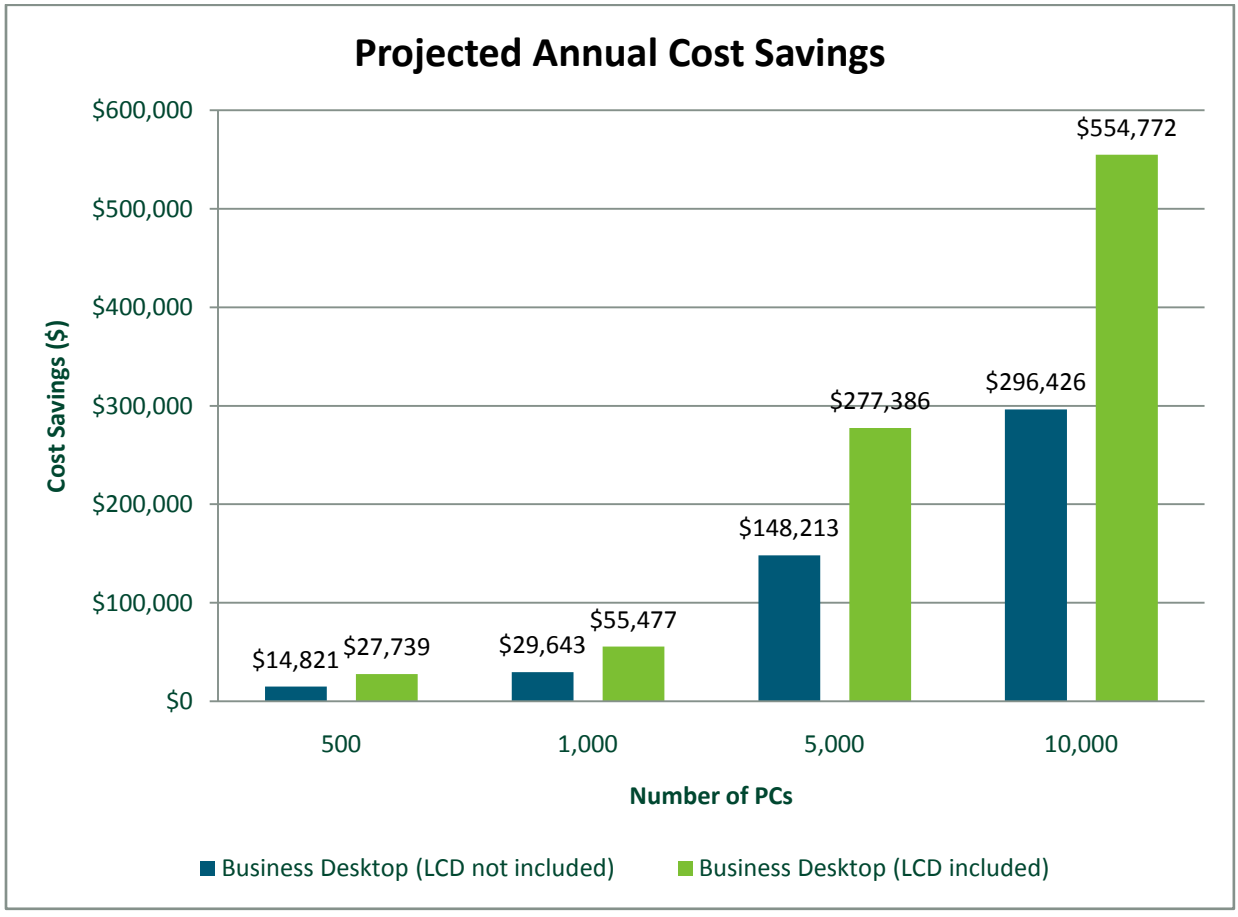


Figure 5: Projected Annual Cost Savings

Mindteck

Conclusion

Implementing a centralized enforceable power management policy can help organizations save significantly on energy costs. Significant cost savings can be realized by ensuring that all PC hardware and software components are optimized to eliminate prevention of low power states. Windows 7 should be leveraged to provide power management control and advanced functionality. Mindteck can help organizations evaluate their current power management posture and provide an end-to-end solution tailored to your business goals. Visit http://www.mindteck.com for more information.

About Mindteck

Global Microsoft Services Ready Partner: As a Microsoft Services Ready partner, Mindteck can bring to the table unique Microsoft-specific Intellectual Property (IP) that has typically only been available to Microsoft Consulting Services (MCS). This deep level of partnership with Microsoft allows Mindteck to bring service offerings (developed by Microsoft subject matter experts) that can help reduce project risk and improve delivery quality through the repeatable application of proven offerings. With regards to the same, Mindteck has access to Windows 7 specific IP, which it can leverage to demonstrate expertise in Windows 7 deployments.

