

# The “Green” Machine

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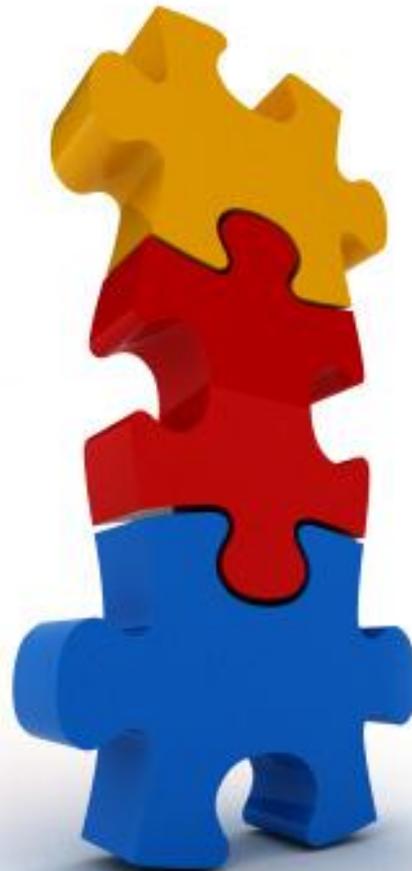
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## Introduction

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### Motives Behind The Idea

“I think it's fair to say that personal computers have become the most empowering tool we've ever created. They're tools of communication, they're tools of creativity, and they can be shaped by their user.”

-- Bill Gates



Most people would agree that computers are needed in today's daily operations. Our research team was very interested in both computers and environmental impacts; it was natural to ask,

“What affects do computers have on the environment in our everyday lives?” In our world, there is a great desire to reduce carbon footprints, both in small and large scale. Even in the computer industry, companies have been looking at more energy efficient components for years. These components range from different hard drive designs, processor types, to the case the computer resides in. Even the smallest change can make a drastic difference. Like everything we do as humans, we start changing one thing at a time around us before we move to gigantic alterations. This project is to do exactly that, make several small changes here on campus at Western Washington University that will hopefully move to a large scale implementation on campus.

### What Is Involved?

This project focuses on the computers we have here on Western's campus. It will show effective and up-to-date computer hardware changes that can be put into place by ATUS, as well as others, including, but not limited to, ResTek, Computer Science Department, and anyone here on campus that needs to build or order a computer in the future. It will address what kinds of computer technology use the least amount of resources to create, and which use the least amount of energy in runtime. The information will be based on written research and conducting interviews with key individuals here on Western's campus that have knowledge key to the success to the implementation. Using the knowledge gathered, a solution is presented that will have the highest margin of energy reduction, without cost as a factor, and then another solution that will reduce the maximum energy usage having cost play an important role in calculation.

### Methodology

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#### Verifiable Research

The majority of our research was obtained through the companies that manufacture the computer hardware that we monitored, as well as third party measurements of energy usage. Many companies show the energy

usage of their hardware on their websites, but some hardware specifications need to be looked up through the manufacture's manuals.

### Interviews

Along with the raw data of the hardware specifications, there exists other data that needs to be obtained. This data is of course, gathered from some of the stakeholders here at Western. This data includes, "What kind of budget is currently used to purchase machines here at Western?" Or, "What vendors are available to ATUS and other departments to purchase computer parts from?" These kinds of questions will be the factors that will vary the recommendations that will be presented.

### Implementation

In this research study, we will only be addressing three specific components of the PCs that ATUS and other university departments would and should consider during PC purchasing. These three components are processors, hard drives, and power supplies. This allows specified and focused research, steering away from generalized concepts and ideas. This creates targeted goals and implementations.

