Recommendations for Tier I ENERGY STAR® Computer Specification

Austin, TX
June 21, 2005

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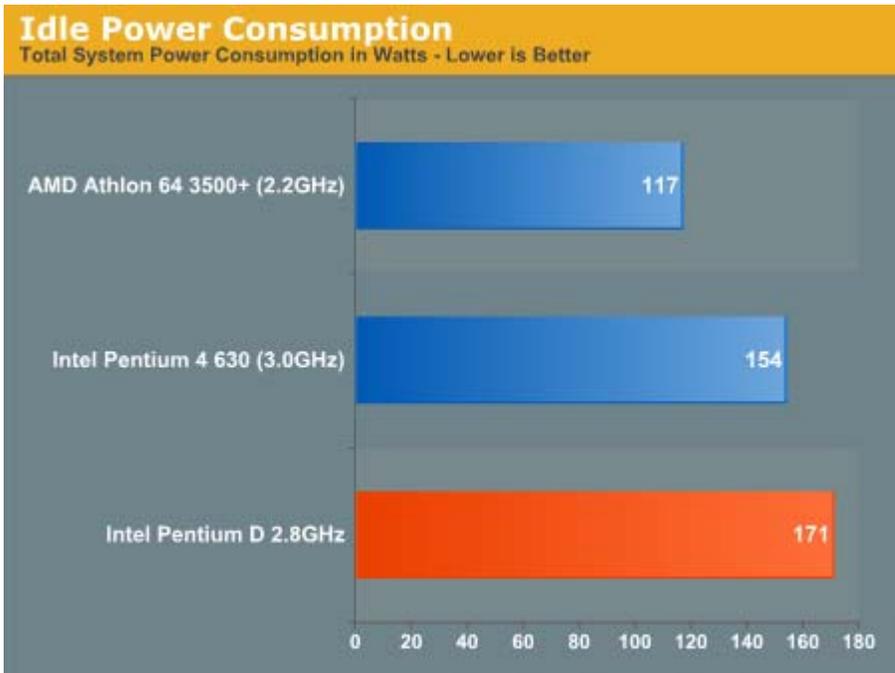
Natural Resources Defense Council
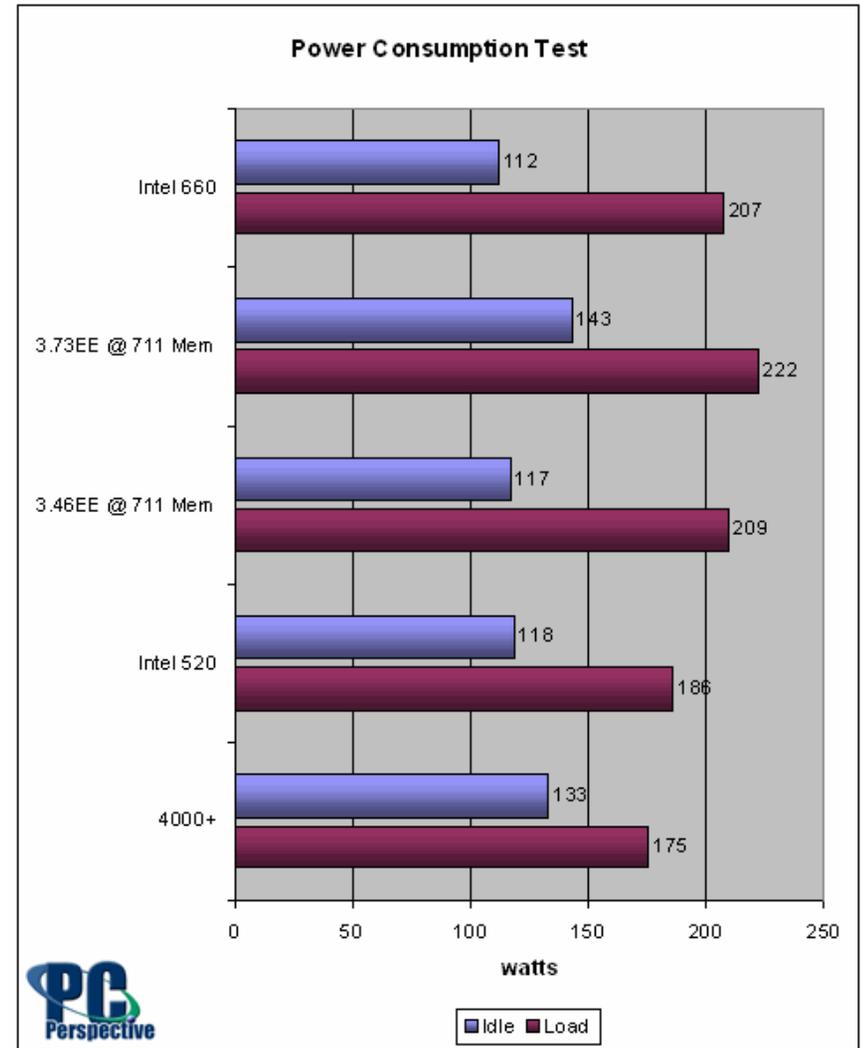nhorowitz@nrdc.org

