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A Better Upgrade, Not a Faster Throw-Away

An activist guide to minimizing the social and environmental impact of computers and reforming the industry

by Amos Batto

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More than any other technology of recent date, the computer has become the quintessence of modern society. Computers have transformed how we work, communicate, and entertain ourselves. Computers fill our homes, our workplaces, and our imaginations in a way that few technologies do. We spend much of our lives in constant contact with computers. If we are not in front of a monitor screen, we are likely to be found with cars, stereos, TVs, and toys which have computer chips embedded inside. Perhaps the very ubiquity of the computer in our lives causes us to loose sight of the social and environmental impacts of our beloved technology. In our minds, computers are the stuff of modernity--the clean and efficient purveyors of information and entertainment which makes our lives rich. We rarely question the costs of this technology, even when we reach into our pocketbooks to buy another. With increasing voraciousness we consume new computers and junk them just as rapidly.

When confronted with your suddenly outmoded PC, the first question you should ask yourself is not what type of new computer to buy next, but why do we live in a world where the technology which was so shiny and new a couple years ago is now the junk poisoning our planet. We should be asking

ourselves if we truly *need* a new computer every couple years and what will each new computer allow us to do that we can't already do. More importantly, what can we do to change our world so that we don't need to consume and junk a PC every couple years? This guide provides suggestions for what you can do to minimize the social and environmental costs of using computing technology and how you can help reform the computer industry so it does not burden the world with such costs.

Living in a World of Planned Obsolescence and Over-Consumption ▲

If we lived in a world more driven by true needs rather than the dictates of capitalistic over-consumption, we would admit that most of the processing power in today's PC is utterly excessive for the vast majority of users. The 80486 of last decade was perfectly capable of the word processing, spread sheet calculations, internet surfing, and email reading which forms the bulk of our computing needs. The problem is that technology companies only make a profit when they can convince an already saturated market to upgrade to their newest gee-whiz gizmos. The only area of the market where growth is truly necessary is in the low-end commodity sector for low-income consumers. Bringing computing technology to the poor is a truly worthy goal, but it brings only marginal profits and most US technology companies focus their efforts on developing products with a surfeit of power and frill to tickle our consumptive desires. If the market only responded to unmet needs, MIT Media Lab's $100 laptop for the rest of the world have been designed a long time ago. Over-consumption and market pressures lead us to continually upgrade to increasingly profligate technologies. Most consumption of new computers in America is the replacement of a perfectly functioning old computer which then becomes toxic waste relegated to the dump.

Unfortunately, the modern tech economy is based on the premise that hardware should be made obsolescent every couple years. Using modern computing technology becomes an cycle of wasteful upgrades every 2 or 3 years. Tech companies driven by need for continual growth to sustain their overblown stock value are finding it increasingly difficult to sell to an already saturated market. To induce us to continually consume anew, they are forced to produce more and more powerful computers that will throw last year's upgrade into sudden obsolescence. As Intel's Andrew Grove candidly admitted, "We eat our own children, and we do it faster and faster ... That's how we keep our lead."[1]

The needless quest to antiquate last year's processor drives chip makers to plan dual and quadruple core processors now that they have reached the practical limits of forcing more clock cycles per second through a tiny sliver of silicon. Meanwhile, harddrive makers are drawing up plans for terabyte drives, since the billions of bytes of storage in todays drives aren't enough space to hold all the data that will be coursing through these multiple processor cores. ATI and nVidia, in turn, churn out power gobbling behemoths to transform all that data into 3-D fantasylands on our screens that will induce us to open our wallets. As if one GPU isn't enough, now they are devising schemes to sell us two and even four graphics cards to process in parallel the billions of pixels per second required to create the latest first-person shooter mayhem. The folly of trying to endlessly "eat our own children" with more and more powerful chips becomes apparent as we survey the roundup of 700 watt power supplies which are being devised to make all this excessive processing possible.[2] Today's energy-sucking behemoths have moved so far from the original IBM 8088 PC that ran on a 1.5 watt CPU and sipped from a 63.5 watt power supply[3] that one commentator compared the modern PC to the obsolete gas-guzzling muscle cars of the 1960s.[4] When the relentless quest for more power doesn't induce enough consumption, the

industry turns computers into statements of style with incompatible case designs and colors. They dream up a plethora of embedded gadgetry and techno chic fashion like iPods so there is always something novel on the market to tickle our consuming desires.

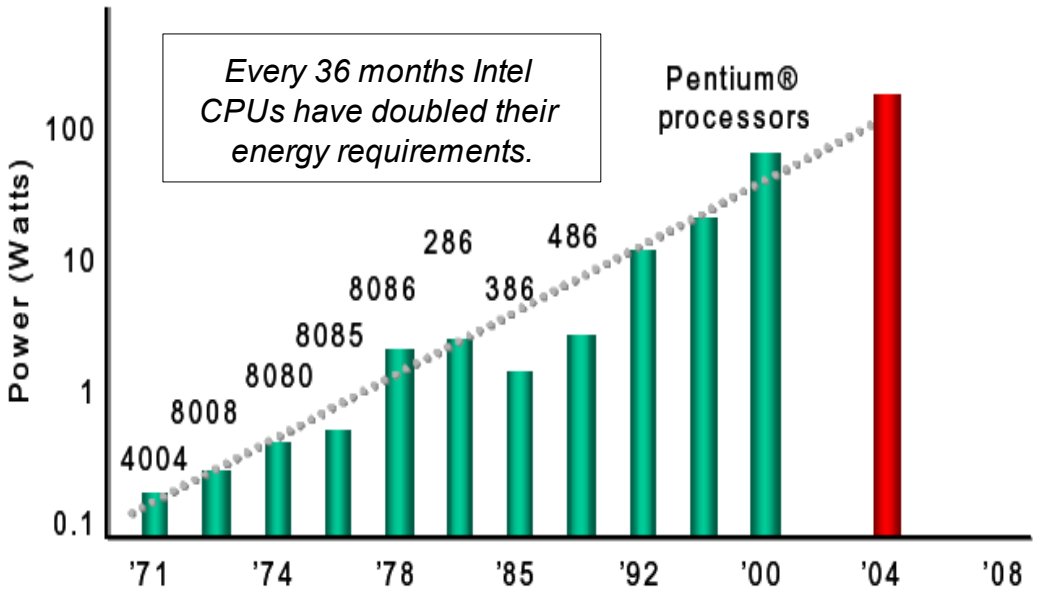


Figure 2: Historical power trend for Intel CPUs

Source: "Emerging Directions for Packaging Technologies", *Intel Technology Journal: Semiconductor Technology and Manufacturing*, Vol 06, Issue 02, May 16, 2002, p 64, ftp://download.intel.com/technology/itj/2002/volume06issue02/art07_emergingdirections/vol6iss2_art07.pdf

Meanwhile, the software companies realize that they will only be able to endlessly sell us more software, if they produce buggy bloatware which forces us into upgrade cycles. If we aren't coerced to buy the upgrade to fix the bugs in the last version, we will be forced to buy the latest software because we can't interchange data with our peers who are using the latest formats which last year's software can't read. Computers have revolutionized the production and dissemination of information, but we can only access that information if we continually upgrade to the latest technology capable of reading it. Each upgrade of the latest bloatware consumes so much more memory and processor time that we are forced to upgrade our hardware at the same time. Once a number of our peers upgrades, we can not risk being left incommunicado and must upgrade just to keep up with the frenetic herd. Each new computer packs millions more transistors, sucks more current, and requires more cooling fans just to function, yet we rarely pause to question the insanity of riding this technological whirlwind.

Each upgrade is regarded as an advancement to be hailed as progress in our society, but we must ask ourselves what have we really done except consume more resources to do the same job as before. MIT's Nicholas Negroponte observes: "Today's laptops have become obese. Two-thirds of their software is used to manage the other third, which mostly does the same functions nine different ways."[5] Undoubtedly, it is a technological wonder that today's desktop computer can pump 2.5 Gb/s of visual eye-candy down a single PCI Express line so we can edit movies at home and play the latest first person shooter from Id Software. Titillated by the latest novelty, we often forget to ask ourselves what is the purpose of our technology.

