



**TASK 4.0 (CEC-PIER PROJECT)**  
*Role of Power Electronics in Achieving  
Higher Efficiency Levels for Desktop  
Computers*



FEB 27, 2008

# Key topics

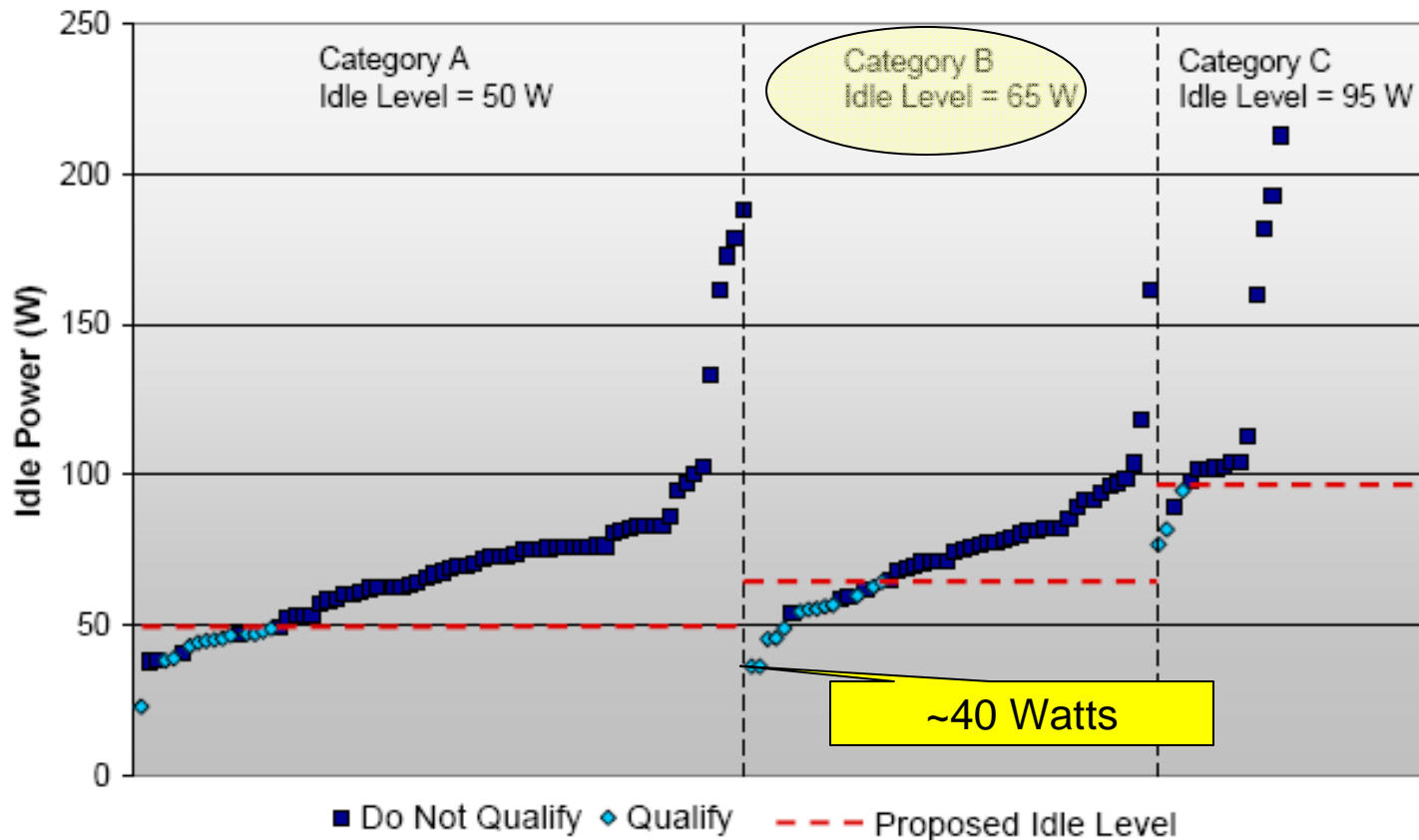
- Introduction
- Platform selection
- Component selection
- Testing
- Results and benefits
- Summary
- Acknowledgments

# Introduction

- **History:** the U.S. EPA ENERGY STAR program released its v4.0 computer specification in July 2007, establishing idle mode power consumption limits for the first time
- **The Challenge:** how much more efficient could desktop computers become without sacrificing performance?
- **Funder:** California Energy Commission's (CEC) Public Interest Energy Research Program (PIER)
- **Goal:** To achieve state of the art energy efficiency in desktop computers for office applications by working with manufacturers to assemble, test and demonstrate innovative designs

# Current ENERGY STAR v4.0 specification and data set used to establish it

Desktop Idle by Category



Note that 40 watts idle was readily achievable by multiple designs in 2006-2007. Could we go lower?

# Scope and objective of this research

The objective of this project was to develop the following two desktop computer systems:

1. A **market-ready** computer system that meets a currently accepted *retail price point* for a desktop computer
2. An “**ultimate efficiency**” computer system that achieves the *best combination of efficiency and performance* regardless of cost