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Agenda

1. Idle state definition

2. Idle state test method

3. Results of field measurements

4. Significance of idle to overall savings potential

5. Policy recommendations

6. Strategies for reducing idle power use

Idle power already being compared in industry reviews of computers

Idle Power Consumption
Total System Power Consumption in Watts - Lower is Better

Processor	Watts
AMD Athlon 64 3500+ (2.2GHz)	117
Intel Pentium 4 630 (3.0GHz)	154
Intel Pentium D 2.8GHz	171

Courtesy AnandTech.com

Power Consumption Test

Processor	Idle	Load
Intel 660	112	207
3.73EE @ 711 Mem	143	222
3.46EE @ 711 Mem	117	209
Intel 520	118	186
4000+	133	175

watts

Courtesy PCPerspective.com

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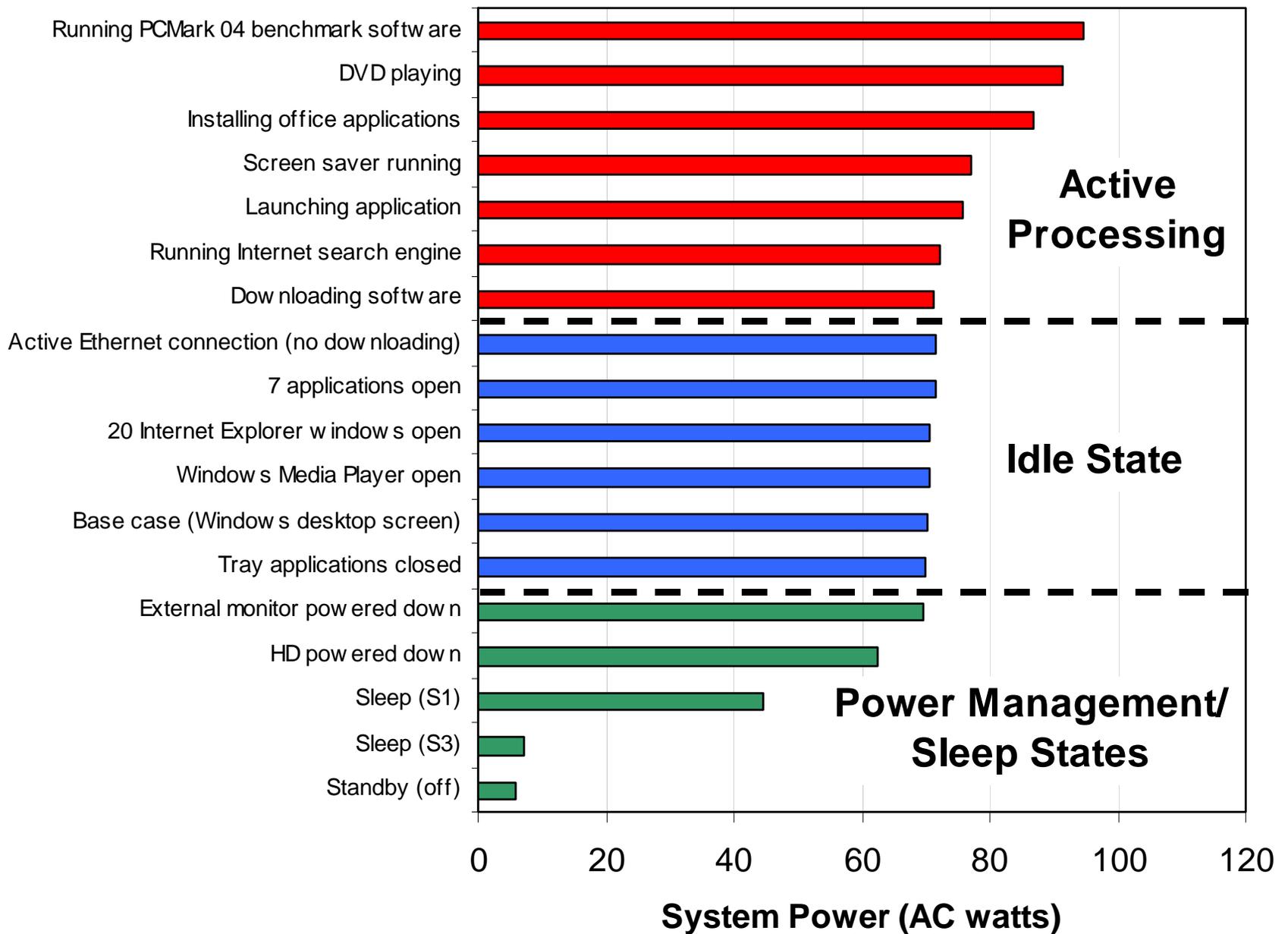THE EARTH'S BEST DEFENSE

Idle State is part of Active Mode

- Active mode -- a wide range of operating conditions including all high performance states and idle state

- *High performance state and power use (e*verything in active mode other than idle state):

  - heavy CPU utilization, ongoing changes to information being displayed on the screen, hard drive and optical drive activity, network activity, etc.

  - Examples: Downloading/sending email or retrieving files from server; saving file to hard drive, manipulating images in visual editing program, ongoing changes to information being displayed on screen, playing music or a DVD, playing a game

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Idle is the low end of Active Mode

- *Low end of activity and power use:* idle state
  - Time is being logged in "System Idle Process" in the Windows Task Manager, CPU utilization is typically less than 5%
  - Examples: User viewing document on the computer screen or typing, but not conducting computationally intensive tasks – sorting, file searches, file save, printing, etc.