Without retreating into Luddism, asceticism, or anachronistic views of a rosy pretechnological past, we need to pause and ponder our real needs and ask how computers help us fulfill those needs. Technology pundits hailed the fact that last year Americans bought 67.2 million personal computers--one for every 4.5 Americans[6]-- yet they failed to ask what real benefit all those computer purchases brought. The Computer Industry Almanac notes that roughly 75% of computer purchases in America are

replacements of an existing unit. The strongest growth is in notebook sales, which are sold mainly to people who already own a desktop computer.[7]

Growth in PCs (in thousands of units)

Year	US PC Sales per year	US PCs in Use	World PC Sales per Year	World PCs in Use	US PC Sales per 1000 People	US PCs in Use per 1000 People	World PC Sales per 1000 People	World PCs in Use per 1000 People
1975	40	40	50	50	0.2	0.2	0.01	0.01
1980	760	1,400	1,100	2,100	3.3	6.1	0.2	0.5
1985	6,600	19,000	11,000	33,000	27.7	79.7	2.3	6.8
1990	9,500	51,000	24,200	100,000	38.2	192.2	4.6	18.7
1995	21,400	86,000	70,100	225,000	81.0	324.1	10.2	39.8
2000	46,000	177,000	130,000	523,000	163.5	629.5	21.4	21.4
2003	48,300	218,000	149,000	738,000	165.0	744.0	23.7	117.0
2005*	56,600	236,000	181,000	896,000	193.4	779.3	29.4	139.1
2010*	66,700	290,000	249,000	1,350,000	222.0	933.8	39.2	196.9

*Projected
Source: "Worldwide PC Market", eT Forecasts, 2004, http://www.etforecasts.com/products/ES_pcww1203.htm
Calculated PCs per 1000 with population numbers before 1990 from "Total Midyear Population for the World: 1950-2050", US Census Bureau, http://www.census.gov/ipc/www/worldpop.html

Even more telling is the growing trend to market computing technology in terms of fashion and lifestyle choices rather than utility and functionality. Not only are PCs being transformed into fashion statements with a myriad of colors and case designs, but computer technology is being commodified, accessorized, and embedded in consumer goods such as Furbies, iPods, xBoxes, Tivos, and Media Centers. After the rush to replace all the PCs in anticipation of the over-hyped Y2K bug, the US computer industry found little growth in primary workstation PCs as shown by the fact that between 1999 and 2002 annual sales only grew from 44.8 to 46.5 million units. The recent rush to sell computers in terms of style and lifestyle conveniences has created new markets for secondary computers as shown by the dramatic increase of 20 million more in PC sales between 2002 and 2005. According to a study by Current Analysis in August 2005, Media Centers account for 43% of US desktop sales as consumers increasingly look toward their PCs as a means of multimedia entertainment;[8] meanwhile IDC predicts that "the future looks bright for vendors offering PCs as digital appliances for the home."[9] Assessing the 2004 Christmas sales, Roger Kay, vice president of Client Computing at IDC, commented that "consumers came out in force in the holiday quarter to pursue their growing interest in PCs and the digital lifestyle."[10] Perhaps our "digital lifestyle" explains the fact that Americans who make up only 4.6% of the world's population bought 33.0% of the PCs sold in 2004. Rather than hailing this fact as proof that the US consumer confidence is strong, we should be deploring the fact that we overconsume a precious resource, which is scarce in much of the world. In the US, there are 779 personal computers per thousand people, while in India, there are are only 14.[11]

Computer consumption in the US is part of a general trend of overconsumption in all the developed countries which deprives the majority of the world of valuable resources. According to a 1998 UN Human Development Report, 20% of the world's population living in the most developed nations account for 86% of total private consumption expenditures. Meanwhile, the bottom 20% living in the

world's poorest countries only consume 1.3%. Computers, like so many other amenities of our wealthy lifestyle, require vast amounts of energy. The 20% that live in the most developed nations consume 58% of the world's total energy, while the bottom 20% only use 4%.[12] Surveying the vast inequalities, the UN report soberly concludes that "tomorrow's human development" depends upon "changing today's consumption patterns." The report commences with a clarion call for us to reevaluate the ways in which we consume:

> Consumption clearly contributes to human development when it enlarges the capabilities and enriches the lives of people without adversely affecting the well-being of others. It clearly contributes when it is as fair to future generations as it is to the present ones. And it clearly contributes when it encourages lively, creative individuals and communities.
>
> But the links are often broken, and when they are, consumption patterns and trends are inimical to human development. Today's consumption is undermining the environmental resource base. It is exacerbating inequalities. And the dynamics of the consumption-poverty-inequality-environment nexus are accelerating. If the trends continue without change—not redistributing from high-income to low-income consumers, not shifting from polluting to cleaner goods and production technologies, not promoting goods that empower poor producers, not shifting priority from consumption for conspicuous display to meeting basic needs—today's problems of consumption and human development will worsen.
>
> . . . In short, consumption must be *shared, strengthening, socially responsible and sustainable*.[13]

As the report details, the way which we in the developed world consume has an effect on the way that the rest of the world lives, or fails to adequately live.

Although computers form only a part of our consumptive habits, they form a vital element and are emblematic of the information age we are entering. If we reform the ways in which computers are created, bought, used, and disposed, the effects will redound into larger spheres, since computers are the linchpin in the manipulation and transference of information which will constitute the basis of the future digital economy. As humans increasingly interact and define themselves through technology, society itself and the rules of social interaction will be shaped by the computers we use. As we hope for a better future for our world, we must ask ourselves how we can make our consumption of computers be "shared, strengthening, socially responsible and sustainable" as the UN report advocates. These are not easy propositions and the solutions are often debatable. Nonetheless, this activist guide hopes to educate you about the major issues, motivate you to action, and link you into collective efforts for reform.

Environmental and Social Impact of Computers ▲

Without a doubt, computers have brought us great benefits in terms of communication and productivity gains. As a society, we would be foolish to wholly reject computer technology, yet we must recognize the folly of treating computers as an unvarnished good to be endlessly consumed anew without thought for their environmental and social costs.

The environmental impact of each new power-hunger, polluting computer is significant. A recent UN University study found that 1.8 tons of raw material are required to manufacture the average desktop

computer and monitor. Roughly 240 kilograms of fossil fuels, 22 kilograms of chemicals and 1,500 kilograms of water are used to make a desktop PC and a 17 inch CRT monitor.[14] The environmental costs become alarming when considering how precipitously new PCs are being produced. Over 1 billion PCs had been produced in the world by the end of year 2002. The Computer Industry Almanac predicts that cumulative total will double within six years to over 2 billion by the year 2008.[15]

When we think of pollution, we generally think of the industries of the past based on steel and coal industries. Yet, in Southeast Asian countries such as China and Malaysia where environmental standards are lax, electronics manufacturing in the modern information age can be just as polluting as the dirty industries of yore. Even with tighter regulations on the use of toxins to prevent leakage into the environment, silicon chip manufacturing has hardly been benign in the US. In 1995, the production of a single six-inch silicon wafer required 3,200 cubic feet of bulk gases, 22 cubic feet of hazardous gases, 2,275 gallons of deionized water, 20 pounds of chemicals, and 285 kilowatt hours of electrical power. In the process, 25 pounds of sodium hydroxide, 2,840 gallons of waste water, and 7 pounds of miscellaneous hazardous wastes were generated.[16] Most of that industrial waste was handled responsibly, but some has been released into the environment. In 1993, 44% of the 122 million pounds of production-related waste from the US electronics industry was released into the environment or transferred off-site. Released chemicals such as acetone, xylene, and toluene deplete the ozone layer, while xylene, acetaldehyde, and dichlo9 contaminate the ground water. The most commonly-released chemicals for the semiconductor industry were hydrochloric acid and sulfuric acid which are used in the etching and cleaning process.[17] Because this industrial waste was handled irresponsibly in the past, the Silicon Valley is dotted with 29 superfund sites caused by the pollutants spewed by the stars of the modern high-tech economy. Intel, AMD, Hewlett Packard, IBM, Fairchild Semiconductor, Teledyne Semiconductor, Raytheon, Siemens, Owens-Corning, and Westinghouse all have superfund sites to their name in the Silicon Valley.[18]

Although the tech industry is cleaner and more efficient today, the environmental impact of the industry hasn't necessarily fallen due to the sheer increase in the amount of electronics being produced and junked. In the mid-90s a large silicon chip factory cost 1 billion to build and required 10 to 15 megawatts to operate, whereas today it costs $2.5 to $3 billion and sucks 25 to 30 megawatts. A 1999 study estimated that the 300 American chip fabs and their suppliers consumed 1% of the nation's electrical output.[19] The majority of that energy comes from burning fossil fuels which contribute to global warming. In water-strapped Southwest, where most of the American chip fabs are located, silicon manufacturing hogs precious water resources.