# Another way to envision this project...



Desktop form factor

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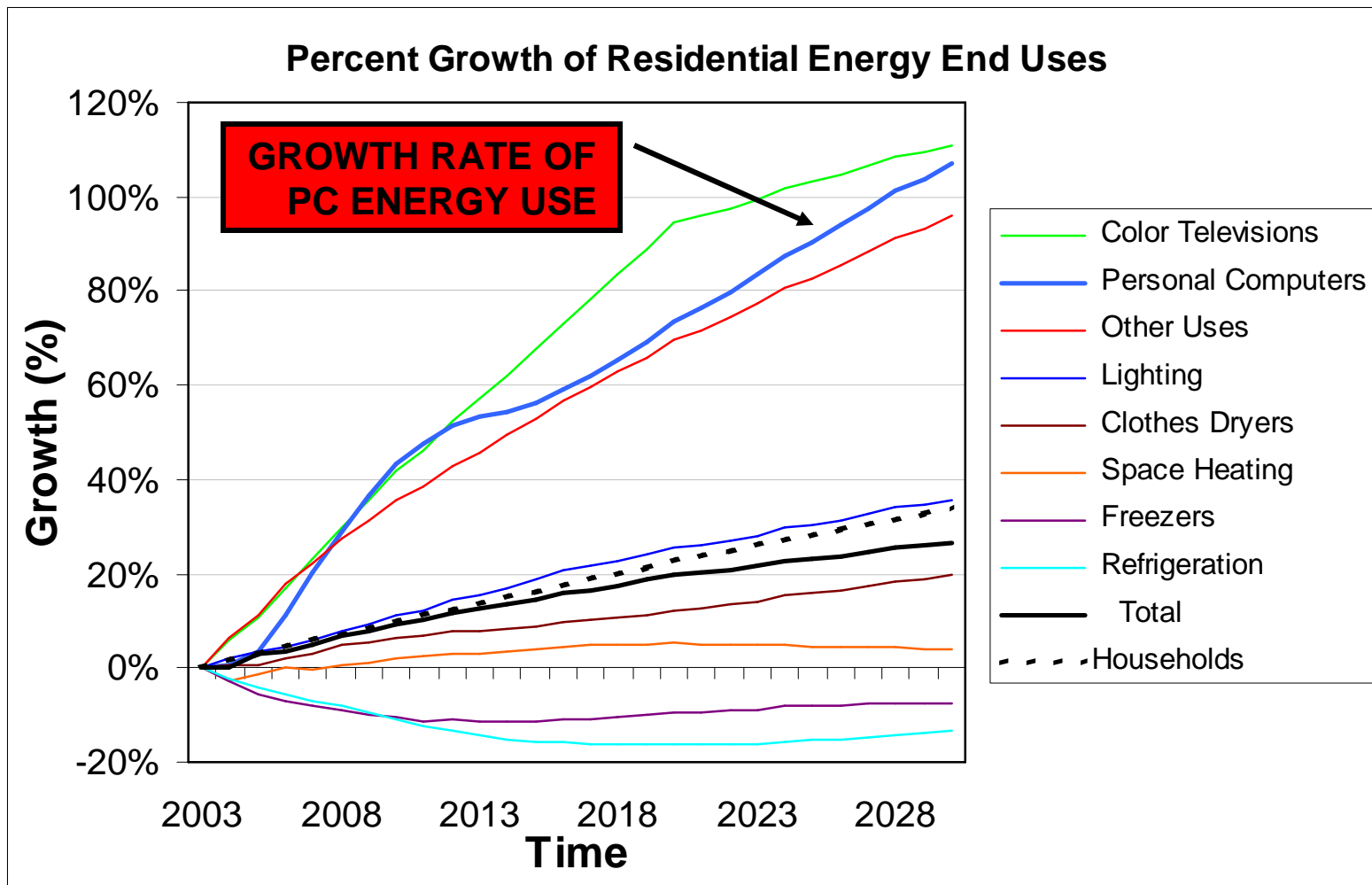
Laptop energy efficiency

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Highly efficient, smaller form factor desktops?

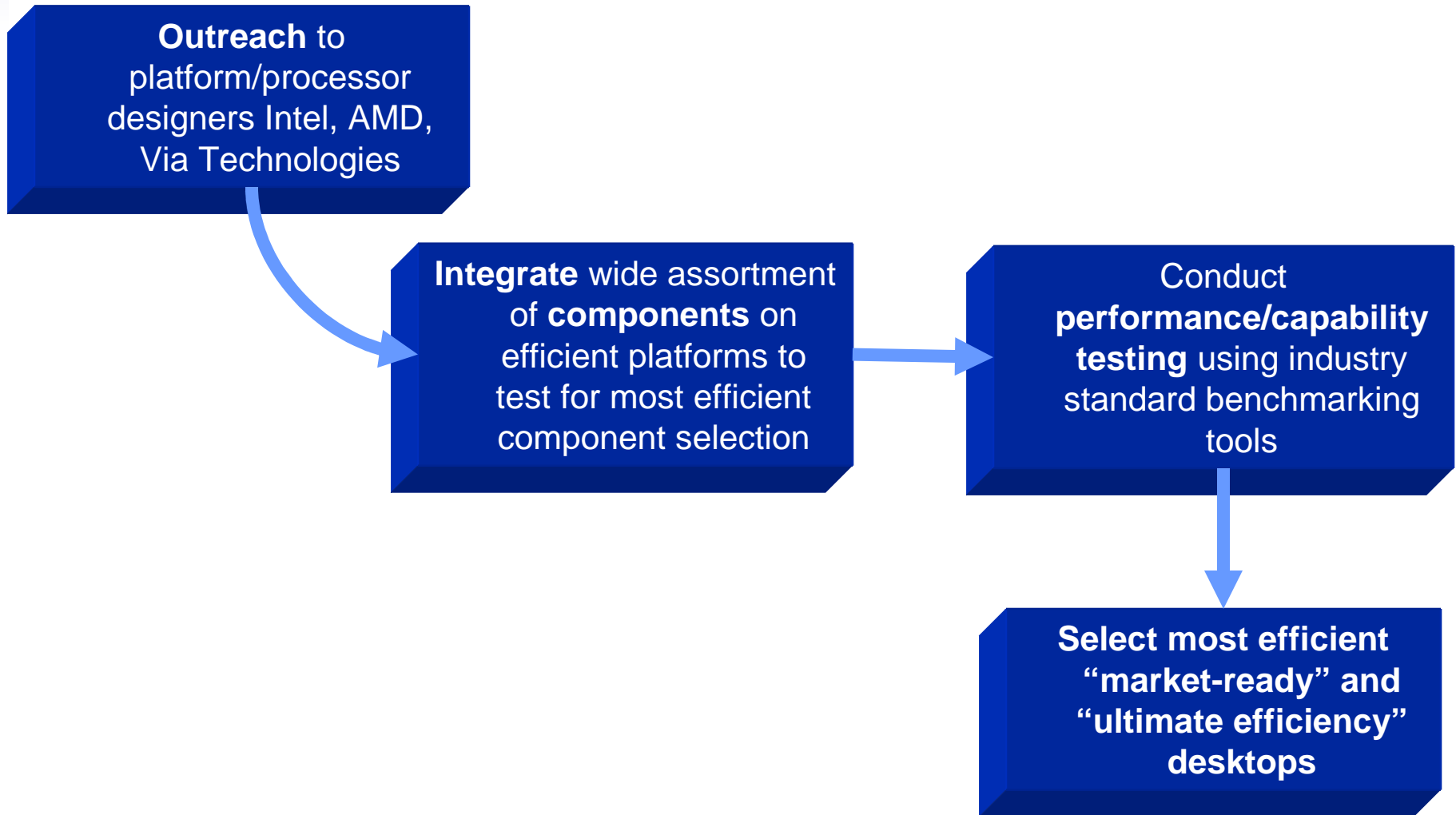
# Why focus on PC energy efficiency?