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Active Processing
- Running PCMark 04 benchmark software
- DVD playing
- Installing office applications
- Screen saver running
- Launching application
- Running Internet search engine
- Downloading software

Idle State
- Active Ethernet connection (no downloading)
- 7 applications open
- 20 Internet Explorer windows open
- Windows Media Player open
- Base case (Windows desktop screen)
- Tray applications closed

Power Management/ Sleep States
- External monitor powered down
- HD powered down
- Sleep (S1)
- Sleep (S3)
- Standby (off)

System Power (AC watts)

Base system: Athlon 64 3500+, 1GB DDR1, nVIDIA GeFORCE 4 MX440 video card, 80 GB HD, DVD-CD-RW, stock power supply

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Proposed Definition of Idle State

A computer is in idle state when

- it is fully operational (not asleep) with all internal hardware and monitor connected

- operating system is fully loaded

- no hard drive or optical drive activity is occurring

- no Ethernet, modem, or wireless network connection is established

- no keyboard or mouse activity is occurring

- no additional USB or Firewire devices are connected

- no user input is occurring from the keyboard or mouse

- information displayed on screen is not changing

Appeal of Idle State Savings: Invisible to User and Virtually No Performance Impacts
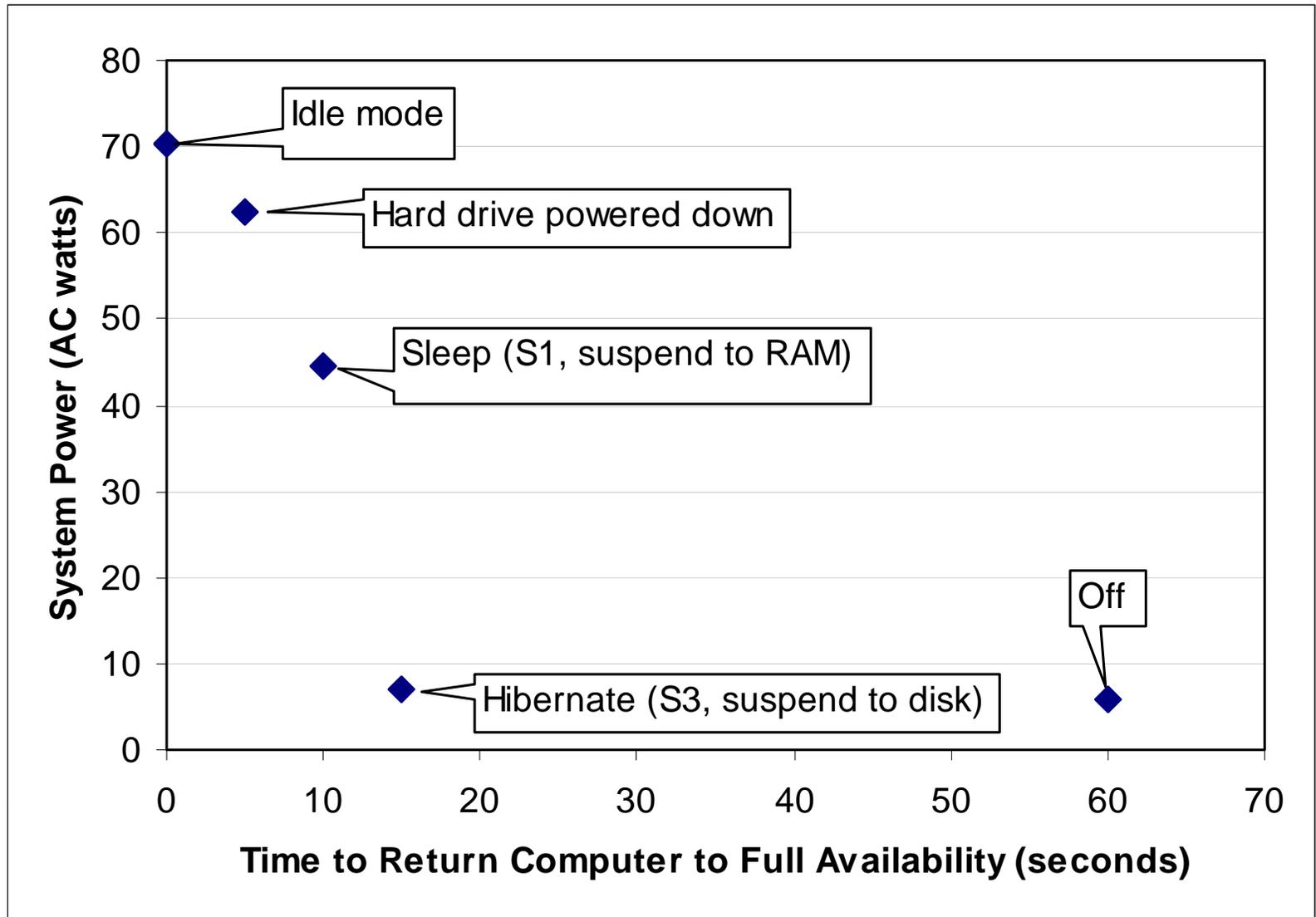
Test Procedure Development

- Goals of final test procedure:

  - Measurements gathered indicative of real world idle power

  - Test relatively simple to conduct

  - Measurements are repeatable in different labs and with different technicians

  - Measurement is meaningful across a range of different product configurations and form factors (e.g. computers with integrated screen vs. desktops with tower separate from monitor)

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Questions to answer through field testing

- How does the number of programs affect idle state power?