If the environmental cost of an upgrade doesn’t give you pause, consider the fact that each new computer purchase is contributing to the inhumane exploitation of workers in Southeast Asia. Most electronics are assembled by Taiwanese, Japanese, and Korean companies which operate with little regard for workers' rights or health in poorer countries like China and Malaysia. In recent years, even the final assembly of computers is increasingly switching to Southeast Asia as companies are forced by a competitive market into a race to the bottom. Companies like Quanta specialize in building laptops at a minimal 3% profit margin and companies like Gateway have laid off their US workers and switched to Chinese assembly. Electronic assembly workers are often young women who are overworked and their health endangered due to eye strain, repeated motion disorders, and exposure to hazardous heavy metals and adhesives. In countries like China and Vietnam, workers rights are largely nonexistent; and in other countries like Bangladesh and the Philippines, workers rights exist only on paper. When electrical assembly workers stand up and demand better wages, they are frequently fired, and even

blacklisted, arrested or beaten in some cases.

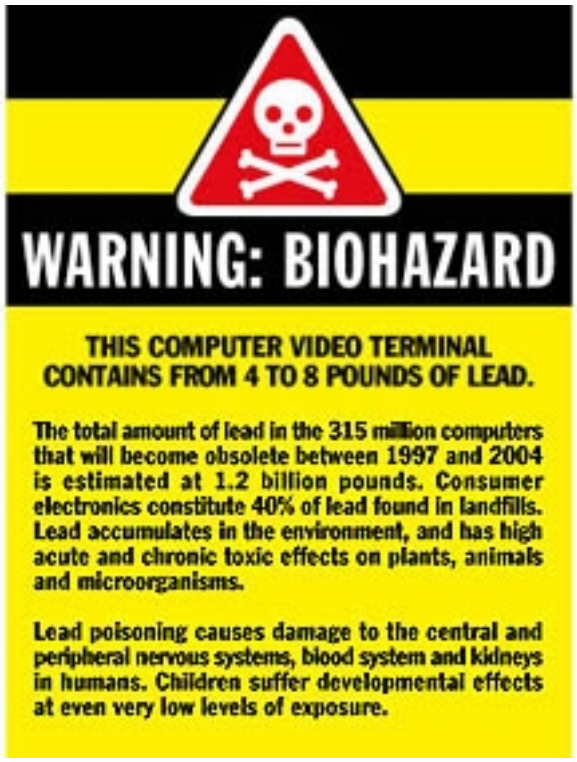
By buying a new computer, you are contributing to economic globalization and the growing disparity between the rich and the poor. Apologists for neoliberal trade often argue that industries such as electronics brings needed jobs to people who would otherwise be unemployed. Some Chinese are benefiting from the new managerial, engineering, and professional jobs created by free trade, but the vast majority of new jobs pay far below a "living wage" which would adequately supply their human needs. These jobs aren't enough to support a family. Many of the workers in the electronics factories are young women from the countryside who are sent into the cities to earn a supplemental income for the family. For instance, most of the workers at Shenzhen Action Electronics in Guangdong Province, China are young women as young as 14 years old who have come from the countryside. They live in company dorms with 10 or 12 people to a room. In a typical 65 hour work week, they are paid $18.91, or 29 cents an hour. Out of this salary, workers pay for their food, which lowers their weekly earnings to just $15.57.[20]

The National Labor Committee calculates that a living wage in China would be 87 cents an hour,[21] so we can see that these jobs are hardly helping the Chinese. If China tried to raise the wages of these workers or created more stringent safety and environmental standards, international manufacturers would just pick up and go to another country such as Vietnam or Bangladesh. These jobs create a race to the bottom and pressure countries to not enact social reforms which safeguard the health and well-being of the working poor. As a country such as China creates a new wealthy class of managers, engineers, entrepreneurs, and international businessmen, that wealth is not being shared with the rest of Chinese society. At the same time, the developed countries like the US are losing manufacturing jobs and the workers who used to do these jobs are being forced into lower-paying service jobs. Economists who tout the benefits of free trade forget to mention that its benefits accrue to the wealthy while the costs are mainly born by the poor. The global trade in electronics is part of the reason why there is a growing gap between the rich and the poor both at home and abroad. Since the early 1980s, income inequality as measured by the gini index has grown from 32 to 44.7 in China and from 40 to 46.6 in the US. Neoliberal economics and free trade policies have caused lower class worker's wages to remain stagnant, while upper class incomes have dramatically increased in both countries.[22]

The Hazardous Disposal and Recycling of Computers ▲

Not only is the creation of computers an environmental and social disaster, their disposal is similarly detrimental. Every time we junk our old PC, we are contributing to a looming toxic waste problem. CPUs and monitors contain a welter of chemicals and heavy metals which can cause cancer, birth defects, and hormone disruption and damage body organs if they are allowed to leak into the environment. CPUs contain chromium which damages DNA and mercury which harms the nervous system and kidneys. The PVC (polyvinyl chloride) and brominated flame retardant plastic in your computer releases carcinogenic dioxins and furans when manufactured and/or burned. The wires are coated with plastics which leach out phthalates which cause birth defects. A Cathode Ray Tube monitor is a veritable toxic waste container with lead, phosphorous, cadmium, barium, mercury, zinc, and vanadium inside. Despite the fact that the EPA banned the dumping of CRTs in October 2001, the lack of enforcement ensures that many CRT monitors will continue being dumped in municipal waste so that the 3 to 8 lbs of lead in each monitor can potentially leach into the ground water. Roughly 40% of

the heavy metals in US landfills, including lead, mercury, and cadmium, come from discarded electronics. According to the Silicon Valley Toxics Coalition, the 315 million American computers which have become obsolete contain 1.2 billion pounds of lead.[23]



Warning to attach to your computer monitor from the Computer TakeBack Campaign.

In contrast to Europe and Japan, the US has taken only lackluster steps to prevent their computers from ending up in the garbage heap. The National Safety Council estimated that only 11% of the 20.6 million computers which Americans put out of commission in 1998 were recycled.[24] This percentage may have improved marginally after the National Electronics Product Stewardship Initiative was launched in 2001 "to maximize the collection, reuse, and recycling of used electronics." The NEPSI brought together representatives from a dozen state governments, 15 electronics firms, and 17 environmental organizations, recyclers and academic institutions, but it seems to have generated more talk than concrete plans. The NEPSI wanted to create a "viable financing mechanism" to pay for recycling and create "appropriate incentives to design products that facilitate source reduction, reuse and recycling; reduce toxicity; and increase recycled content."[25] Sadly, there seems to be little agreement about who should be paying the costs. Michele Raymond, an expert in recycling programs around the globe, found that only 9 out of 35 state recycling managers thought the NEPSI would ever lead to a national electronics recycling program.[26] As part of the NEPSI, the Electronic Industries Alliance began advocating voluntary recycling programs and helped initiate a year-long pilot project in October 2001 to test three models of recycling: a municipal, a retailer, and a consumer drop-off model. The EIA, which represents 1300 electronics companies in the US, probably realized that some *pro forma* effort at recycling was called for, if only to head off more stringent government oversight when the EPA banned the dumping of CRT monitors.