Source: U.S. Department of Energy: Energy Information Administration, "Annual Energy Outlook 2006,"

<http://www.eia.doe.gov/oiaf/aeo/overview.html#consumption>

# Identifying best available technology for office productivity desktop computers



# Process for achieving savings from various components (some are synergistic)

1. Major savings first achieved by choosing mobile on desktop processors and motherboards optimized for efficiency
2. Then hard drives and memory components chosen to minimize load
3. Then the most efficient fan selected for the cooling load needed
4. Lastly, the power supply was properly (right) sized to the expected load and selected for maximum efficiency at that load

Component Improvement	Idle Power Saved (W ac)	Percent Idle Power Saved	Total Annual Energy Savings (kWh)	Percent Annual Energy Savings
Power Supply	3 – 4	6% – 9%	18 – 24	6% – 10%
Hard Drive	5 – 6	10% – 14%	31 – 37	10% – 15%
Physical Memory	1 – 2	3% – 5%	6 – 12	2% – 5%
Case Fan	2 – 3	6% – 8%	12 – 18	4% – 8%
<b>Total</b>	<b>11 – 15</b>	<b>25% – 36%</b>	<b>67 – 91</b>	<b>22% – 38%</b>

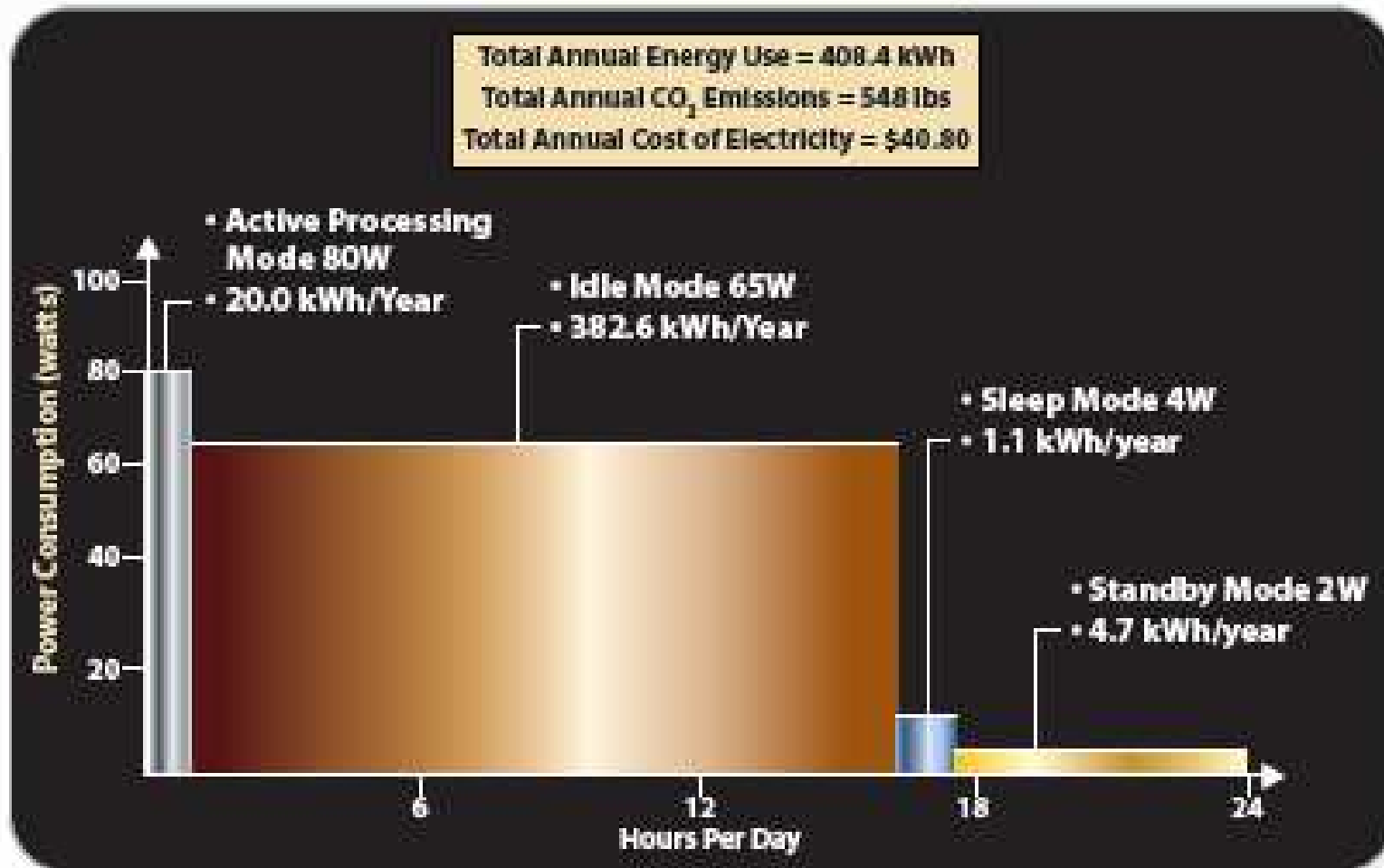
Table 1 - The effects of using best-in-class components on the power consumption of highly efficient desktop computers. Some synergistic interactions are also possible between certain components, which have not been documented in this table.