- How does the network connection affect idle state power?

- If the monitor is asleep, does that affect computer idle state power?

- What is the appropriate way for the test procedure to address computers with integrated screens and laptops?

- How long to wait before making measurement?

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Test Procedure Used for Field Measurements

- Inexpensive field meters used to make a large number of measurements in multiple offices and homes (more recommendations to come on formal test method)

- Start up a computer that is connected to the Internet/network with a power meter connected. All peripherals other than the keyboard, monitor, and mouse disconnected.
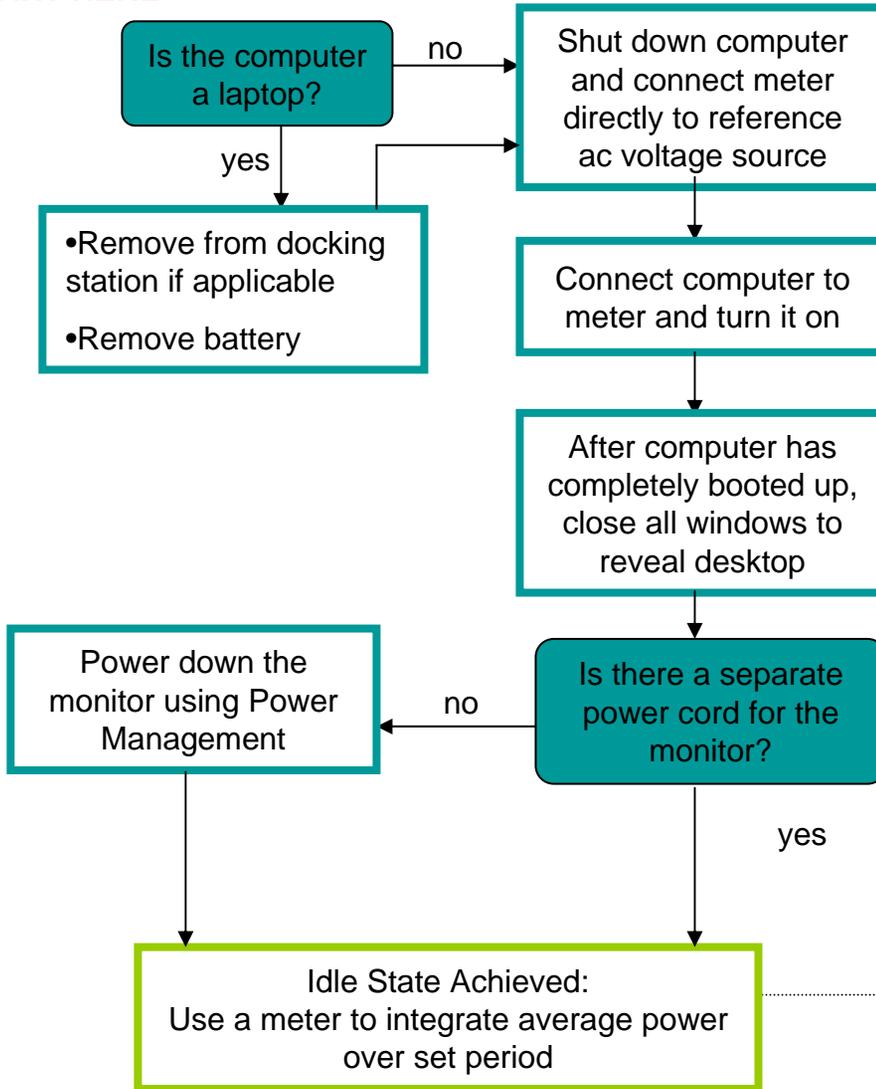
Making the Measurement

- Record the max, min, and mode of the idle state power over a 5 minute period in the following configurations:

  - Desktop screen at the beginning of the start up process (with programs that have automatically loaded open and operating) and network/Internet connected
  - All programs (including those loaded during the startup process) closed, desktop screen displayed, network/Internet connected
  - Desktop screen displayed, all programs closed and network/internet disconnected

  Shorter version of test procedure was used in retail setting to capture idle model data for new computers

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IDLE STATE TEST SEQUENCE

RECORDED DATA

START HERE

Is the computer a laptop?

→ no → Shut down computer and connect meter directly to reference ac voltage source ┈┈> Voltage from power source

yes ↓

•Remove from docking station if applicable

•Remove battery

Connect computer to meter and turn it on ┈┈> Detailed information about the computer including at least:
•OS and version
•Processor type, number and speed
•Total and available physical memory
•Video card name, resolution, RAM, and bits per pixel
•Power management scheme

After computer has completely booted up, close all windows to reveal desktop

Power down the monitor using Power Management ← no ← Is there a separate power cord for the monitor?