These efforts have made little headway in dealing with the mounting problem of electronic waste in the US. The amount of consumer electronics thrown way by Americans is growing by 25.7% every year.[27] In the year 2000, we threw away 125,340 tons of monitors and 93,474 tons of PCs.[28] The problem will only get worse as the National Resource Council predicts that 250 million computers will be dumped within 5 years. Despite these alarming facts, Bush's EPA has been content to let the electronics industry police itself and only promotes voluntary recycling programs. In January 2003, the EPA launched its Plug-in to E-Cycling Campaign to encourage private industry and citizens to recycle electronic waste, or "e-waste" as it is called. These voluntary measures promoted by the EIA and EPA have had limited impact and have done little to raise public awareness about the hazards of e-waste. HP's own surveys show that 95% of American consumers do not know the meaning of the term "e-waste," and 58% are not aware of an e-waste recycling program in their community.[29] Another study from the State of Florida found that 81% of consumers weren't even aware that their computers could be recycled.[30]

Sadly, the misperception that there is no computer recycling is often truer than not. Despite the efforts of conscientious people to avoid contributing to the e-waste problem by recycling, very little of the materials in a "recycled" computer will be recovered. Silica (glass) is the most common component by weight in an old computer, but it is either very difficult to extract or difficult to reuse because it contains lead. The typical computer contains 13.8 pounds of plastic, yet very little will be recycled. Some of the plastics used in electronics like PVC are unrecyclable and others like high impact polystyrene (HIPS) have no resale value in the recyclables market. Even plastics like ABS and polycarbonate which can be recycled have limited value because they are mainly downcycled into lower quality products. Recycled ABS must be at least 99% pure in order to be reused in an ABS electronic part and it can't contain more than 15% recycled content before its material properties start to degrade. Many computer components contained mixed plastic which is often worthless and difficult to process.[31]

Burning plastic insulation off wires in Guiyu, China may release hazardous dioxins, furons, and brominated flame retardants. © Basel Action Network

Computer makers do not design their products to be readably disassembled and separated into their constituent elements for recycling. Printed circuit boards and chips do contain valuable gold, silver, platinum, palladium, copper, and aluminum, but it is difficult and costly to extract them. Often recycling is more polluting than leaving the computers in a landfill. For instance, to get the copper out of wires, some recyclers burn off the plastic insulation, releasing chlorine which destroys the ozone layer and brominated flame retardants which disrupt hormones. Burning PVC wire insulation also creates deadly dioxins and furans and releases heavy metal neuro-toxins and phthalates which cause birth defects and developmental problems.

Efficient and safe computer recycling requires a large investment in expensive shredders, sorters, and smelters to extract the valuable materials from the dross. Computer reycling has to be subsidized, because it is too unprofitable and labor intensive to extract the $4.25 of recyclable material from the typical CPU and CRT monitor. Many electronics recyclers strip out a few valuable components and dump the rest back on the garbage heap, or sell it abroad where labor costs are low. An estimated 220,000 tons of American e-waste is exported abroad every year.[32] The Basel Action Network, an environmental group which opposes the international trade in toxic refuse, estimates that between 50% and 80% of the American e-waste which is “recycled” is actually being exported abroad. Most of it goes to China, India, Pakistan or Thailand where recycling is an unregulated cottage industry. Whole families work to extract materials, exposing themselves to toxins and poisoning their soil and air. The most valuable materials are extracted, while the majority of the hazardous materials are left to pollute the water and soil in these countries.[33] The toxic products we consume and junk so avidly become

environmental hazards in the backyards of people all over the world. So much of our e-waste is left on the ground that Ted Smith, national chair of the Computer TakeBack Campaign, comments, “This isn’t e-waste recycling, this is e-waste dumping.”[34]

Woman in Guiyu, China cracking open monitors to remove copper yokes worth 80¢ ©Basel Action Network

In the city of Guiyu, China, 100,000 people are reported to work in e-waste recycling. According to the Basel Action Network, people in Guiyu disassemble electronics with chisels, hammers, and their bare hands. To extract copper yokes worth 80¢ from CRTs, Women and children smash monitors and TVs with hammers and expose themselves to lead and toxic phosphor dust. The broken monitor glass, which is 20% lead by weight, is washed in the local rivers, so it may be sold to glass recyclers. The local water has become so foul, that drinking water has to be shipped in from 30km away. Motherboards and chips are dumped into open air baths of nitric and hydrochloric acid to extract precious metals. These baths emit chlorine and sulfur dioxide gases and their contents are dumped into rivers. Wires and printed circuit boards are burned in open fires to remove the plastic, releasing a miasma of toxins and heavy metals. People live, eat, and play among piles of e-waste, chemical baths, and burned plastic ash. Tests by the Basel Action Network found the ground to be permeated with heavy metals. Unsurprisingly, local people report increased respiratory illnesses and higher rates of childhood leukemia from living in this toxic waste zone.[35]

The situation in Guiyu is hardly unique. Investigators in other places in China, India, and Pakistan have observed similar toxic working conditions for recycling e-waste. For instance, people working in battery dismantling workshops in Mayapuri and Buradi districts in India are dangerously exposed to carcinogenic cadmium. The dust in these workshops contained 40,000 times more cadmium than typical indoor dust.[36] The electronics which are recycled in these sorts of places doesn't just come from the trade in e-waste. Much of it also comes from the legal trade in "used" computers. According to the Basel Action Network, as much as 75% of the electronics and computers sent to Africa for reuse is actually unrepairable e-waste. BAN's investigators in Nigeria found that much of the exported electronics was unsafely dumped or burned in open fires. The price that poor countries such as Nigeria have paid for bridging the digital divide with used computer equipment has been accepting tons of e-waste to find enough salvageable parts.[37] No country should have become a toxic waste repository in order to participate in the modern information age.

Our toxic e-waste is exported abroad to endanger other people's health and poison their environment, because the US government has refused to ratify the 1994 Basel Convention banning the international trade in hazardous wastes. Unlike the 165 other nations which have ratified the Convention, the US has been remarkably unwilling to control what happens to its e-waste, to the point that it failed to implement the treaties of the Organization for the Economic Cooperation and Development(OECD)

which control the trade in hazardous waste.[38] For this reason, the computer you give to a recycler is likely to end up as acid wash and plastic ash in Nanhai, China or Karachi, Pakistan. Even if your old computer doesn't leave the US, it may be recycled by prison labor working in a toxic environment. Recycler UNICOR processed 44 million pounds of e-waste in 2004. It employs a 1000 inmate employees in seven penitentiaries who are paid between $0.23 and $1.15 an hour. UNICOR gives prisoners hammers and tells them to break CRT screens when they are only wearing regular prison uniforms, cloth gloves, and simple dust masks for protection. The prisoners eat their lunches surrounded by toxic dust which permeates their clothes and hair. This same dust gets tracked through out the prison, because the prisoners don't have facilities to wash off or change their clothes after leaving the work site. When a safety manager at the Atwater Federal Penitentiary in the San Joaquin Valley filed a complaint with OSHA about the unsafe working conditions, the prison tried to silence him and cover-up the problem. Even after the prison had hastily cleaned up the facility, an OSHA inspector still found a number of safety violations for working around hazardous materials and tests showed lead, barium and cadmium in the air of the prison.[39]

Minimizing the Harm of Your Computer ▲

Think twice before you turn your old computer over to a recycler. It might end up being disassembled by children on a polluted riverbank in China or contaminating a prison in California. The Silicon Valley Toxics Coalition (SVTC) has assembled a list of recyclers who have signed a Pledge of True Stewardship which promises to practice safe recycling and not export e-waste abroad. If you can't find a responsible recycler in your area on the list,[40] it might be better to let your computer molder in your closet for the time being. Although your musty slippers might not appreciate its company in the closet, it is probably better to leave your old computer undisturbed, rather than risk exposing its toxic contents to workers and the environment.