# Selection of components

	Stock Configuration		Energy Efficient Configuration	
	Component	Model Number	Component	Model Number
<b>Power Supply</b>	Jou Jye 400 W, 80Plus	SGE- 400AHNK	SolyTech 185 W, 80Plus	Smallest 80+ multiple output power supply available!
<b>RAM</b>	Kingston 2x1GB Value RAM	KVR800D2N 5K2/2G	Wintec 1x2GB AMPx	3AXT5400C4- 2048
<b>Fan</b>	Rosewill Ultra Quiet	RFX-120	Ebmpapst	4412 F/2GLL
<b>Hard Drive</b>	Hitachi Deskstar, 200GB	HDT722520D LA380	Seagate Momentus Hybrid HDD, 120GB	ST9120822AS

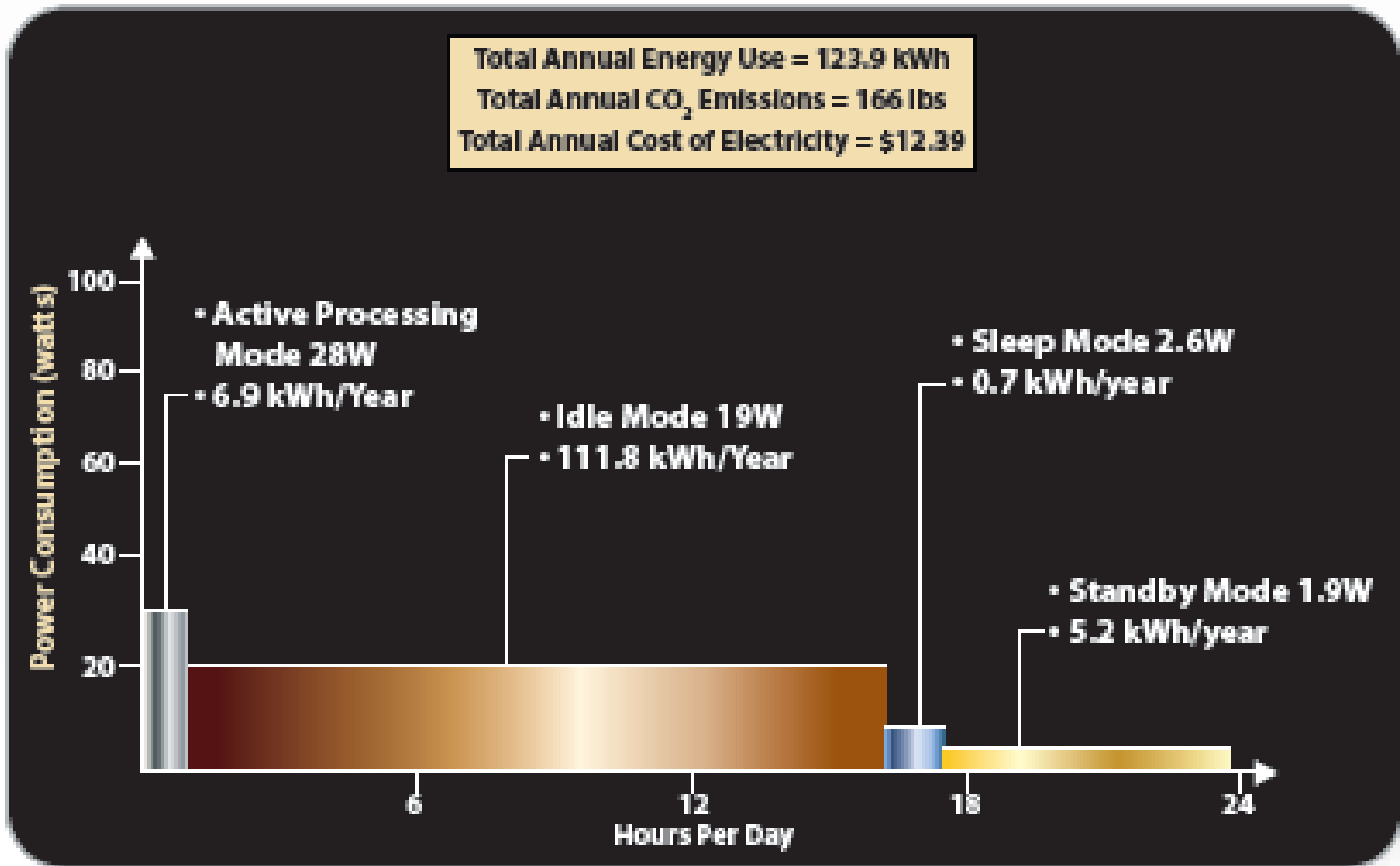
# Idle mode energy consumption is dominant, even with some use of power management