yes ↓

Idle State Achieved:
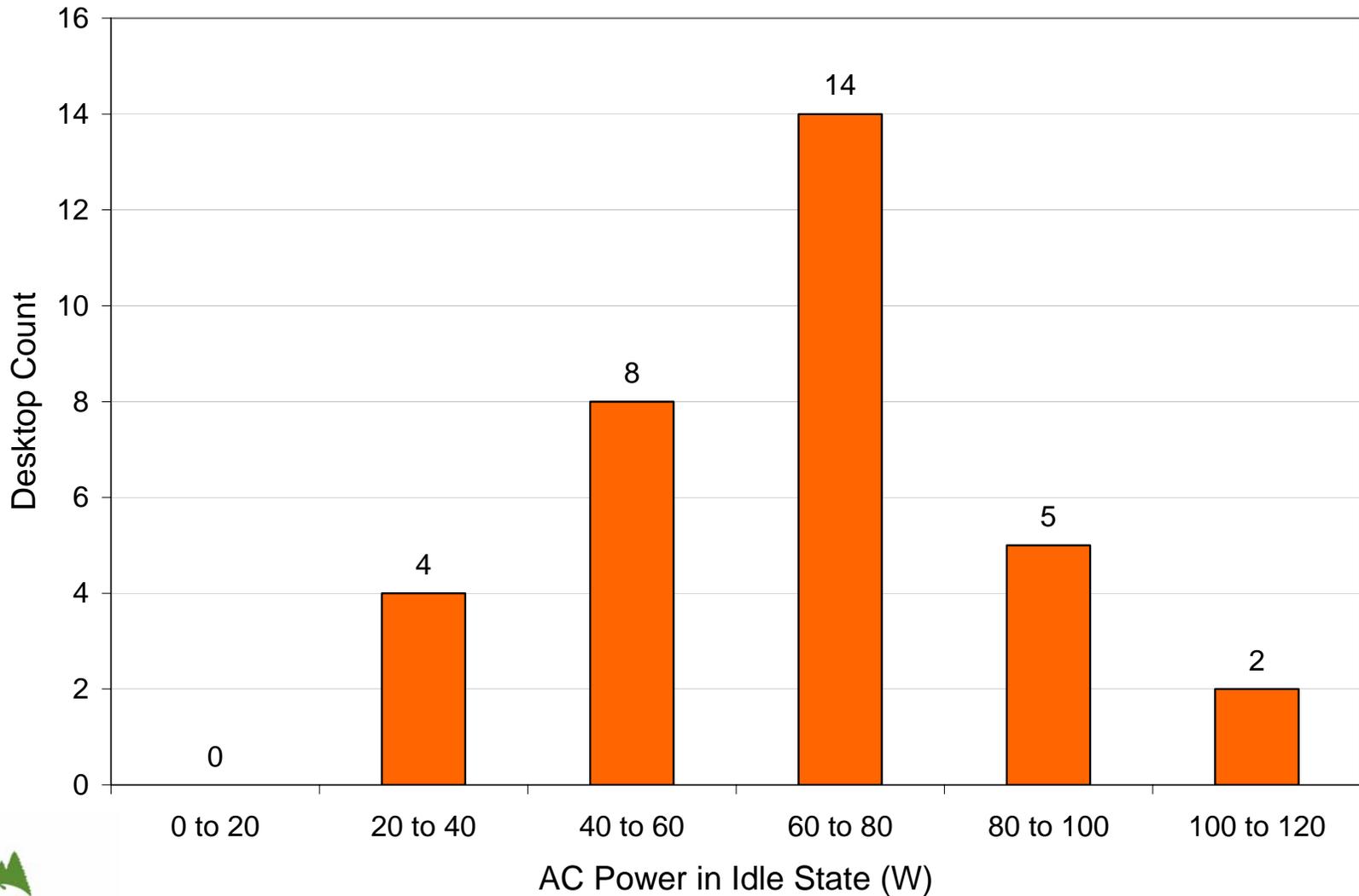Use a meter to integrate average power over