A number of computer companies will recycle your old computer for fee between $10 and $34. If you buy a new computer from Dell, they will now take your old computer off your hands for free. HP will not only recycle your old computer for free when you buy a new computer from their webstore, they will give you a $50 discount off the price of the new computer to boot. Although HP's recycling facilities hasn't signed the pledge, they do practice safe recycling and don't export abroad according to the Silicon Valley Toxics Coalition. Dell, on the other hand, used to contract its recycling out to UNICOR which not only uses prison labor, but also exports e-waste abroad. Although Dell denied that it was exporting e-waste, SVTC issued a report exposing Dell's activities. Public backlash was so great that Dell cut its contracts with UNICOR in 2003 and promised to practice clean recycling in the future.

If you really are concerned about mother nature, you won't consider buying that new computer from Dell or HP in the first place. No matter how energy efficient your new computer claims to be, it is far better to go on using your old computer. An estimated 81% of the total energy cost of a computer lies in the original manufacturing. The average desktop computer and 17" CRT requires 6400 megajoules to manufacture, but only 500 megajoules to run for a year.[41] The energy that you expend to keep an old crufty computer running for an extra year or two is a mere fraction of the energy costs of creating a new computer. The extra seconds you have to wait for your word processor to open are worth the wait, knowing that you just saved 1.8 tons of raw materials used to create an new computer. The fact that you can't go charging through toxic sludge in Doom 3 with your old computer shouldn't bother you

when you know that you aren't helping to create a toxic wasteland in someone's backyard in China. Use those extra moments when your old processor chokes on too much data to stretch and reflect on what is truly important to you.

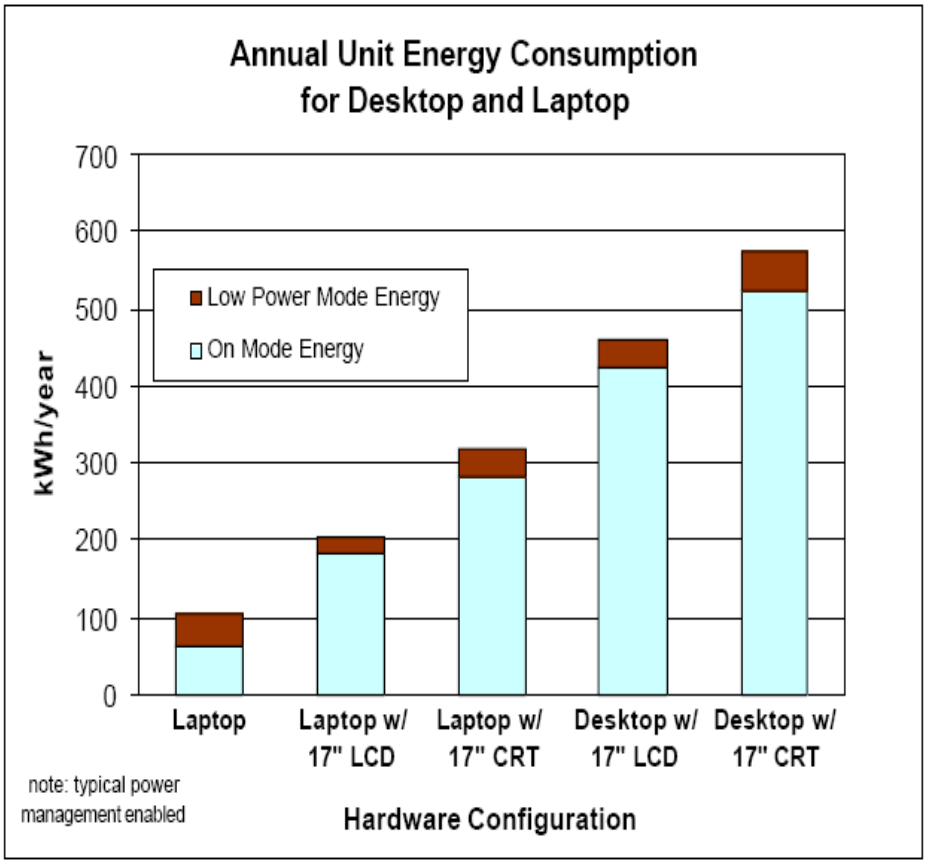
The next time you think about replacing your computer, consider upgrading instead. You might be able to squeeze an extra year or two out of your CPU by adding an extra stick of RAM or installing a DVD-ROM. The 1.7 kilograms of fossil fuels and chemicals and 32 kilograms of water used to create a new 2 gram DRAM chip are far less than the resources expended to create a whole new computer.[42] Consider this move carefully, because it won't do an good to upgrade and then find that you still need to buy a new computer two months later. More memory or a faster harddrive will only marginally speed up a poky computer. In that case, consider buying a new motherboard and processor, rather than replacing the whole computer. If you can't upgrade, consider buying a used or refurbished computer at ebay, Refurb Depot, or Computer Renaissance so you won't be responsible for creating another resource-hogging machine.

Unfortunately, upgrading your computer is often not a desirable option. The speeds and standards for RAM and optical drives keep changing so fast that these components often can't be reused. Many computers are built on odd form factors and don't have any extra expansion slots in the front, so the case also can't be reused. The power requirements keep increasing so you will have to junk your old power supply. Upgrading computers is often a suboptimal solution because computer makers are so frenetically pursuing new powerful features at lower costs, that modularity, upgradability, and past compatibility fall to the wayside at the designer's bench. Dell showed back in 1996 with its OptiFrame case that computer cases could be designed with modularity to accommodate future technological change (and easy recycling), but this sort of design has not been promoted by the industry. The fact that no computer maker maker has even attempted to design a laptop which allows the motherboard to be replaced speaks volumes about priorities in the industry.

For some people, an outdated computer simply won't serve their needs. When I worked at an engineering firm, my boss once calculated that it made financial sense to buy the latest and greatest technology, because every millisecond his Verilog emulator twiddled away was less time for banging out the code which earned him a living. If you find that you must buy a new computer, make sure that your old computer finds new life in someone else's hands. If you don't have a good friend or relative who needs it, donate it to a needy NGO, charity, or school. Before donating it, make sure to clean all the personal data off your computer with a free software program like Eraser for Windows or Wipe for GNU/Linux. Hearts and Minds has compiled a list of groups that will take your old computer and donate it to a good cause. The EPA has some helpful links for donating old computers and cell phones. Although your computer may be worthless junk in the US, it still has a great deal of value in poorer countries. I have worked on projects in Guatemala and Bolivia which fixed up old computers for schools and NGOs and can testify to the good that comes from reusing old technology abroad. Even if your computer doesn't work any more, consider selling its useful parts on ebay or giving them away on DIYParts.org.

When buying a new computer, try to maximize its life span by buying a higher quality computer which won't be outmoded in the next six months. Buying a computer with a faster processor and large amounts of memory will make your machine last longer than the cheapest available Celeron, Sempron, or C3. Still, even the fastest processor on the market today probably won't make your computer last much longer than the fourth or fifth fastest speed of processor, so there is no need to pay the overblown

prices to stay on the bleeding edge of technology. If you are trying to economize but still want a long-lasting computer, look for the slowest processor in the newer line of processors which run on a faster system bus speed. A good rule of thumb is to look for a computer whose processor is worth roughly $200 if made by Intel or $160 if made by AMD. If you think that you will want to upgrade to Vista, Microsoft's next operating system, you should buy a computer with a 64 bit processor, 1 GB of RAM, and a stand-alone graphics card. Most of Intel's integrated GPUs won't be able to handle Vista's visual eye candy.[43]



Source: *Suzanne Foster and Chris Calwell, "Laptop Computers: How Much Energy Do They Use, and How Much Can We Save?", National Resources Defense Council and Ecos Consulting, August 2003, p. iii, http://www.efficientproducts.org/reports/computers/NRDC_Laptops_FINAL.pdf*

Today, many people are buying laptops as secondary computers—an option which you should avoid if you can get by with only one computer. If you need both a laptop and a desktop, consider just buying a 15.4" or a 17" laptop which can serve as both a desktop replacement, and a laptop. If you require a light laptop or need more screen space at home, consider a laptop and an external LCD monitor to use at home. Some of the lightest laptops may require you to buy a docking station to attach an external screen. In general, laptops consume less resources and energy to manufacture. They require less plastic and metal and have fewer printed circuit boards. Although it requires the same amount of energy to produce the processors inside, laptops tend to have integrated chipsets, so there are fewer total chips and printed circuit boards than in a desktop. Moreover, laptops require less energy to run and are highly efficient. In recent years, laptops have made a number of advances in energy efficiency such as CPU throttling and Instantly Available PC (IAPC).