## Class B ENERGY STAR Computer



# Major savings across active, idle and sleep modes

## Ultimate Efficiency Computer



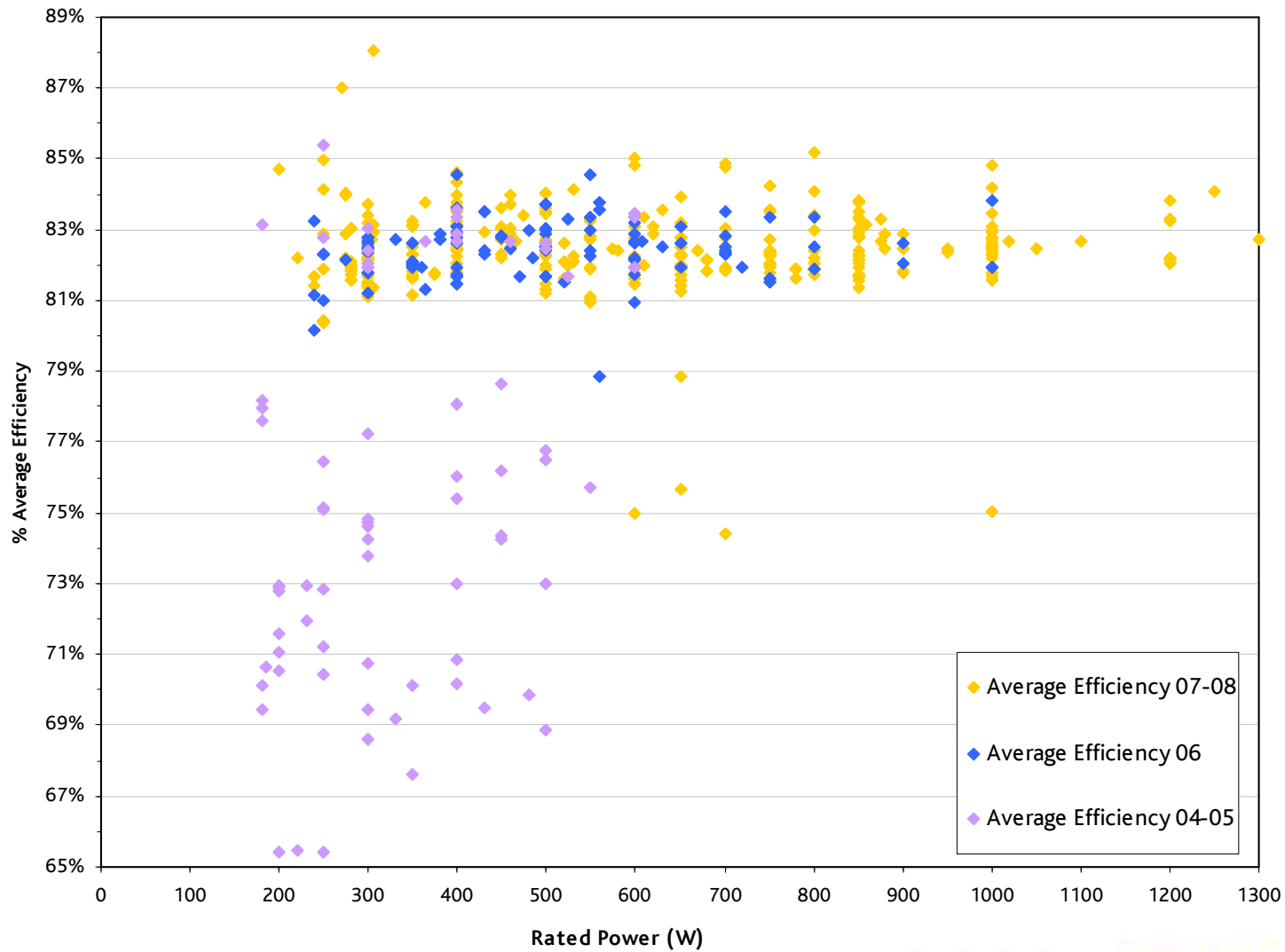
# Conclusions

- Wide range of desktop platforms from different vendors and highly efficient component choices with can be used *today* (< **\$50 incremental cost at retail with small quantity purchase**) to create efficient office productivity desktops with energy use about half of what is required by ENERGY STAR v4.0
- Incremental cost of more efficient components < \$50 with payback in the first 2 to 3 years of operation
- Technology exists today to exceed ENERGY STAR's already stringent v4.0 desktop targets by **over 60% by using mobile-on-desktop platforms**, systems that look and perform like desktops but with the power profile of a laptop

