Computer Power Management in Practice:
A Case Study of Office Desktops

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Computer Power Management and User Behavior

- **Goal: reduce energy wasted while device is idle**
- **Low-power modes exist**
  - **Sleep**
  - **Hibernate**
  - **Shutdown / soft off**

- **Users control use of modes**
  - **Automatic settings**
  - **Manual options**

- **Most research focuses on devices**

- **We focus on user behavior**

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Research Questions

➢ **What settings are enabled?**

➢ **Which users are more likely to have sleep enabled?**

➢ **How much does the use of automatic sleep settings reduce the time computers spend in user-idle state?**

➢ **What about manual power management?**

    ➢ **How often are manual options used?**

    ➢ **Are they used as a substitute for automatic settings or a complement?**

UCI Computer Monitoring Study

➢ **Subsample of Computer Use Survey respondents**

  ➢ **Online survey questions about users and their computers**

➢ **Monitoring Study**

  ➢ **March-July 2014**

  ➢ **115 staff, faculty, and graduate students**

  ➢ **Questionnaire**

  ➢ **Researcher recorded automatic PM settings**

  ➢ **Remotely monitored office desktops for several weeks**

    ➢ **CPU off**

    ➢ **CPU sleep**

    ➢ **CPU on, User active**

    ➢ **CPU on, User idle**

Observed Automatic PM Settings

Display

17%

83%

Enabled

Not enabled

Sleep

15%

85%
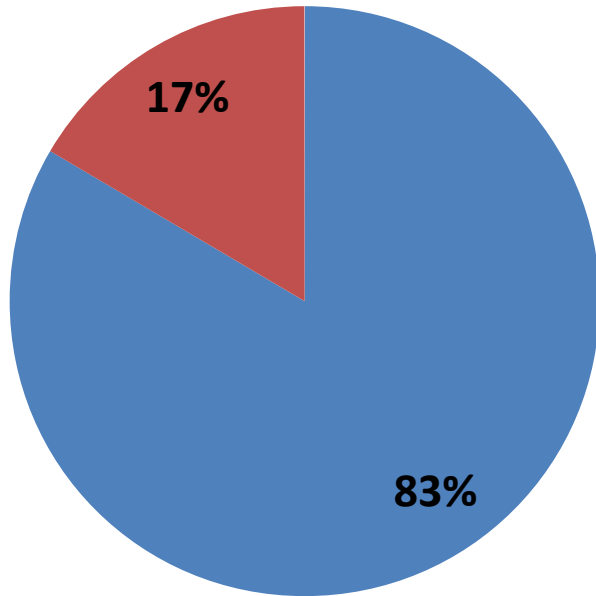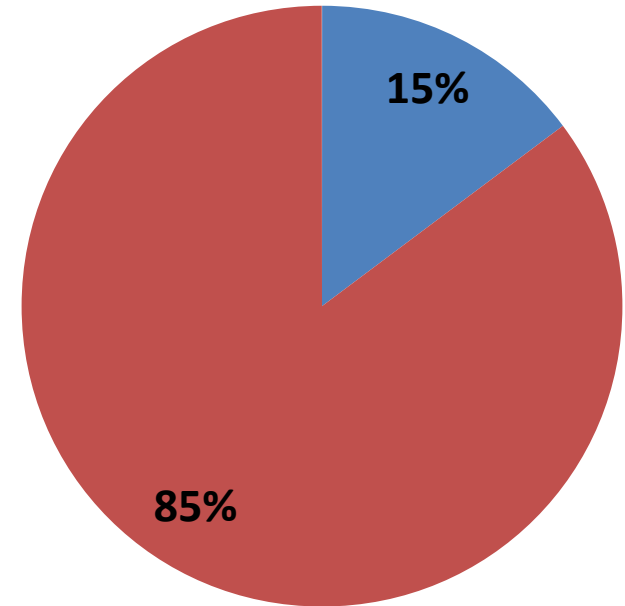
Variation in Idle Delay Before Transitioning to Sleep

	Set length of idle delay before sleep transition			
Sleep enabled	**up to 10 minutes**	**25 to 30 minutes**	**1 hour**	**2 hours or more**
17	5	5	3	4
	29%	29%	18%	24%

Has Anyone Ever Changed the Automatic PM Settings?