### Data Collection

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#### ATUS's Current Standard

The current build that is being used by ATUS (the most recent computers that ATUS has ordered) contain the following components:

- i. Intel Core 2 Duo E7500
  - a. Cost:  $\approx$  \$115
  - b. Average Energy Use: 65 Watts
- ii. Dell 320 GB SATA II 16 MB Cache
  - a. Cost:  $\approx$  \$50
  - b. Average Energy Use: 6.5 Watts
- iii. Dell 255W 88% PSU
  - a. Cost:  $\approx$  \$40
  - b. Average Energy Use Wasted:  
30.6 Watts

Total Cost:  $\approx$  \$165

Total Average Energy Use/Waste: 102.1 Watts



## New Hardware Energy Use

Energy usage is the focus of this project. This aspect is only one element of saving resources, but it the one that can make drastic noticeable changes as well as can be easily modified, and therefore one of the highest in value to consideration for departments working with a large amount of hardware. Since as stated above, the current ATUS computer build (through the list three components) uses about 100 Watts. Through new hardware, our research team sees great potential to largely reduce the excess energy usage.

### Processors

Processors are the main driving force within a computer. Every command that is issued through a computer is sent through the processor. Processors are often called Central Processing Units, or CPUs. This presents a large amount of active time for the processor, and therefore a large potential for saving energy. There exists several types of processors, and for each type, other hardware is directly affected. For the sake of simplicity, this research project will specifically target the CPU without consideration of the other hardware it affects.



### Hard Drives

In this category, our research team decided to focus on the main two categories of hard drives currently active on the consumer-level market. These types are disk-based hard drives and solid state drives. Hard drives are the active piece of hardware in a system that stores any data on the computer. This data includes applications, including operating systems, word processors, and special purpose applications, as well as documents and stored files which would include Word documents, PowerPoint presentations, and any saved data used by users. Disk-based drives are made of platters of disks that store data on spinning disks. Computers use a large amount of energy spinning the disks and maintaining very high rotations per minute for quick and easy access to the files. On the other side of the coin, solid state drives have no moving parts, just electric signals that excite silicon chips to store the data. This requires significantly less energy to run and maintain. However, with greater efficiency comes a greater value and cost.



## Power Supplies

With power supplies, there is a current program/certification in place to measure and rate energy efficiency of a given power supply. This certification is named 80 PLUS. This standard allows the consumer view where a product ranks in comparison with other products in energy waste. Below is a chart that shows the level of certification that can be achieved by a given power supply with respect to the energy efficiency at a given workload operating at either 115 volts, or 230 volts. In this research based project, we are looking at 115V computers, and comparing to the current ATUS standard, which ranks 80 PLUS Silver, performing at 88% efficiency.



80 PLUS Test Type	115V Internal Non-Redundant			230V Internal Redundant			
	Fraction of Rated Load	20%	50%	100%	20%	50%	100%
80 PLUS		80%	80%	80%	Not defined		
80 PLUS Bronze		82%	85%	82%	81%	85%	81%
80 PLUS Silver		85%	88%	85%	85%	89%	85%
80 PLUS Gold		87%	90%	87%	88%	92%	88%
80 PLUS Platinum		Not defined			90%	94%	91%



## Results

Below is a chart showing different components in their categories and their cost ranges and energy use.

Category	Component	Cost Range	Average Energy Use/Waste
Processor	Intel Core 2 Series	≈ \$75 - \$300	65 W – 130 W
	Intel Atom	≈ \$80 - \$200 *	.65 W – 13 W
	Intel I Series	≈ \$120 - \$950	73 W – 130 W
	AMD Phenom Series	≈ \$70 - \$120	65 W – 140 W
	AMD Athlon II Series	≈ \$60 - \$120	45 W – 95 W
	Hard Drive	WD Caviar Green	≈ \$55
WD Caviar Black		≈ \$80	8.2 W – 10.7 W
WD Caviar Blue		≈ \$50	6.1 W – 6.8 W
WD SiliconDrive III (SATA)		≈ \$1300	1.5 W – 2 W
WD SiliconDrive II (PATA)		No Longer Sold	.005 W - .01 W
Kingston SSDNow V Series		≈ \$150	2 W – 2.4 W
Power Supply	Dell (88% Efficiency) 80 PLUS Silver	≈ \$50	30.6 W
	Antec EarthWatts 380 80 PLUS Bronze	≈ \$45	57 W
	Antec Basiq 350	≈ \$40	87.5 W