Unfortunately, desktop computers haven't incorporated most of these new energy-saving features and have instead upped their energy requirements to accommodate to multiple central processors, more powerful GPUs, and more power-hogging accessories. Despite the claims of the Electronic Industries Alliance that "[t]he U.S. high tech industry is the only industry whose products become smaller, cheaper, better, faster and more environmentally friendly year after year",[44] desktop PC makers have focused on increased power rather then increased energy efficiency. According to the National Resources Defense Council, the average laptop only uses 104 kilowatt-hours per year compared to the 576 kWh/yr used by the average desktop computer and 17" CRT (460 kWh/yr with a 17" LCD).

Switching from a desktop to a laptop computer can save 470 kWh or $40 per year in energy.[45] If a fourth of the desktop computers in the US were replaced with laptops, the annual energy savings would be 20 billion kWh.[46] Before you switch, remember that far more energy is consumed in the original production of a new computer, so keeping your old inefficient desktop running is still more environmental than buying a new laptop.

Annual Energy Costs per Computer

Configuration	Operational Energy* (kWh/yr)[47]	Operational Energy Cost (US dollars)[48]	Production Energy* (kWh/yr)[49]	Total Energy (kWh/yr)	Total Energy Cost (US dollars)	CO2 Production (lbs/yr)[50]
Laptop	104	$9,03	500	604	$52,43	914
Laptop w/ external 17" LCD	203	$17,62	630	833	$72,30	1261
Laptop w/external 17" CRT	319	$27,69	630	949	$82,37	1437
Desktop w/ external 17" LCD	460	$39,93	445	905	$78,55	1370
Desktop w/ external 17" CRT	576	$50,00	445	1021	$88,62	1546

*Operational energy is the annual energy expended in running a computer. Production energy is the energy expended to initially produce the computer divided over the lifespan of the computer. For instance, 1775 kWh is used to produce a desktop PC and 17" CRT, which is divided over the 4 year lifespan for 445 kWh/yr.
Note: Most people probably have lower operational energy for their computers. Eric Williams estimates that the average desktop computer with 17" CRT only uses 139 kWh/yr. A study by Averatec found that the average household laptop only uses 26.1 kWh/yr and the average office laptop uses 41.1 kWh/yr.[51]

The efficiency of a laptop must be balanced by the fact that laptops usually don't last as long and most of the parts in a laptop can't be upgraded or even fixed for a reasonable cost. Laptops are generally only used for about 2.5 years compared to the 4 year life span of a desktop computer.[52] The industry has prioritized lightness over durability and designs throw-away laptops which resist easy upgrade and repair. Many of the laptops in use today will be junked when Microsoft's Vista finally arrives because they don't have empty memory slots and their 32 bit processor and integrated graphics processor can't be upgraded. Sadly, millions of perfectly functional computers will be outmoded by wasteful bloatware which demands a 64 bit processor, 1 gig of memory, and 3D graphics to adequately run.[53]

Laptops aren't junked at a higher rate than desktop computers only because they can't be upgraded, they also have a higher failure rate. Even laptop brands which have a reputation for reliability break with alarming frequency. Mac laptops were ranked among the most reliable brands according to *PC World*'s January 2006 reliability survey, yet a MacInTouch survey of 10,000 Mac owners found that 21% of all Mac laptops had to be repaired in the first year. According to another industry study, 18% of laptops are physically damaged and returned for repair in their first year of life. The cause of 90% of these failed laptops in the first year are drops and liquid spills,[54] yet rugged notebooks could easily be designed to withstand these extra stresses at little extra cost and weight. Twinhead has shown with their new Durabook line what can be done if the priority is placed on durability and energy efficiency, rather than lightness or power. The Durabook N14RA only weights 0.5 to 0.7 lb more and retails for $150 to $250 more than an a normal laptop,[55] yet it features a magnesium alloy case that is 20 times stronger than usual ABS plastic, a spill-proof keyboard, a locking optical drive, and an anti-shock mounted LCD and harddrive. If the whole industry designed their laptops to be drop and spill proof in this way, the mass market would drive down the costs so much that the difference in price between these these more durable parts and today's conventional parts would be vanishingly small. Consumers are partly at fault for not demanding more rugged laptops, yet until Twinhead debuted the Durabook line, the industry

never offered a viable alternative that didn't cost double the price of a normal laptop.

Laptops are readily added to the mounting piles of e-waste, because fixing them often costs more than simply buying a new model. If a laptop breaks after the 1 year warranty expires, most customers make the economically rational choice to junk it and buy a new one. Computer companies explicitly discourage people from even trying to fix their own laptops when it breaks, so laptops will only be serviced through the brand company. For the intrepid few that dare to void their warranty and try to fix their laptop themselves, they are met with a host of unnecessary obstructions. Laptop chassis could be redesigned to facilitate easy disassembly with an ordinary Phillips screw driver, yet most are also held together by a tangle of plastic pressure tabs which readily break and are extremely difficult to pry apart. Laptop owners, who ignore the warnings in the owner's manual about opening up their laptop, often find that replacement parts are too expensive to justify repair. Quanta and Compal together manufactured 28 million laptops in 2005--almost half of the 60 million produced in the world[56]--yet not a single one of their design specs are publicly available on the internet,[57] so people can't find the original part numbers for components. Instead, people are forced to order expensive replacement parts through the brand companies such as Dell or HP-Compaq who have renumbered all the parts to preclude people from ordering cheaper parts directly from the manufacturer.

Given the recent consolidation in the laptop manufacturing market among a few Taiwanese companies, the big players could easily agree among themselves to use standardized parts to facilitate easy repair as has happened with the ATX form factor for desktops. For instance, there could be 3 standardized form factors for parts on 12", 15", and 17" laptops, so a keyboard taken off one 15" laptop would fit into another 15". Of course there would always be specialized notebooks that don't comply with the standard form factor just as there are nonstandard desktop computers. Nonetheless, people who know that they might want to upgrade or fix their laptops in the future would buy the standardized units just as they buy ATX desktop computers today. In the past when laptops were considered overpriced specialty computers, standardization was hardly necessary, but today the global market for laptops is expected to grow 17.8% annually[58] and laptops will shortly replace desktops as the standard computer. Given the tremendous environmental costs of manufacturing and junking all these laptops with short life cycles, we must demand that our laptops be durable, fixable, and upgradeable, rather than planned obsolescence black boxes whose inner contents are a mystery to the owner.

Since most laptops will rapidly become toxic waste in the municipal dump, avoid buying laptops which don't run on either an Intel Pentium M or an AMD Turion MT (unless you are buying an Apple Powerbook). The other chips either consume too much power, or have so little processing power that they lend themselves to rapid junking. Unfortunately, the Windows programs of the future will probably require a better graphics processor than the standard integrated GPU from Intel which comes with most Pentium M (with Centrino chipset) laptops. Pentium M laptops with Intel Extreme Graphics 2 or Intel Graphics Media Accelerator 900/950 are incredibly energy efficient, but I only recommend buying one if a long battery life is your first priority and you don't plan on upgrading to more graphics-intensive software in a couple years. If you are trying to economize, I recommend looking for a laptop with a 64 bit Turion MT with at least 512 MB of RAM and an ATI Radeon Xpress 200M GPU or better.

▲

Energy Star

European Union

Germany's Blue Angel

Sweden's TCO 1999

Sweden's TCO 2003

Scandinavia's Nordic Swan

Buying Products Certified with an Eco-Label

A number of eco-labels have been created to certify the environmental merits of products, so that buyers can readily identify them without doing much research. In the US, products which are consume less energy and have power saving features bear the Energy Star logo. Energy Star desktop computers have power management which consumes up to 70% less energy than a computer without power management. When the Energy Star specification was first implemented it was a notable advancement, but today almost every hardware manufacturer has power management, so the logo has become more of a rubberstamp than an indication of real energy efficiency. EfficientProducts.org is urging Energy Star to increase their certification requirements and they have compiled a list of over 65 monitors which meet more stringent efficiency standards. Unfortunately, Energy Star and EfficientProducts.org consider energy usage to be the sole criteria in their certification.