# Questions

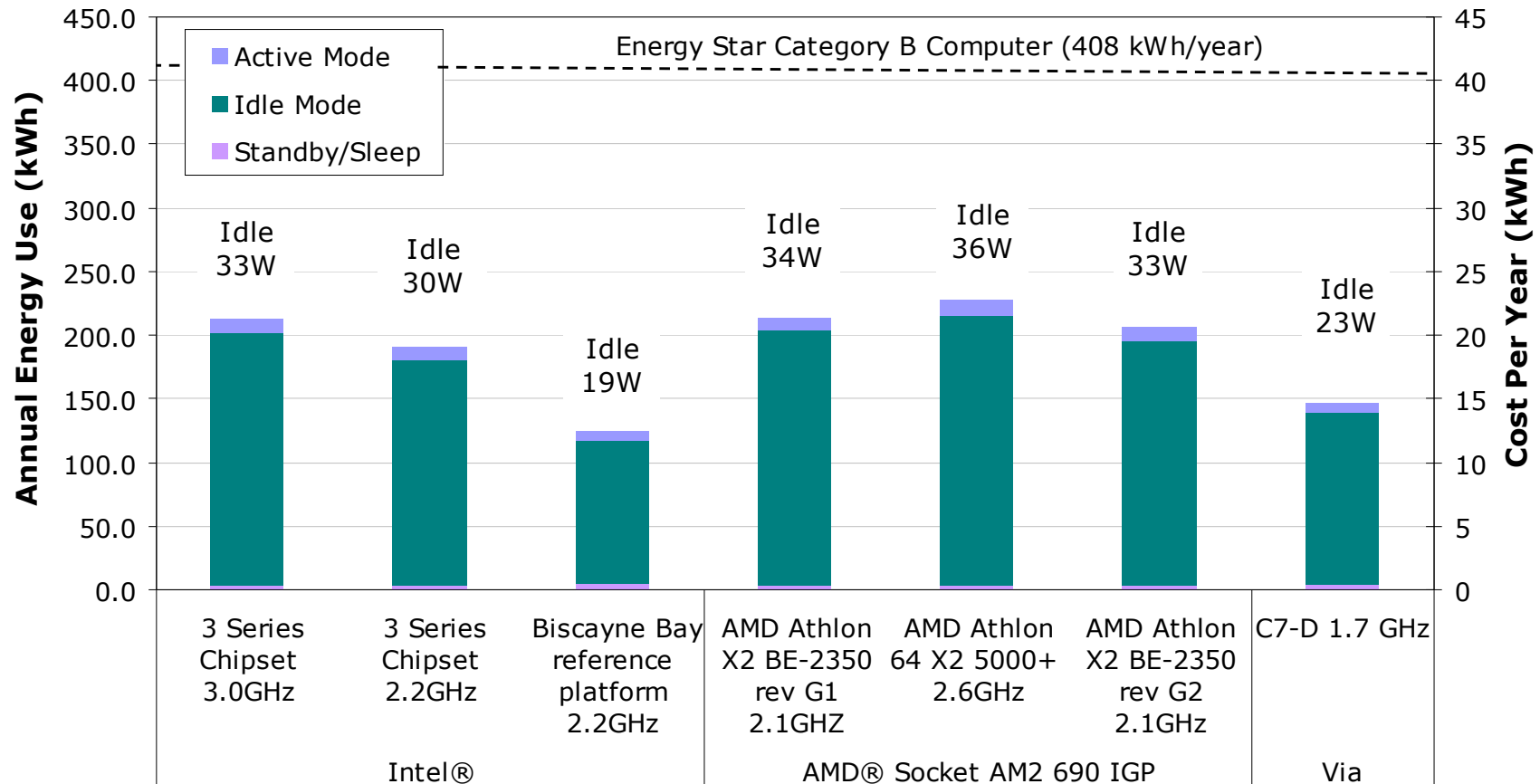
- Thank You!

# Computer power supply efficiency has improved greatly, but power supplies are also getting much larger



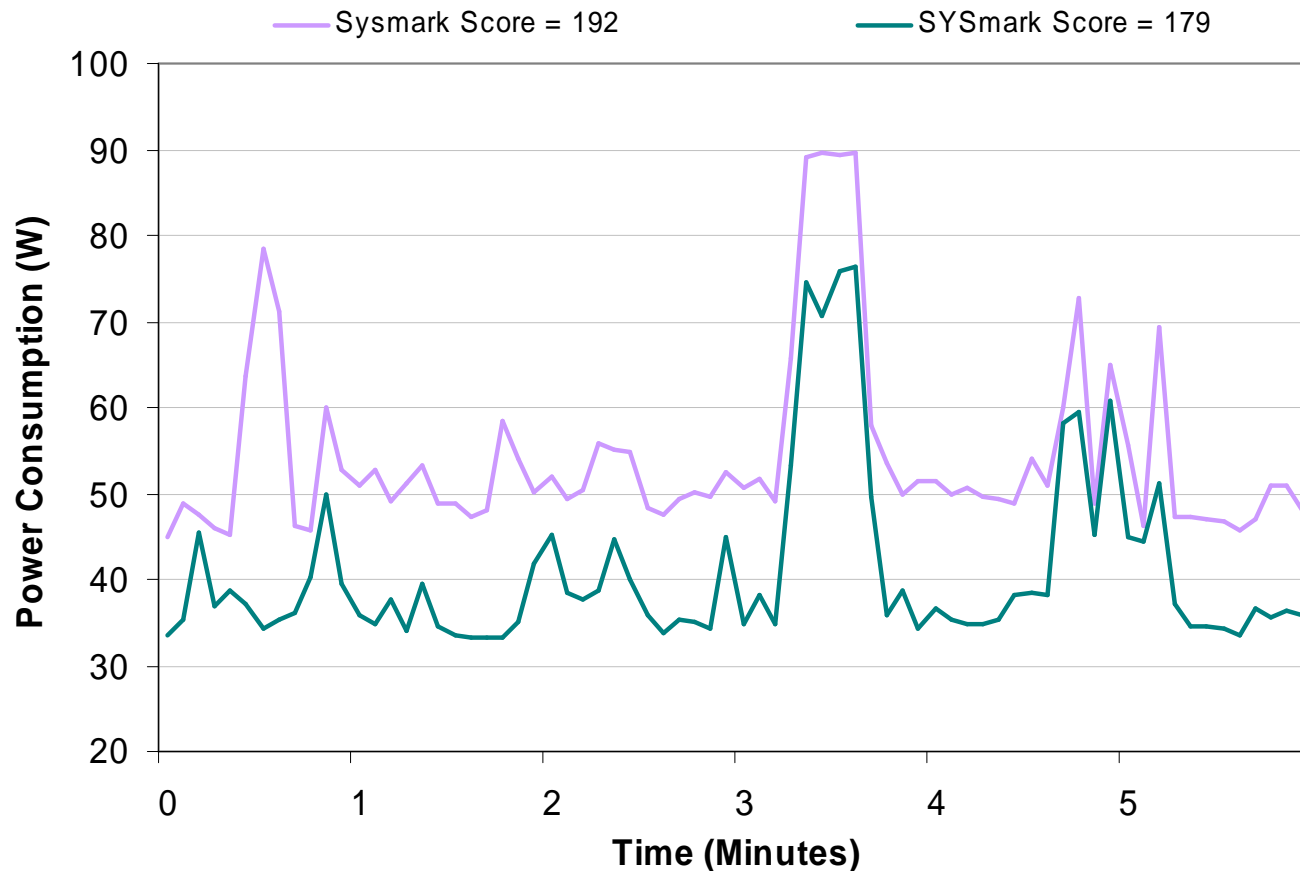
# Key results: lowest power consuming model had second best benchmark score/kwh