set period ┈┈> Record average power
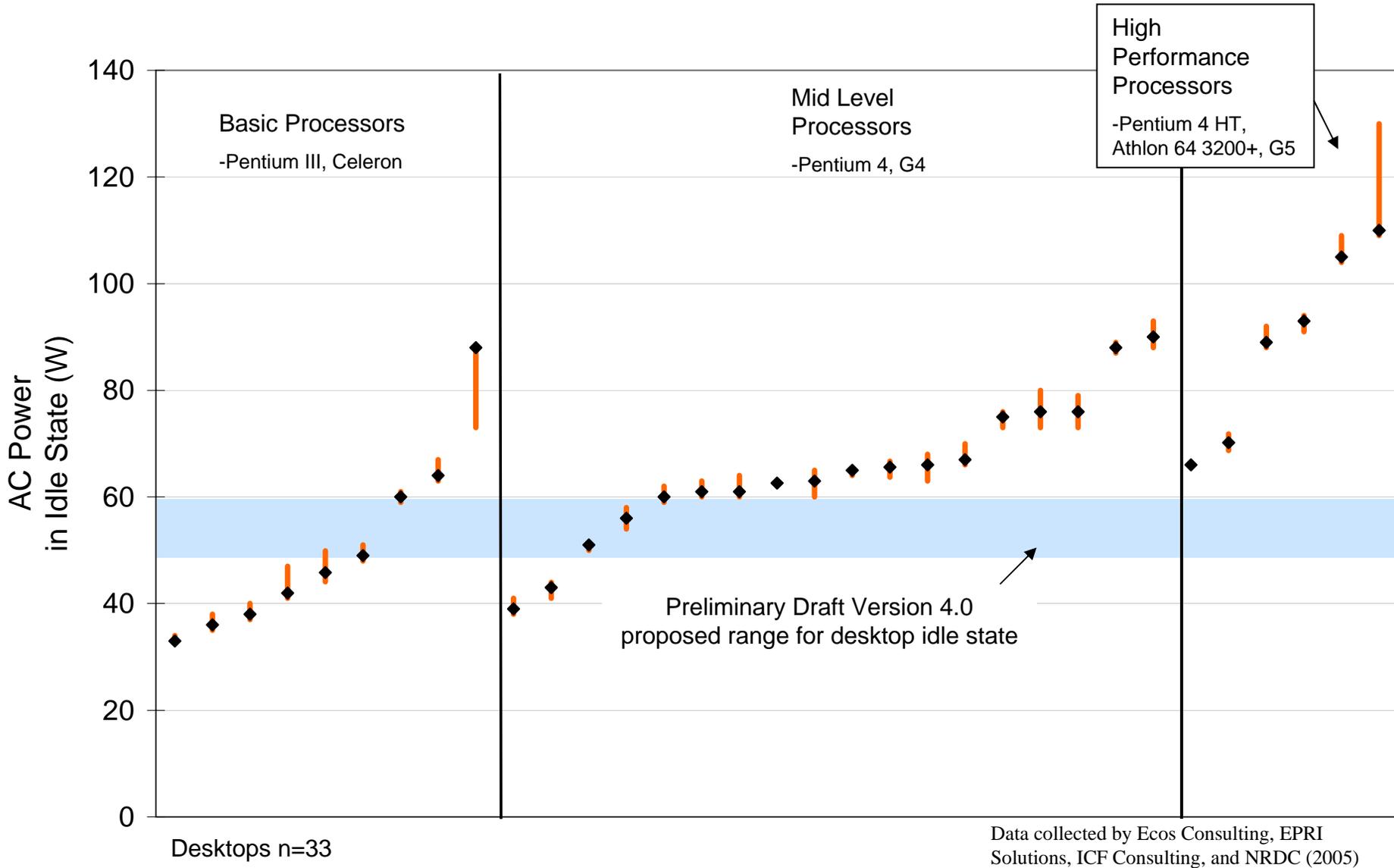
Characteristics of Desktops Tested