Pie chart:
- **I changed** — 35%
- **Someone else** — 30%
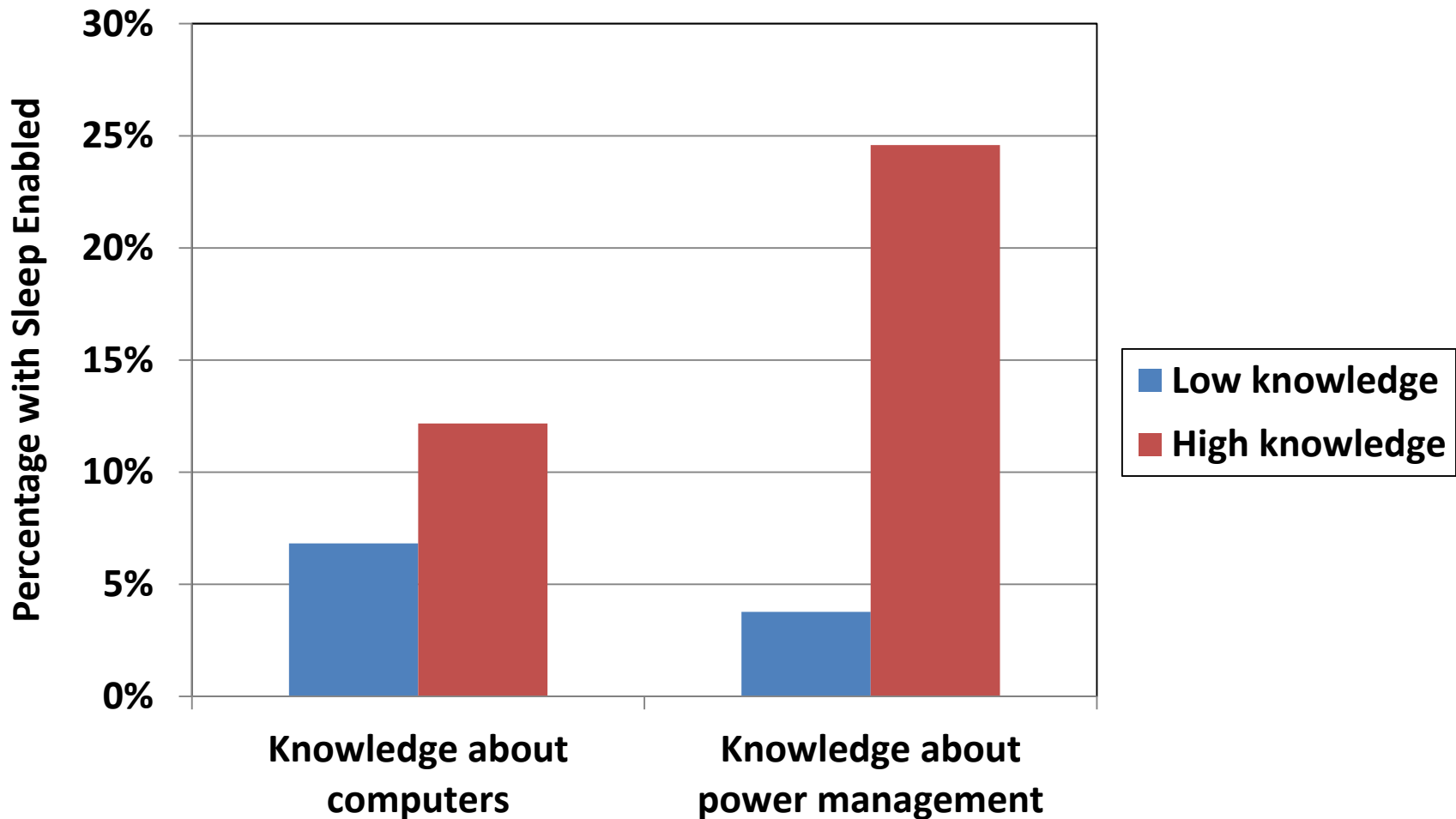- **Nobody** — 18%
- **Don't know** — 17%