Europe has created more holistic eco-labels which give a more accurate indication of the green merits of products. Look for products with the European Union eco-label, the German "Blue Angel", the Swedish "TCO", or the Scandinavian "Nordic Swan." The Computer TakeBack Campaign has compiled helpful charts comparing these eco-label's requirements for desktop computers and notebooks. Although these labels are rarely used in the US, they list their certified products online so you can easily search for these greener alternatives. Before buying hardware, check these lists of all the computer products which has been certified by the various eco-labels:

[Desktop Computers] [Notebooks] [CRT Displays] [Flat Displays]
[Printers] [Multifunction Printers] [Scanners] [Keyboards]
[Certifications per Company] [Eco-Labels OpenOffice Spreadsheet]
(These lists were compiled on Dec 23, 2005, so check the various eco-label websites if buying a more recent product.)

Many of these European eco-labels offer only a limited selection of computer equipment due to the fact that manufacturers haven't made it a priority to deal with the extra fees and paperwork of certification. The Blue Angel certification which was established in 1978 is the oldest and most recognized eco-label, but its catalog only lists a few computers from Dell, Fujitsu-Siemens, Compaq, and MAXDATA. The Nordic Swan catalog offers an even more limited selection of computers from only Fujitsu-Siemens. At this time, the EU eco-label catalog doesn't list any certified laptops or desktop computers, but it is a new certification that hopefully will become the industry standard in the future.

Eco-Labels for Computers and Computer Accessories (as of December 23, 2005)				
Eco-Label	***Eco-Label Web Page***	***Catalog of Certified Products***	***# Computer Certifications***	***# All Hardware Certifications***
Energy Star	http://www.energystar.gov	http://www.energystar.gov/index.cfm?c=ofc_equip.pr_office_equipment	798	1962
EU Eco-Label	http://europa.eu.int/comm/environment/ecolabel/index_en.htm	http://www.eco-label.com/default.htm	0	0
Blue Angel	http://www.blauer-engel.de	http://www.blauer-engel.de/englisch/navigation/body_sitemap.htm	36	68
TCO 1995	http://www.tcodevelopment.com	http://www.tcodevelopment.com (Select the language "English" in the upper right corner, and go to the "Search Certified Products" box.)	5	409
TCO 1999			20	1907
TCO 2003 Displays			0	543
Nordic Swan	http://www.svanen.nu/Eng/default.asp	http://www.svanen.nu/Eng/products	19	23
80 PLUS	http://www.80plus.org/	http://www.80plus.org/manu/manu_psu.htm	0	21
All Eco-Labels	http://europa.eu.int/comm/environment/ecolabel/other/int_ecolabel_en.htm	http://www.ciber-runa.net/guide/All-Eco-LabelProducts.html	878	4931
Note: *# Computer Certifications* include desktop computers and notebooks. *# All Hardware Certifications* include desktop computers, notebooks, flat panel displays (LCD and Plasma), Cathode Ray Tube displays, printers, multifunction printers, scanners, keyboards, and power supplies.				

The most helpful European eco-label for buying computer hardware is the certification from the TCO, the Swedish Confederation of Professional Employees. Originally, this group focused on certifying hundreds of greener CRTs and LCDs since the monitor is considered the most environmentally hazardous part of the computer. In recent years, the TCO has begun certifying a wider variety of hardware and updating their standards to promote more environmental technologies. A TCO certified computer has low energy consumption, reduced magnetic and electrical field emissions, an easy-to-read display, and complies with the EU's Restriction of certain Hazardous Substances directive. Only a few Dell OptiPlex desktops and Asus laptops are TCO certified at this point. Nonetheless, there is good selection of TCO certified CRT and flat displays. Look for the 2003 certification for displays, since its standards are more stringent than the 1999 and 1995 certifications.

In general, it is more environmental to keep old energy-inefficient computers and peripherals, rather than buy new energy-efficient units. If buying new, however, look for an energy-efficient monitor and power supply, because these two components account for 77% of the energy used by a typical desktop PC. Buy an flat panel display instead of a CRT, because it uses half the power and the mercury in a flat panel display is considered less of a hazard than the lead in a CRT. LCDs and DLPs (Digital Light Processing) are more energy efficient than plasma displays.[59] Several Japanese companies such as NEC are now making mercury-free LED backlights to replace the hazardous mercury backlights in LCD screens. Sony and Toshiba already offer a few laptop models with mercury-free LED backlights and more computer makers will offer them in the coming year. As LED backlights become more

common, look for flat panel displays which use them, because they are less toxic and more energy efficient than conventional LCDs (plus they can display a wider spectrum of colors).[60]

Percentage of Energy Used by Different Parts of the Computer in 2002*

Part in Desktop PC**	Percent of Energy Use	Part in Laptop	Percent of Energy Use
17" CRT Monitor	55%	14.1" LCD XGA display	27%
Power Supply Loss	22%	Power Supply Loss	10%
AGP Graphics Card	6%	External graphics	7%
Pentium 2.2GHz DT CPU	5%†	Pentium 4 M CPU	10%†
Drives (includes HD and DVD)	4%	48 GB harddrive	8%
		DVD	2%
Chipset	1%	Mobile Intel 845 chipset	12%
		I/0 Controller Hub 3-Mobile	3%
		WLAN	2%
		Clock generator	4%
Memory	1%	Memory	1%
Video RAM	1%		
Other	5%	Rest of system	14%

* Only includes energy to operate the computer, not to produce it.
** Typical desktop PC using about 150 watts with integrated audio/LAN, AGP GX graphics, HD, DVD, and 17" CRT.
† The percentage of power used by the CPU is too low and should probably be increased to 15%-20%. A Pentium 4 2.2GHz uses 55.1 or 57.1 maximum watts. Intel probably measured wattage when the CPU is in power saving mode and published these numbers as a way to deflect criticism from the growing energy requirements of the Pentium 4.
Source: Intel (2002). Terrence J. McManus, "Moore's Law & PC Power", talk at the Tulane Engineering Forum 2002, Sept 13, 2002, p. 28, 37, http://www.eng.tulane.edu/Tef/Slides/Tulane-Moore's%20Law%20Sept02.ppt [61]

One of the most overlooked parts of a computer is the power supply. Although Apple's iMac and NEC's Powermate eco PC use high efficiency power supplies, the $15 to $20 unit found in the average white box computer is only about 60% to 70% power efficient.[62] If buying a separate power supply, look for a high efficiency unit on the list of 80 PLUS certified power supplies which are guaranteed to have over 80% power efficiency at peak mode. Some power supplies such as the Antec Neo HE are not only 20% more energy efficient, but also don't drain power from the wall when the computer is turned off.[63] Unlike most computer parts, it is more environmental to replace an old inefficient power supply, because it takes little energy to produce a new efficient power supply compared to the amount of energy the old power supply wastes in operation.

Energy efficiency can also be increased by using peripherals that draw power from USB or Firewire ports. If you need a peripheral with an external power supply, look for one with a sleep mode and a switching mode power supply, which can adjust the amount of power drawn from the wall unlike a normal linear power supply. When turned off, most CRTs don't draw any power whereas most LCDs continue drawing power, but CRTs use roughly twice as much energy as LCDs when on. If you don't have switching mode power supplies on your peripherals, BITS Limited makes a handy $30 power strip (Smart Strip model# LCG3) with 10 outlets which automatically cuts off energy to peripherals when the computer is switched off. Finally, energy can be saved by turning off screen saver programs and enabling the system to automatically turn off the monitor and harddisks and enter sleep and

hibernation modes when inactive. In MS Windows this can be enabled under **Power Options** in the **Control Panel**.