Annual Energy and Idle Power of Various Computers



# 15% to 40% less power use than ENERGY STAR in idle and big savings when actively processing

Active Mode Power Consumption While Running SYSmark 2007  
Preview Office Productivity Scenario (W)



# Market-Ready Desktop Computer



Our market-ready efficient computer provides an example of the high level of energy efficiency that can be achieved with today's desktop computer technology at price points comparable to typical enterprise desktop computers.

If all U.S. businesses purchased desktop computers comparable to the one shown here, this would negate the need for about two typical coal-fired power plants.

## Platform and Components

Platform  
CPU  
  
185W Power Supply  
2GB RAM  
Fan  
120 GB Hard Drive

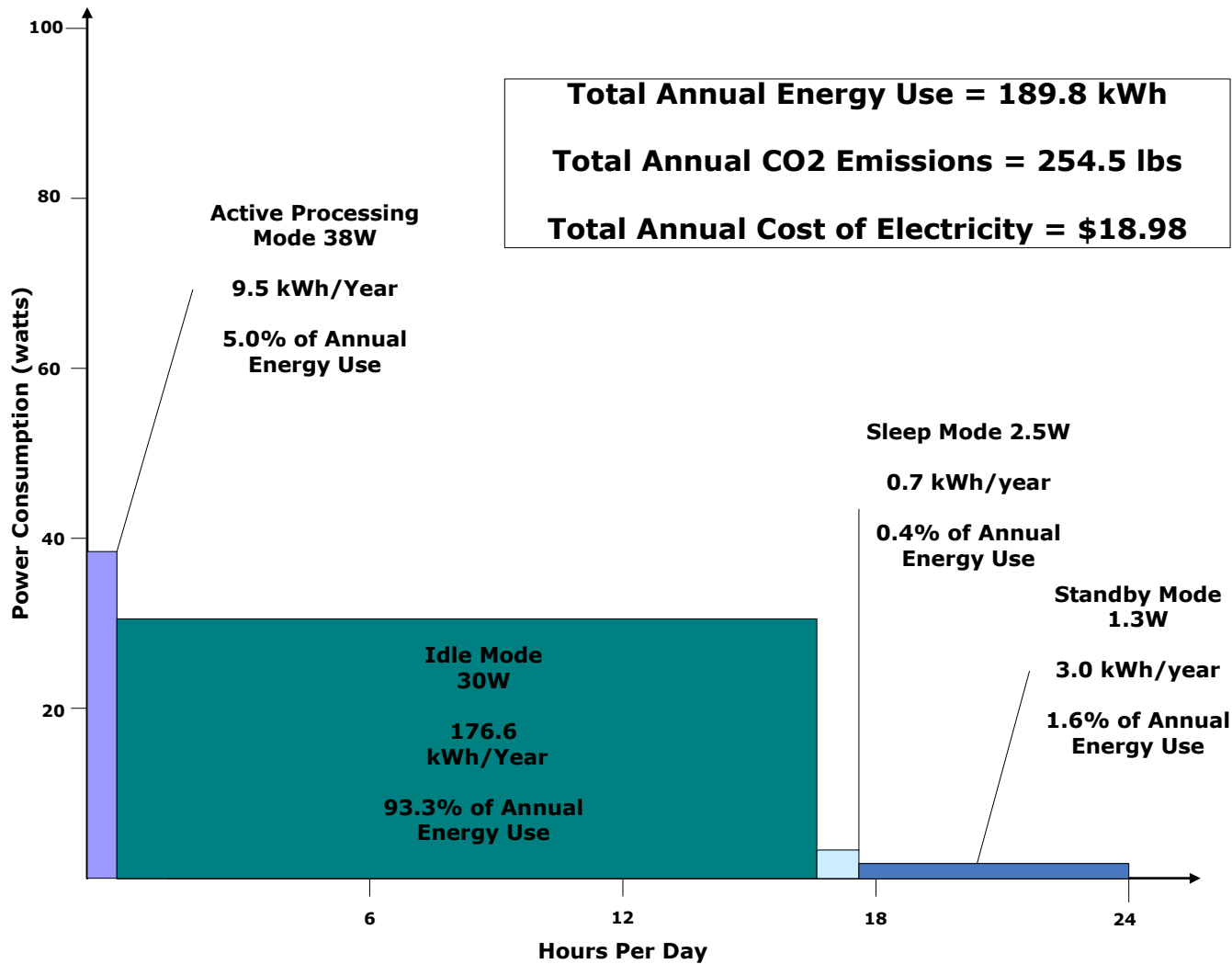
## Name or Model Number

Intel® 3 Series Chipset  
Intel® Core™ 2 Duo E6850  
2.2 GHz  
Soly Tech 80PLUS®  
Wintec 1x2GB AMPx  
ebm-papst 4412  
Seagate Momentus Hybrid Hard Drive

	Annual per Unit Savings Over ENERGY STAR Category B Computer	Annual National Savings If Adopted by All U.S. Enterprises
CO <sub>2</sub> Emissions Reduction	292 lbs.	8.6 million tons
Energy Savings	218 kWh	12.8 billion kWh
Utility Bill Savings	\$22	\$1.28 billion

~\$50 more based on additional retail cost of components we purchased, with a simple payback easily within the lifetime of the computer (2 to 4 years)

# Market-Ready Desktop Energy Profile



# Ultimate efficiency desktop computer



The ultimate efficiency desktop represents a blend between desktop and mobile computing platforms that manufacturers should strive for to maximize efficiency in the future. This machine might not meet today's desktop price points but could give significant customer demand and economies of scale.