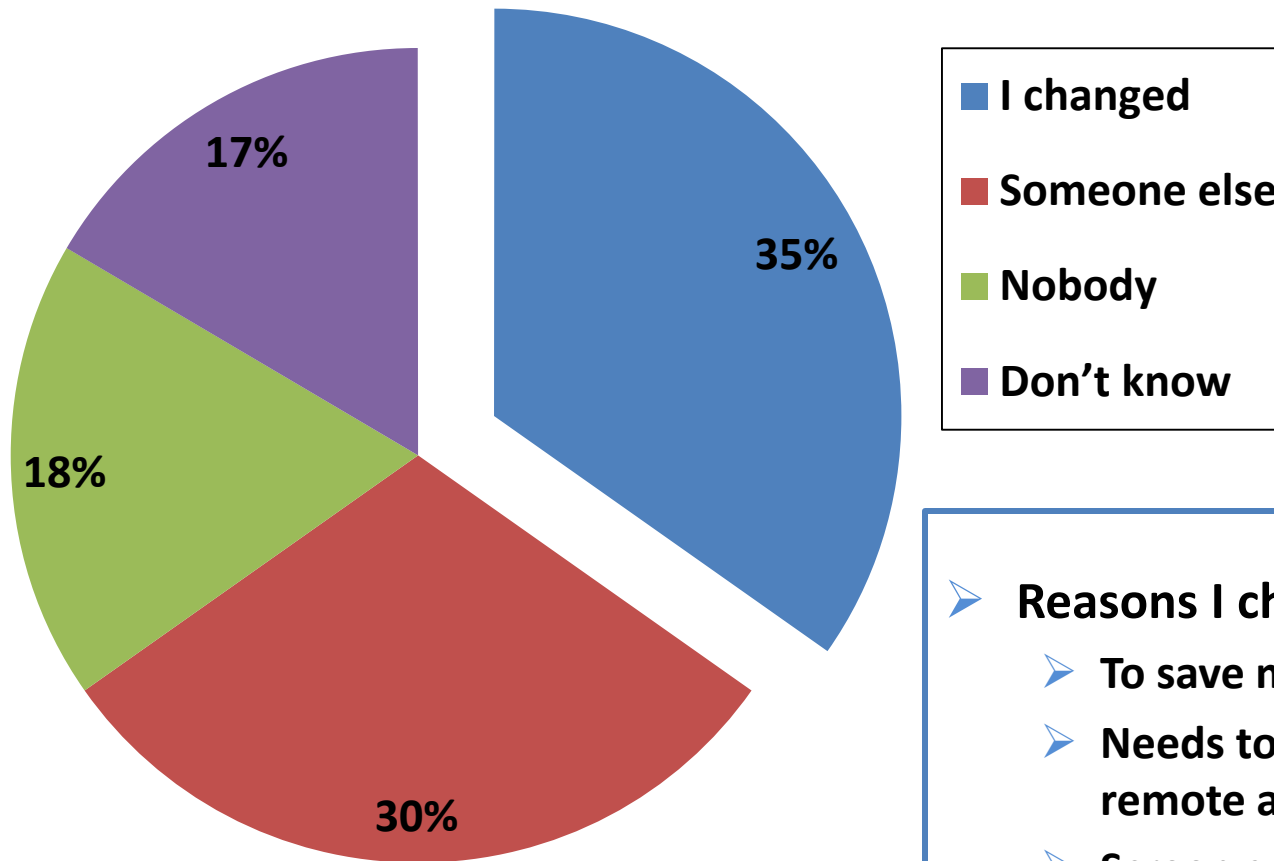
> **Reasons I changed settings**
> > **To save more energy (49%)**
> > **Needs to stay on for backups