Unique proposition through Smart Energy Lab: Mindteck has thorough knowledge and expertise in one touch deployment of Windows platforms. Mindteck can enable automatic deployment and smooth migration to the Windows 7 platform. In addition, Mindteck has deep expertise in developing and implementing Power Management Policies done in its Smart Energy Lab, which will enable efficient power consumption. Mindteck is thereby positioned to reduce the time to market for the entire end to end solution.

Infrastructure Consulting Expertise: Mindteck has a dedicated IT Infrastructure Center of Excellence which comprises of highly skilled and technologically updated individuals. The Infrastructure team has the capability to evaluate your environment and suggest the most optimal deployment strategy for the Windows 7 deployment and migration in a way to minimize the downtime.

Mindteck

Appendix: Test Details

Test Bed

The test bed consisted of the five PCs (high-end, business desktop, business laptop, P4 desktop, netbook) connected separately when in test to a power strip (see figure 6). The power strip was connected to a watts up? PRO power meter[6]. The LCD monitor used for the desktop PCs was connected to a separate power source except when its power consumption was measured.

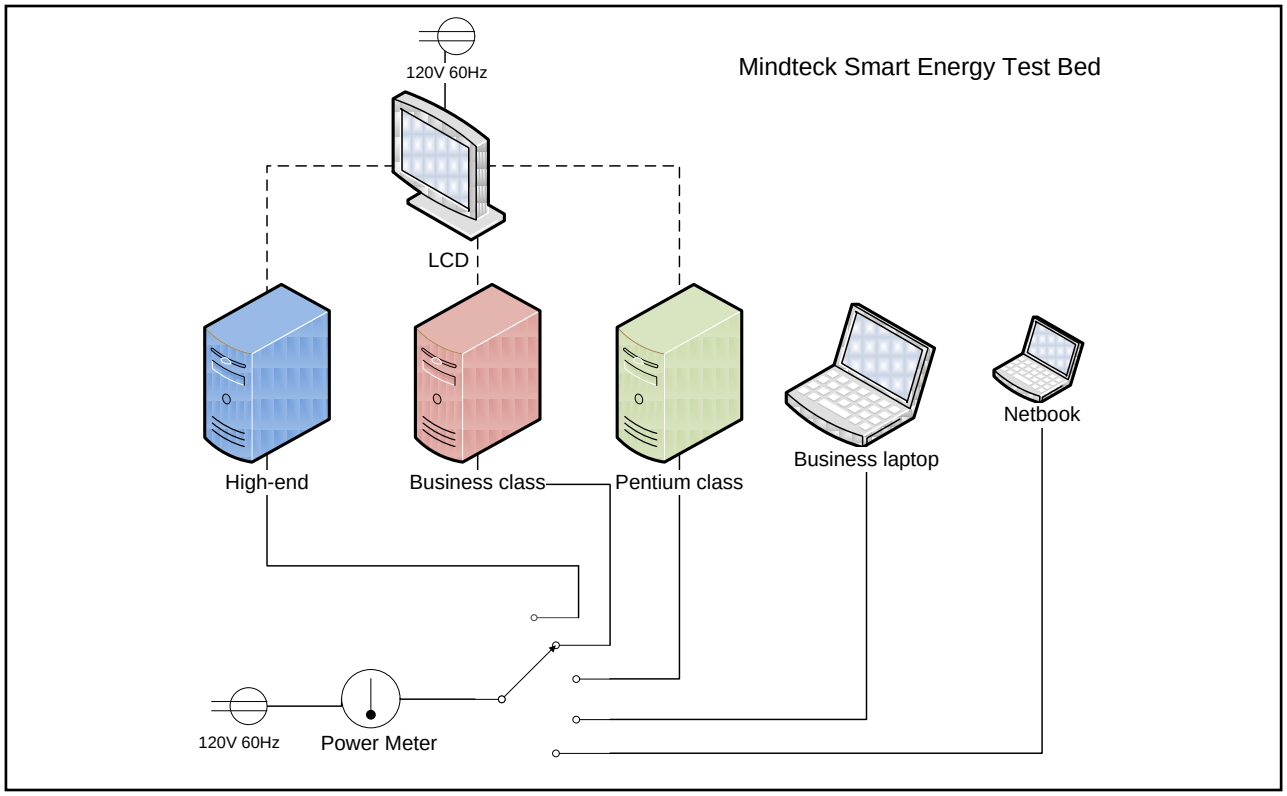


Figure 6: Smart Energy Test Bed

Hardware specifications:

1) High-end PC, HP Elite 7000 MT, Quad core i7 @ 2.8 GHz, 4GB RAM
2) Business Desktop, Dell Optiplex 330, Intel Core2 Duo E4500 @ 2.2GHz, 2GB RAM
3) Business Laptop, HP 6530b, Intel Core2 Duo P8400 @ 2.26Ghz, 2GB RAM
4) P4 Desktop, Dell Dimension 3100, Intel Pentium 4 @ 2.8GHz, 1GB RAM
5) Netbook, HP Mini, Intel Atom N450 @ 1.66 GHz, 1GB RAM

[6] Specifications can be found at https://www.wattsupmeters.com/secure/products.php?pn=0&wai=404&spec=4

Usage profiles:

1) Idle: No user input, no applications running (except default systray), wait 10 minutes for steady state and ensure no processes are accessing I/O.
2) Low-usage: VB Script used to open Excel, write a block of text 988 characters of text, save spreadsheet, pause for 8 seconds using Wscript.sleep (x) function with no CPU impact, repeat.
3) High-usage: Looped full-screen video of 25 MB WMV file played with Windows Media Player.
4) S3 Sleep: No user input.

Test Methodology

For each hardware and usage profile configuration:

1) Clear meter memory (meter set to sample at 1 second intervals)
2) Start meter readings
3) Execute scripts if applicable
4) Collect samples for 10 to 60 minutes depending on power variance
5) Use average of total kWh over time of test sample total kWh/(total time of sample in seconds) = average Watts.

Power calculations

All measurements were taken in Watts (joules/second). The annual cost of 1 W was calculated as follows:

Annual cost per W is 8766 hours/ yr (including leap year) / 1,000 x $0.0973/kWh = $0.8523/W/yr

Annual costs were calculated by taking the individual state power measurements for the applicable hardware and multiplying by the percentages at the various power states for each power measurement profile and multiplying by cost/W/yr.

Numeric Results

Windows 7 Power Consumption (Watts)

	Without LCD				With LCD			
PC Type/Profile	S3 Sleep	Idle	Low	High	S3 Sleep	Idle	Low	High
High-end	2.15	45.20	49.05	66.80	2.15	82.70	86.55	104.30
Business Desktop	4.50	45.90	51.86	83.58	4.50	83.40	89.36	121.08
Business Laptop	0.50	22.10	26.68	29.20	0.50	22.10	26.68	29.20
Pentium 4 Desktop	1.70	57.30	66.07	79.40	1.70	94.80	103.57	116.90
Netbook	0.00	12.60	14.80	17.50	0.00	12.60	14.80	17.50

Mindteck

Annual Cost (USD)

	Without LCD					With LCD				
PC Type/Profile	No S3	No S3 (work day)	Light S3	Average S3	Aggressive S3	No S3	No S3 (work day)	Light S3	Average S3	Aggressive S3
High-end	$40.25	$12.58	$10.11	$9.27	$8.47	$72.21	$17.62	$12.99	$11.43	$9.91
Business desktop	$39.20	$12.09	$9.54	$8.71	$7.89	$71.16	$20.38	$15.67	$14.12	$12.57
Business laptop	$19.28	$5.66	$4.40	$3.99	$3.57	$19.28	$5.66	$4.40	$3.99	$3.57
Pentium 4	$49.85	$14.81	$11.55	$10.48	$9.41	$81.82	$23.10	$17.68	$15.89	$14.10
Netbook	$10.98	$3.03	$2.30	$2.06	$1.82	$10.98	$3.03	$2.30	$2.06	$1.82

Annual Cost Savings for Multiple PCs (USD)

Configuration/# of PCs	**1**	**500**	**1,000**	**5,000**	**10,000**
Desktop (LCD not included)	$29.64	$14,821	$29,643	$148,213	$296,426
Desktop (LCD included)	$55.48	$27,739	$55,477	$277,386	$554,772

Comparative Power Consumption (W) and Improvement (%) with varying driver configurations and older hardware

OS	**Windows XP**			**Windows 7**			**% Improvement Win7**		
PC Configuration	**Idle**	**Low**	**High**	**Idle**	**Low**	**High**	**Idle**	**Low**	**High**
P4 Updated Drivers	64.2	69.7	89.8	57.3	66.1	79.4	10.75%	5.16%	11.58%
P4 Out-of-box	64.2	68.7	106.2	57.3	66.1	79.4	10.75%	3.78%	25.24%
High-end Updated Drivers	47.2	48.0	67.7	45.2	49.1	66.8	4.14%	2.29%	1.33%
High-end Out-of-box	50.5	54.3	78.0	45.2	49.1	66.8	10.50%	9.54%	14.36%

* S3 Sleep not available for XP without updated drivers