If all businesses purchased computers comparable to the one shown here, this would negate the need for about three typical coal-fired power plants.

## Platform and Components

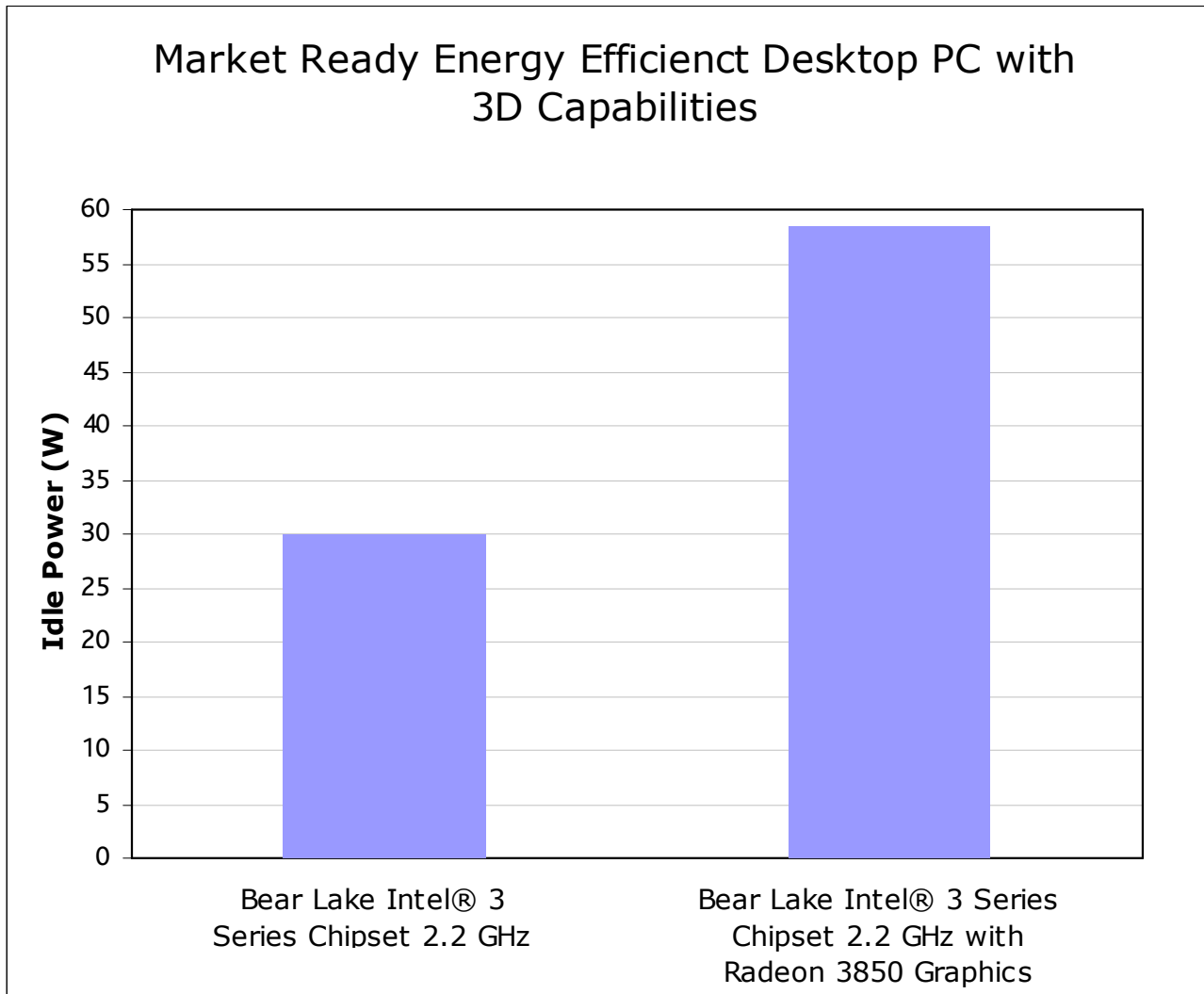
Platform  
Intel CPU  
65W External Power Supply  
1GB RAM  
160 GB Hard Drive

## Name or Model Number

Intel® Biscayne Bay reference platform  
Intel® Core™ 2 Duo T7500  
2.2 GHz Dual Core  
Dell PA-1600-0601 EPS  
CEON 2x512 GB Black Diamond  
Samsung HM16HJI Hybrid Hard Drive

	Annual per Unit Savings Over ENERGY STAR Category B Computer	Annual National Savings If Adopted by All U.S. Enterprises
CO <sub>2</sub> Emissions Reduction	380 lbs.	11.2 million tons
Energy Savings	284 kWh	16.7 billion kWh
Utility Bill Savings	\$28	\$1.67 billion

# Even efficient video cards still double the power consumption of an efficient PC



# ACKNOWLEDGEMENT

- We would first like to thank Intel, AMD and Via Technologies for their generous donation of motherboards, processors, time and support during the course of this project. Our success would have been impossible without their active participation.
- We would like to thank the California Energy Commission's Public Interest Energy Research Program (PIER) that funded Ecos and the Electric Power Research Institute (EPRI) to conduct this research.

# Questions

## Contact Information

- Baskar Vairamohan - [bvairamohan@epri.com](mailto:bvairamohan@epri.com)
- Chris Calwell – [ccalwell@ecosconsulting.com](mailto:ccalwell@ecosconsulting.com)
- Peter May-Ostendorp – [postendorp@ecosconsulting.com](mailto:postendorp@ecosconsulting.com)