- Sample data included 7 manufacturers (Apple, Dell, Compaq, E-Machine, Gateway, HP, and Sony) and 3 Ecos-assembled units

- A total of 33 desktops were measured; 17 were measured in offices, 11 desktops were measured in retail stores, and several were measured in the Ecos lab

- Desktop processors ranged from basic to high performance
    - AMD: Athlon 64 3200+
    - Intel: Celeron, Pentium 3, 4, and 4 HT
    - Apple:G4 and G5

- Processor speeds ranged from 450 MHz to 3.4 GHz

- Video cards ranged from basic motherboard video cards to high performance video cards

- Data included 4 different operating systems (Mac OS X, Windows 2000 Pro, XP Pro, and XP Home)

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Measured Desktop High, Low, and Typical Idle State Power

AC Power in Idle State (W) (y-axis, 0 to 140)

Basic Processors
-Pentium III, Celeron

Mid Level Processors
-Pentium 4, G4

High Performance Processors
-Pentium 4 HT, Athlon 64 3200+, G5

Preliminary Draft Version 4.0 proposed range for desktop idle state

Desktops n=33

Data collected by Ecos Consulting, EPRI Solutions, ICF Consulting, and NRDC (2005)

•12 of 33 desktops consumed less than 60 watts in idle state (36%)
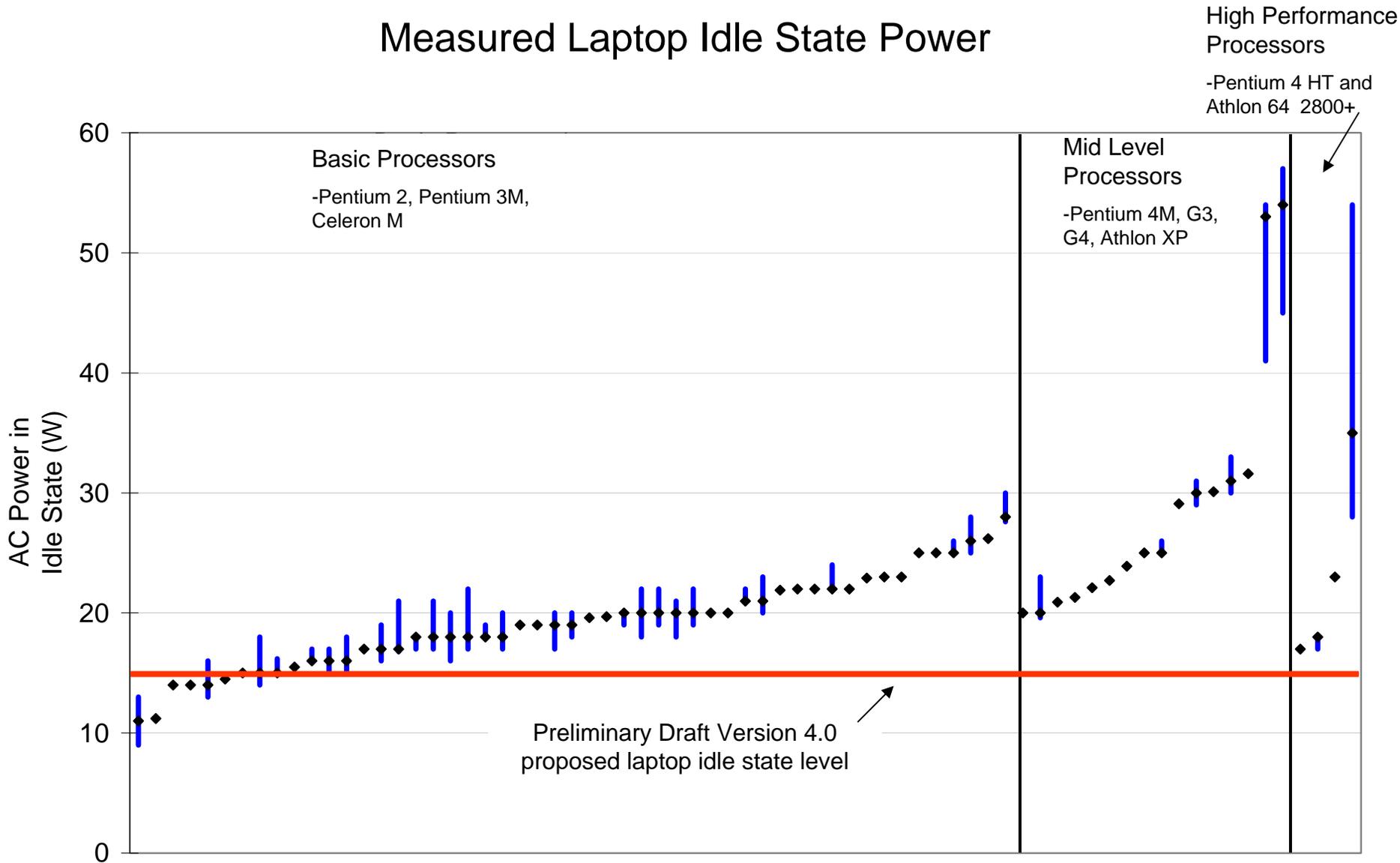
Key Field Measurement Findings

- 16 out of 33 desktops were tested in more detail
  - Disconnection from a network resulted in:
    - No change in power consumption in 50% (8) of desktops tested
    - < 5% change in power consumption in 38% (6) of desktops tested
  - Closing programs from the system tray had <u>no effect</u> on idle mode power consumption
  - Number of windows/applications open had minimal (less than 2%) effect on power consumption

- Follow-up testing conducted on systems incorporating innovative design features to save energy

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Characteristics of Laptops Tested

- Sample data included 13 manufacturers (Acer, Apple, Compaq, Dell, Fujitsu, Gateway, HP, IBM, MicronPC, MiTAC, Sharp PC, Sony, and Toshiba)

- A total of 71 laptops were measured; 42 were measured in offices, 21 laptops were measured in retail stores, and 8 were measured at LBNL

- Desktop processors ranged from basic to high performance
    - AMD: Athlon 4 to Athlon 64 2800+
    - Intel: Pentium 2 to Pentium 4 HT
    - Apple:G3 to G4

- Processor speeds ranged from 133 MHz to 3.3 GHz

- Video cards ranged from basic motherboard video cards to mid level video cards

- Data included 7 different operating systems (Mac OS 8.6, X, X 10.2.2, Windows 98, 2000 Pro, XP Pro, and XP Home)

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Measured Laptop Idle State Power

Questions about laptop measurements

- Current Idle State level too low for today's models to meet?

- What screen settings used?

- What type of PM scenario used?

- Could "battery mode" settings become default factory setting? (processor power scaling even when plugged in)

Field Measurements Show Improved Opportunity for Energy Savings with Idle

- Current idle levels are higher than previously assumed. Leads to even greater saving potential.