or remote access (35%)**
> > **Screen going dark too soon (22%)**
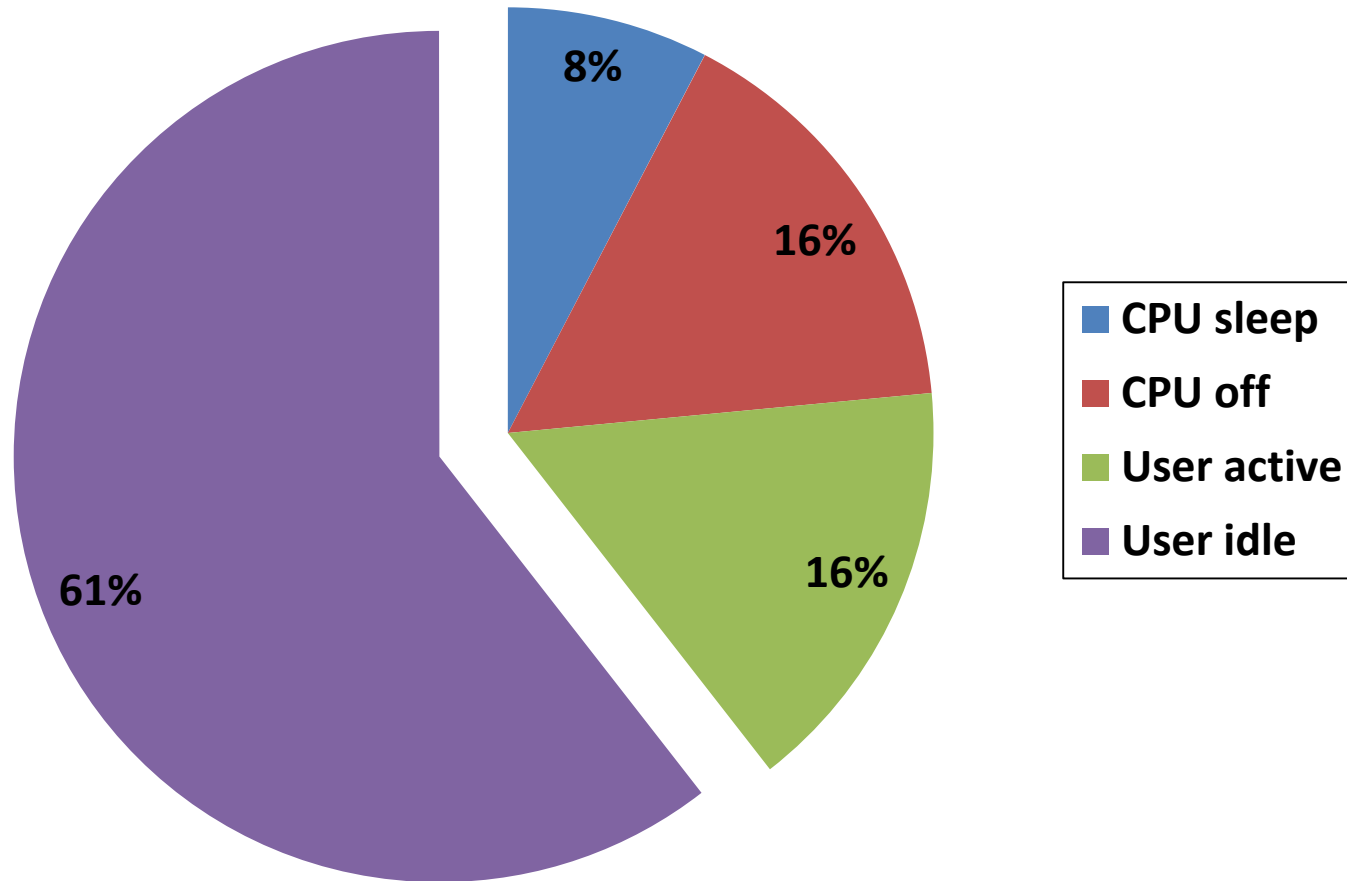> > **I usually return soon (19%)**