\* Not Sold Individually

## Recommendations

### The Green Machine

The first recommendation is that on a budget, the following components are ordered with any new computers being ordered at Western:

- i. AMD Athlon II
  - a. Cost: ≈ \$75
  - b. Average Energy Use: 55 Watts
- ii. Western Digital Caviar Green
  - a. Cost: ≈ \$55
  - b. Average Energy Use: 4.5 Watts
- iii. Dell 255W PSU
  - a. Cost: ≈ \$50



- b. Average Energy Wasted: 30.6 Watts

Total Cost: ≈ \$180

Total Average Energy Use/Waste: 90.1 Watts

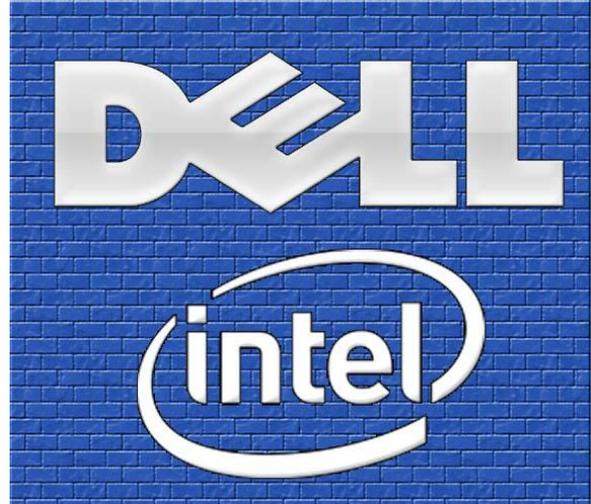
### Ideally Green

The second recommendation is to be used for anytime budget is not a factor in the process of ordering a computer (the most energy efficient PC we could build):

- i. Intel Atom
  - a. Cost: ≈ \$150
  - b. Average Energy Use: .65 Watts
- ii. Kingston SSDNow
  - a. Cost: ≈ \$150
  - b. Average Energy Use: 2 Watts
- iii. Dell 255W PSU
  - a. Cost: ≈ \$50
  - b. Average Energy Wasted: 30.6 Watts

Total Cost: ≈ \$350

Total Average Energy Use/Waste: 33.25 Watts



### Impact

With the gathered information above, and implementing the recommended purchasing practices, we conclude with a few calculations. Looking at the data collected, we can see that between the measured components of the current ATUS standard computer, and the about 620 computers they have in their labs across campus, ATUS uses about 461,900 kilowatt hours (assuming each computer is used for about four hours each day), over the course of all their lifespans (five year cycles) together. If they switch over to the Green Machine, the kilowatt-hours would be reduced to about 407,960. The difference of about 54,000 kilowatt-hours is more than enough to power a typical Bellingham two bedroom apartment for about six years. The amount of energy savings is really shown in the switch to the Ideally Green Machine. Switching to the Ideally Green will use about 150,040 kilowatt-hours, for a savings of about 312,000 kilowatt-hours. This is enough energy to power the same two bedroom apartment for about thirty-five years. This switch would result in a great impact for our surrounding communities here in Bellingham.



## Future Works

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In this study, only a few of many components of a PC were covered. A few components that this study tried, but failed to isolate were video cards and memory. The reason for failure was because of a lack of information provided by the manufactures of the listed hardware components currently purchased by ATUS. Future works we would like to see would be to extend this to all components of a PC, as well as server class computers that Western runs including its web-servers and file-servers. In addition, future work could be expanded to include the harm of the manufacturing process of each component.

## Resources

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