- Computers, including high end models, are still capable of meeting proposed idle levels with hardware changes
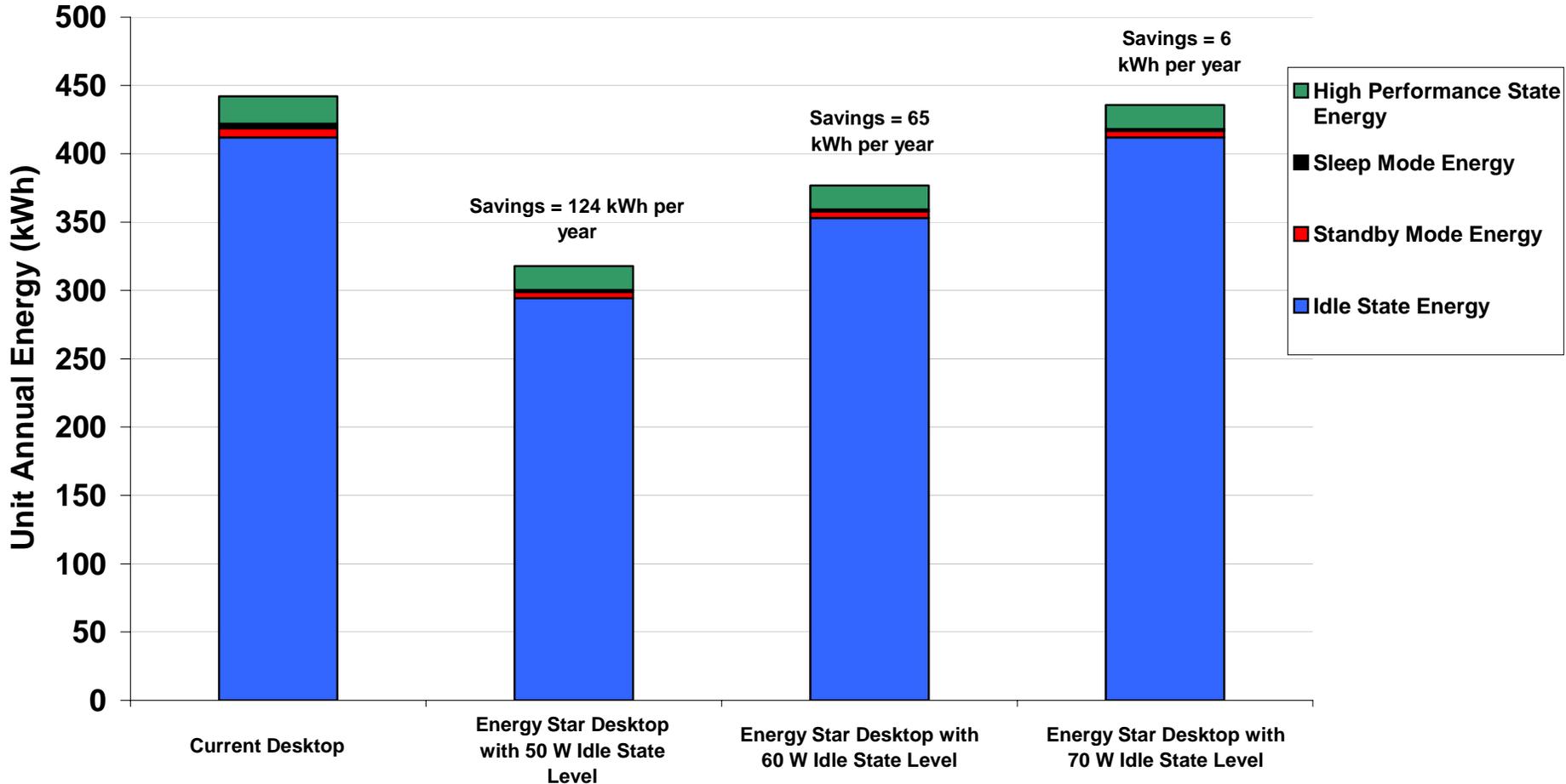
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Regardless of power management settings, idle state dominates annual desktop energy use in offices

		Hours per Day Spent Standby /Off	Hours per Day Spent Sleep	Hours per day spent Idle	Hours per day spent high performance	Energy Spent Idle (kWh/year)	Total Annual Energy (kWh)
On all night	PM disabled	0.0	0.0	23.3	0.7	595	616
On all night	PM enabled	0.0	16.0	7.3	0.7	187	272
Off all night	PM disabled	15.0	0.0	8.3	0.7	212	248
Off all night	PM enabled	15.0	1.0	7.3	0.7	187	227
Off all night	Aggressive PM	15.0	3.0	5.3	0.7	135	184

Idle represents 69 to 97% of total annual energy use, even if power management is enabled

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An Idle Spec of 50 Watts Saves Nearly Twice as Much Energy as an Idle Spec of 60 Watts. 70 Watt Spec Saves Effectively Nothing.

Impact of Idle State on Desktop Computer Unit Energy Savings

Savings = 6 kWh per year

Savings = 65 kWh per year

Savings = 124 kWh per year

Legend:
- High Performance State Energy (green)
- Sleep Mode Energy (black)
- Standby Mode Energy (red)
- Idle State Energy (blue)

Y-axis: Unit Annual Energy (kWh), 0 to 500

X-axis categories:
- Current Desktop
- Energy Star Desktop with 50 W Idle State Level
- Energy Star Desktop with 60 W Idle State Level
- Energy Star Desktop with 70 W Idle State Level

National Level Energy Savings If All Existing U.S. Desktop Computers Met Proposed Levels

- An Idle State cap of 50 Watts has the potential to save 118 kwh/yr per machine, or in total:

  – 18.6 billion kWh per year

  – Equivalent to 1.8% of residential electricity use

  – Equivalent of shutting down approximately 4 large power plants

Above figures do not include laptops or servers. To obtain savings for 25% sales penetration of ENERGY STAR models, divide savings estimates by 4.

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Key Findings Recap

Should be relatively easy to finalize idle mode test method. Range of potentially complicating factors do not impact overall idle level.

Less than 2% variation in power use regardless of:

- Number of Office applications or other windows open

- Network connection established or not

- System tray applications open or closed

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NRDC's Recommendations

- Idle State should be kept in specification in the range of 50 to 60 watts for desktops

- Encourage sub-group to meet to resolve remaining test procedure issues:

  - Resolve test voltages, precision of lab equipment needed, etc. to conform with international standards like IEC 62301
  - Encourage manufacturers to gather and report additional data on their own products
  - 5-minute average measurement of idle power
  - Wait 5 minutes prior to making measurement