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Duty Cycle Results

Pie chart legend:
- CPU sleep
- CPU off
- User active
- User idle

Values shown: 8%, 16%, 16%, 61%

Duty Cycle by Whether Automatic Sleep is Enabled

Chart: Stacked horizontal bar chart showing "Aveirage Percent of Time in State per Day" for three categories.

- **Overall** — User idle: 61%. Annotation with arrow: "Same as pie chart on previous slide"
- **Sleep enabled** — User idle: 15%
- **Sleep not enabled** — User idle: 68%

Legend:
- CPU sleep
- CPU off
- User active
- User idle

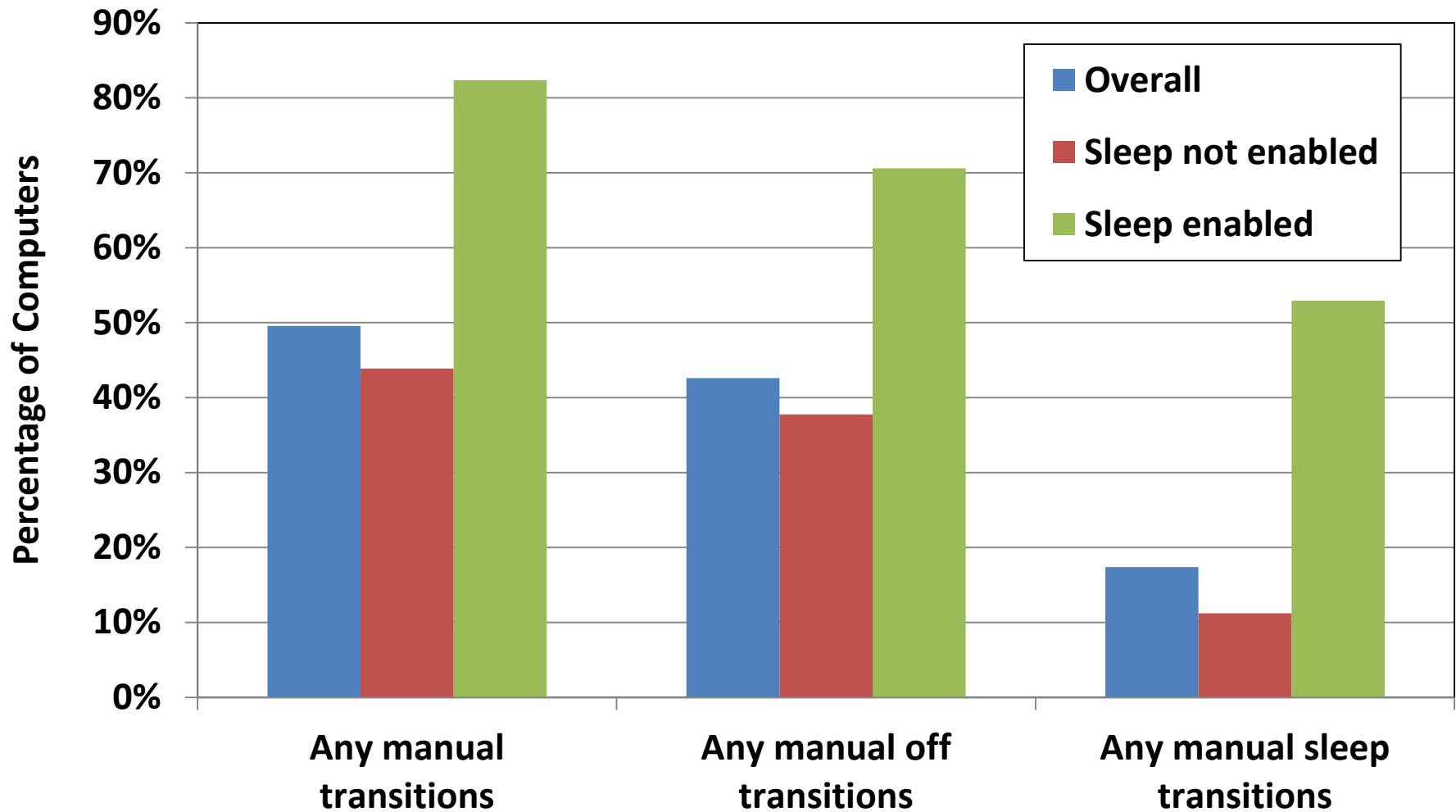X-axis: 0%, 20%, 40%, 60%, 80%, 100% — "Aveirage Percent of Time in State per Day"
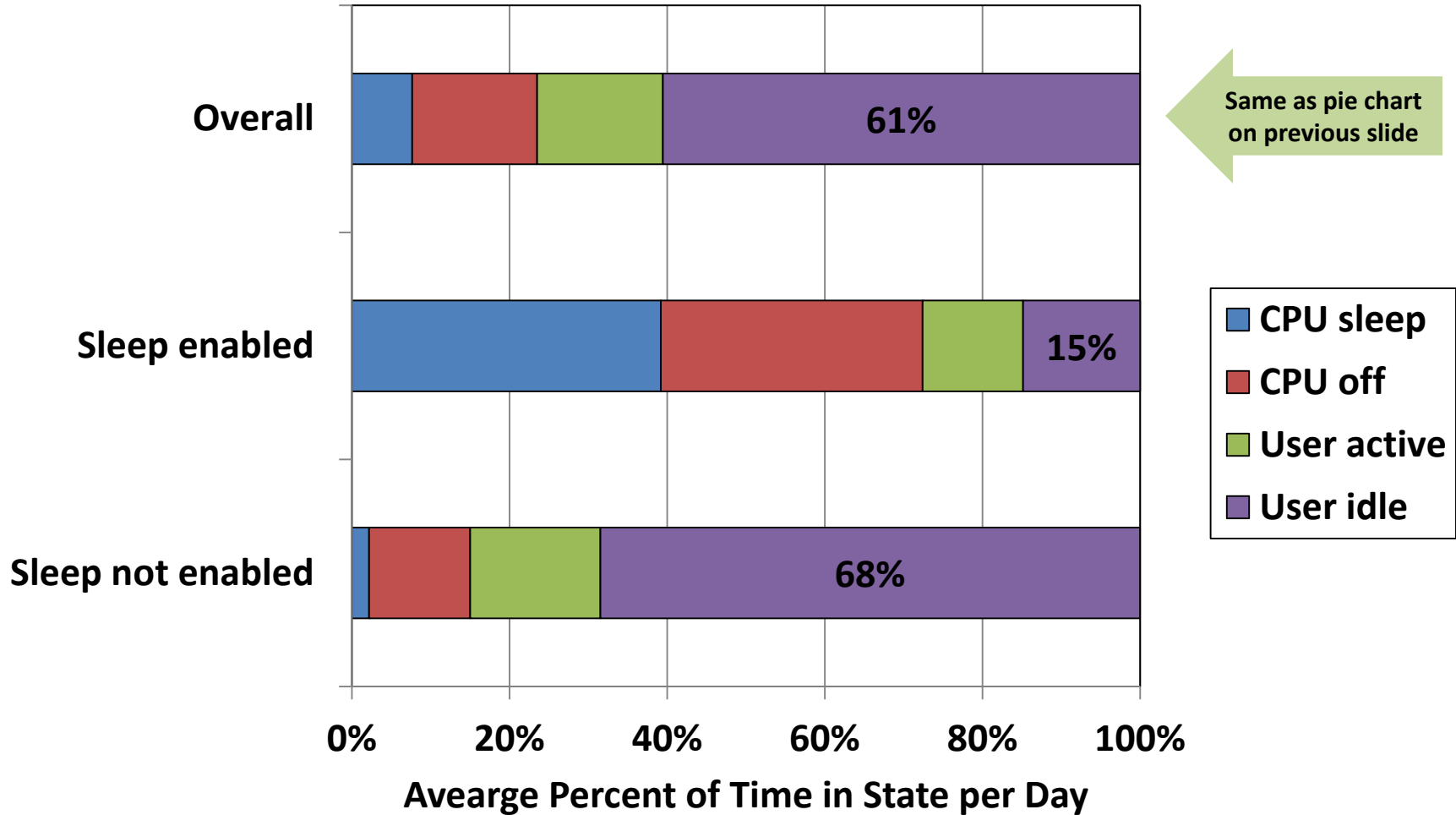
Variation within Computers with Automatic Sleep Enabled

