California Plug Load Research Center

Computer Power Management: Findings from a Survey and Monitoring Study

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Sponsored by Calit2 and the California Energy Commission



Computer Power Management and User Behavior

Low-power modes exist

- Sleep
- > Hibernate
- Shutdown / soft off
- User controls use of modes
 - Automatic settings
 - Manual options



Most research is device-focused

We focus on user behavior



Sample Results – Five Studies

		Desktops			Laptops		
	Method	Sleep	Off		Sleep	Off	
PG&E / Barr, Harty & Nero	Monitoring, 110,000	1%	5%		15%	22%	Commercial
ECMA-383, 3rd edition	Monitoring, 500	5%	45%		35%	25%	Commercial
Fraunhofer / CEA	Survey, 1000	25%	36%		25%	42%	Residential
Bensch & Pigg	Survey, 1000 + monitoring, 42	51%		71%		Residential	
Chetty et al.	Survey, 20 + monitoring, 38	25	5%		64%	,)	Residential



Research Questions

- What is the enabling rate for power management (PM)?
 - Manual PM
 - Automatic PM
- > How much of the time are computers in user-idle mode?
- What reasons do users give for changing their automatic power management settings, or for not using manual options?
- What else helps explain why some people enable power management more than others?



UCI Computer Use Survey

- Study of UCI population
 - Online survey, May-June 2013
 - Staff, faculty, students, retirees
 - ➢ N = 2,081
 - Variety of departments, schools, and centers
 - User-based approach all the computers a person uses

Main computer types:

- Work desktops 1,041
- Home desktops 599
- Laptops 1,729
- Total 3,369



UCI Computer Use Survey

PM and usage behavior for each computer

- Use of manual PM
- Use of automatic PM
- Whether automatic PM settings were changed
- Hours of use
- Variables that might help explain behavior
 - Reasons respondents give for PM behavior
 - Type of computers (laptops, desktops, home v. work, OS, age)
 - Control over computer (sharing, home v. work)
 - Knowledge about computers or PM
 - Cost (who pays for electric bill)
 - Demographic differences (age, gender, role/occupation)



UCI Computer Monitoring Study

Subsample of survey respondents and their workplace desktops

- March-July 2014
- 125 staff, faculty, and graduate students
- Questionnaire
- Researcher recorded automatic power settings
- Remotely monitored 119 computers for several weeks
 - CPU off
 - CPU sleep
 - CPU on-User active
 - CPU on-User idle



Survey: Reported Average Hours of Use, By Day of Week



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Did Anyone Change the PM Settings



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Control over Automatic PM Settings on Main Office Desktop



Reported Automatic Power Management

"Does this computer automatically go into any of the low-power modes listed below after a period of being inactive or at a specific time? If you aren't sure, read the descriptions and think about how the computer acts when nobody has used it for a while."



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Automatic Power Management from Survey

Percent of computers reported to automatically transition into a low-power mode or shut down



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Reports of Manual Power Management Behavior

When you won't be using the computer for several hours, what percent of the time do you leave the computer in each of these states?



Manual Power Management from Survey

Percent of computers that are manually put into sleep or hibernation or shut down 80% or more of the times that the respondent leaves the computer for several hours



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Combination of Reported Automatic and Manual PM



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Top Reasons Given for Ever Leaving Computer On





Top Reasons for Changing Power Management Settings



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Monitoring Study: Duty Cycle Results for Office Desktops



Monitoring Study: Observed Automatic PM

	Enabled	Disabled	Not available on this OS	Missing data		
Sleep or standby	20%	77%	0%	2%		
Hibernate	2%	57%	18%	23%		
Shut down	0%	4%	82%	14%		
Any PM	20%					
Some rows do not add to 100% due to rounding.						



Self-Reported versus Observed Automatic PM Settings

			Any automatic PM settings enabled in Monitoring Study		
		#	Enabled Disabled		
Any automatic PM reported in Survey	Yes	64	30%	70%	
	No	10	0%	100%	
Overall accuracy rate			39%		

N = 74 who are using the same office desktop in the monitoring study as in the survey, and who report that nobody has changed the PM settings on that desktop since the survey.



Understanding Self-Reported v. Observed Automatic PM

Reporting error

Respondent didn't notice, understand, and remember events correctly

Reporting bias

- Social desirability, self-serving bias
- Demand effects ("helping" the researcher)

Results are more consistent with reporting error than bias

- Research design reduces both types of bias
- > Size of disparity larger than other known reporting biases
- Size of disparity larger for automatic PM than manual PM
- Results suggest user confusion about automatic PM...



Confusion about Automatic PM: Who Gets It Right

- High rates of "don't know" responses for PM, especially for office desktops
- Higher accuracy in reporting automatic PM for respondents with more experience:
 - > Higher self-rated knowledge of power management
 - > More control over office desktop
 - Changed PM settings for office desktop
- Higher rates of automatic PM for these groups





Confusion about Automatic PM: User Interface

- Power plan descriptions did not match underlying (changed) settings
- Automatic hibernation option under "advanced settings"
- Trained researchers had difficulty looking up settings



"Today, personal computers typically support an almost overwhelming variety of power management options...."

-- Chetty et al. 2009



Confusion about Automatic PM: User Interface

If the user has to look up instructions for how to engage PM, PM will probably not be used





Main Findings

- In the survey, most people reported engaging at least one type of PM behavior (automatic, manual, or both):
 - > 88% office desktops
 - > 94% home desktops
 - > 99% laptops

- Monitoring study shows that many users seem to be confused about automatic PM for office desktops
 - Much more accurate for manual PM than automatic PM
 - Probably higher accuracy for home desktops and laptops than for office desktops



Recommendations, Part I

- People are not enabling PM at desirable rates
 - Traditional solutions:
 - Ship computers with automatic PM settings enabled
 - Educate and encourage users







Recommendations, Part II: Issues with User Behavior

Confusion about PM

- > Solution: clearer, more intuitive user interface
- > Knowingly disabling or leaving computers on



- > Solution: solve the problems that users report
 - Faster restart times
 - Better, easier ways to engage remote access and allow automatic backups and updates while in low-power modes
- > PM user behavior much worse for office desktops
 - Solution: more workplace-specific outreach
 - Encourage employees to discuss PM with co-users and IT managers
 - Encourage and motivate IT managers and department heads



Acknowledgements

Special thanks for the support and assistance of:

- California Energy Commission, especially Brad Meister and Ken Rider
- California Institute for Telecommunications and Information Technology (Calit2), especially director Dr. G.P. Li and IT specialist Chris Battista
- Representatives of the Information Technology Industry Council, industry and nonprofit groups who contributed feedback.
- UCI's Office of Information Technology
- Robert Kleppen, Verdiem Corporation
- CalPlug researchers, especially Sergio Gago and the student interviewers and installers, Palak Hirani, Nancy Lo, Amir Samadaghaei, Jimmy Tong, and Crystal Torres.

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