**Percentage of Computers with Sleep Enabled
in Categories of Time Spent in Sleep Mode and User Idle Mode**

Why?
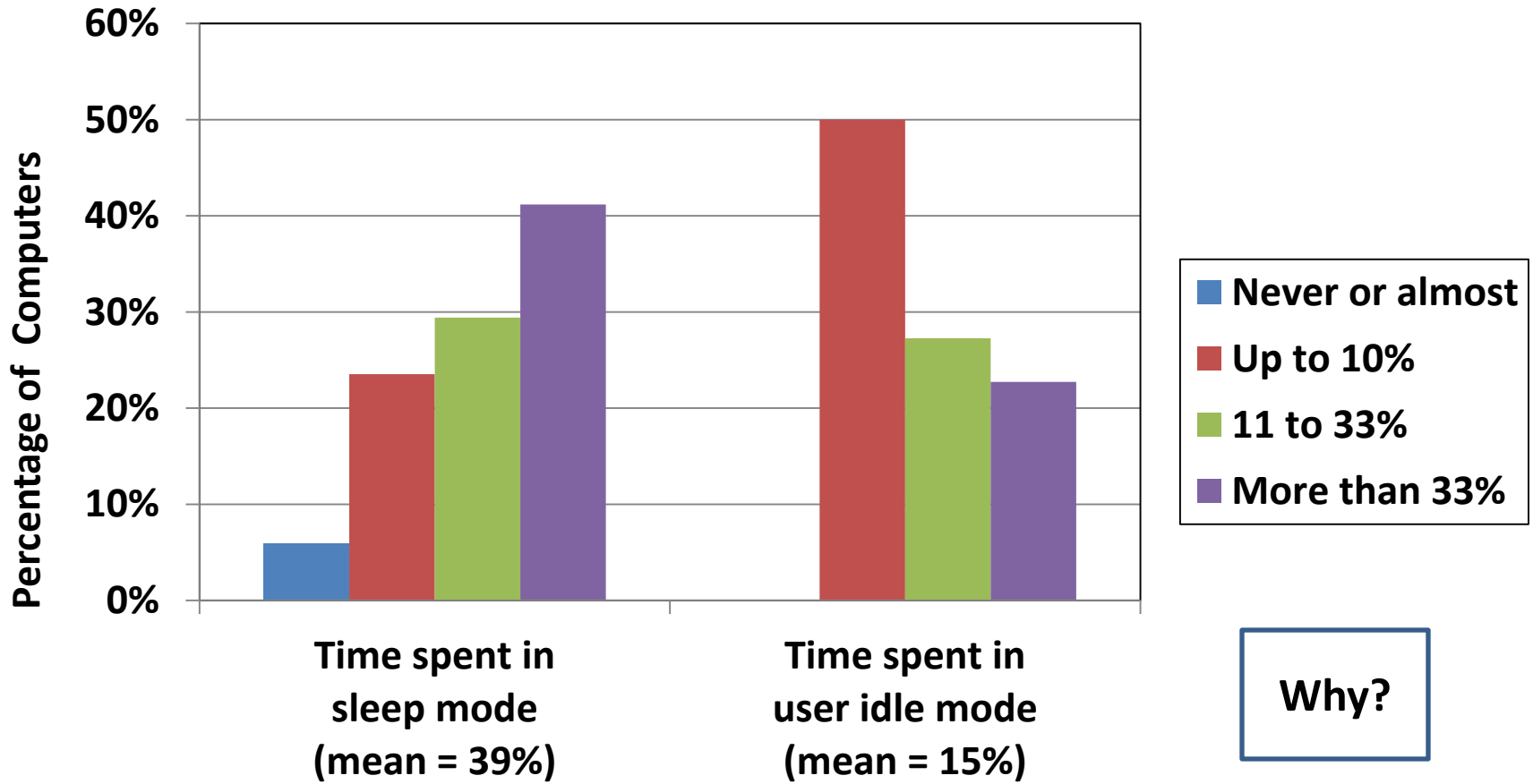
Users with Automatic PM Enabled More Likely to Use Manual PM

➤ **The majority of office desktops do not have sleep settings enabled**

➤ **The users most likely to have sleep settings enabled are those who are knowledgeable and who report changing the settings**

➤ **Desktops that have sleep enabled show more efficient duty cycle results – 15% idle versus 68% idle**

➤ **Part of the increased efficiency is because users with automatic sleep enabled are <u>more</u> likely to use manual PM options than those with sleep disabled**

➢ **Observed patterns are more complicated than "typical" models**

    ➢ **Varied delay times to sleep, ranging from nine minutes to four hours**

    ➢ **Automatic sleep can be interrupted or interfered with by other processes**

    ➢ **Some people without sleep enabled save energy with manual PM**

    ➢ **Varied active use: some office computers have long idle periods during weekdays, other are used evenings and weekends**

Computer Energy Saving: A Multipronged Approach

- **Solutions bypassing users**
  - **Ship computers with sleep enabled**
  - **Reduce energy consumed in idle mode**
  - **Centralized admin control of office computers**

- **Why users still matter**
  - **Someone is disabling sleep on most computers**
  - **Sleep will still be better than idle**
  - **Centralized admin control won't work for all organizations, or for all members of an organization, or for residential users**

- **Toward a more user-based approach**
  - **Pay attention to <u>how</u> users are behaving toward PM, and <u>why</u>, to design hardware, software, and policy systems that make energy saving fit better with users' actual patterns.**

User-based Solutions: Some Ideas

➢ **Revise the user interface**

  ➢ **Make it easier to get to settings and to change them**

  ➢ **Make it obvious that computer is in low-power mode and how to resume**

➢ **Address technical problems**

  ➢ **Make it faster to resume from low-power modes**

  ➢ **Remote access, automatic backups and updates**

  ➢ **Processes that interfere with sleep mode**

➢ **Recognize range of users when designing policy, outreach**

  ➢ **Variation in knowledge**

  ➢ **Variation in control over computers**

  ➢ **Variation in willingness to adopt more stringent PM settings**

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