If buying a high-end desktop computer, choose an AMD PC rather than a G5 Mac or Intel PC. The EPA has recognized AMD for designing processors with improved energy efficiency in recent years.[64] Although Intel and PowerPC chips used to consume less wattage than AMD chips, the power requirements for a high-end Pentium and G5 are now significantly higher than the latest Athlon 64. Check Appendix B for the energy requirements for each chip. AMD's Athlon, Geode, and Opteron optimize processing power per cycle which is more energy efficient than Intel's policy of increasing processing power by upping the number of cycles per second. Jem Matzan calculates that an AMD Athlon 64 X2 3800+ system will only use an average of 81 kilowatt hours per month, whereas a Intel Pentium D 820 system requires 123 kWh. Using the Athlon system will save $36 per year in electricity. A high-end dual G5 PowerMac will consume even more energy than both a Pentium D PC and an Athlon 64 X2 system.[65] On the other hand, G5 iMacs are more energy efficient than most low-end Intel PCs. The new iMac built on Intel's innovative Core Duo CPU takes energy efficiency a step farther by running the whole system and display on less than 100 watts.[66]

Before buying a computer from one of the big computer makers, see how Greenpeace rates the toxicity of the computer maker. Take the time to read the Silicon Valley Toxics Coalition's computer industry report card for 2003 and the more comprehensive report for 2002. Each computer maker is ranked according to their environmental policies. Educate yourself about the environmental and recycling policies of the manufacturer of your prospective computer. At the end of the SVTC's 2003 Report Card in Appendix F, there is a list of the companies' websites where you can find this information. If buying from a bricks-and-mortar store, make a point to ask the sales person whether the computer can be taken back for recycling. The more customers demand recycling, the more retailers will wake up to this issue.

Make sure that any computer you buy has plenty of free expansion slots in the back and front so you can upgrade it in the future. If you are buying a laptop, get one with a free memory slot and plenty of USB ports. To prevent your laptop from ending up on the garbage heap when the harddrive fills up, make sure that the harddrive can be replaced without having to remove the keyboard or open the entire chassis. If the harddrive isn't easily accessible, look for a model with a firewire port so you have the option of adding an external Firewire drive, which are reportedly much faster than USB2 drives. Don't buy a desktop computer which uses nonstandard parts or a case with an odd form factor. Most of the major computer brands like HP-Compaq, Dell, and Gateway-eMachines have a nasty habit of sticking nonstandard parts in their boxes to cut corners or lock you into their equipment. Only buy one of their computers if you can verify that they haven't done this. A couple years ago Dell secretly started putting power supplies with strange connectors for the motherboard in their computers. If the motherboard fails, you are forced to buy an expensive Dell part, because the power supply will fry standard replacement motherboards.[67]

When you buy a new computer, think about just buying a new CPU so you can reuse your old mouse, keyboard, and monitor. Each accessory represents a significant amount of resources which you have saved. Avoid buying electronic equipment with free extras, if you don't need them. If you know that you will never use that free printer or digital camera that came bundled with your new computer, don't buy it. Think of it as extra toxic waste that will burden your life rather than a freebie bonus. Similarly, don't buy computers with unneeded parts. If you know that zip drive or floppy drive are unnecessary deadweight, buy a different computer. Many of those extra parts will suck extra power and take extra

time for your computer to check at bootup. When buying accessories such as speakers, scanners, and printers, look for units that draw power from their USB or Firewire ports rather than having separate power adaptors. If buying an accessory with a separate power supply, check that it has an automatic sleep mode or a switching power supply,[68] so it doesn't draw as much power when not in use.

Resist the temptation of buying a cheap computer and then customizing it to your liking. If you know that you will immediately strip out the RAM and graphics card, buy a computer that has the kind of RAM and graphics card that you want in the first place. Many computer makers allow you to customize your new computer online, so you can eliminate the extra deadwood. Unfortunately, most of the major computer makers, won't tell you exactly what parts they put in your computer. To specify higher-quality parts to ensure greater reliability and longer-life, order through a computer builder such as AVA Direct, Hypersonic PC, ABS, PCs for Everyone, Krex, or Vicious Gaming PC which lets the buyer specify the exact brand and part number for all the major components that go into a desktop or laptop. By not ordering a brand name computer, you are less likely to generate more e-waste because you will avoid having to replace the suboptimal parts that come in most Dell, HP-Compaq, and Gateway-eMachines boxes.

If you are more intrepid, build your own computer. When you select parts, enduring quality and energy efficiency should be a higher priority than cheaper price or more power. Good quality parts will cost more (and often use more metal), but they will last longer. Read the recommendations at hardwareguys.com for building a custom desktop computer. Building a custom laptop is a little trickier, but you can get started by looking at this Notebook Buyers Guide for links to suppliers and ask questions in the NotebookForums.com. Take the time to read the online reviews and comments about the parts that you buy. Otherwise, you will end up with a closet full of extra toxic waste. I have an arsenal of modems in my closet, because I didn't take the time to check whether the modems I was buying would work with Linux. Try ordering all your parts from the same vendor at the same time, so they will be shipped in the same box and the UPS man will only make one gas guzzling trip to your doorstep. Resist the temptation to bargain hunt on pricegrabber.com, so you won't order parts from a dozen sources. By building your own, you are burdening the world with extra packaging and manuals, but a few extra boxes are more environmental than buying a white box computer and throwing away the parts that you want to replace. Remember that each extra chip and printed circuit board represents more global warming, toxic waste, and abuse of workers in China,

Whatever you do, there is no way to avoid participating in an exploitative system when you buy your next computer. At this point, there are no "fair trade" electronics, nor has there been much effort to monitor the electronics industry abroad as has happened with the garment and shoe industries. Workers rights and human dignity will be violated, but you can try to minimize your participation in an ugly system. Almost all the parts in your computer will be made in places where labor rights are nonexistent, but you can make sure that the final assembly happens under fairer conditions. If you buy your computer from a major brand like Dell or HP, make it a custom order from their online store because they have to assemble it close to home. To be more confident that your computer comes from home, buy from a maker such as Systemax which advertises "Made in America." The best option is to support a local business by having a mom-and-pop computer store custom build it. While it may cost a little extra, but you will get a computer with standardized parts which are often higher quality than those found in most brand-name units.

Trying to buy a computer which does the minimum of environmental and social harm will go against

all the tenets that you have been taught as a consumer in Western society. More is not better; it is waste. Think less about your wants and more about your needs whenever you buy something. Ask yourself whether you really need a resource-hogging 500W power supply or a $350 graphics card in your new computer. We are inculcated to maximize consumption, but rarely taught to balance our consuming desires with our values. Our religious leaders and our society's mores do a poor job of preparing us for the ethical dilemmas of capitalistic consumerism and over-consumption.

Software to Save your old Computer and the Environment ▲

There are ways to extend the life of an old computer without buying new hardware. Your crufty computer's performance can be improved by by regularly defragmenting your harddrive and removing all the excess programs and TSRs which run in the background. Before you condemn your computer for being a laggard, give it a good spring cleaning and check it for spyware and viruses.

The growth in "free software," or what the business community prefers to call "open source" software, has opened up new ways preserve old computers. Not to be confused with freeware or shareware, free software comes with the source code and gives everyone the right to use, modify, copy, and distribute it. This flexibility with the code allows programs to be stripped down so they use less memory and processing power. For instance, the FireFox web browser was originally part of the larger Mozilla Suite, but a couple enthusiasts decided to hive off the browser code and make a smaller, cleaner design. Although the majority of free software is written for UNIX-like platforms, several of the programming libraries have been ported over to MS Windows and Mac OS X, so many of these programs will now run on any computer. If you have an old computer than can't handle MS Word 11, try downloading a zippy free software program like AbiWord to read the Word documents that friends send you. You can edit and save them in the doc format without anyone knowing better. Likewise, Gnumeric can handle spreadsheets with less strain on your computer than Excel. Many people buy new computers just to get discounted versions of Microsoft Office which come bundled with new computers. There is no need to consume 1.8 tons of raw materials to create a new computer, however, when OpenOffice 2 is just as good as MS Office for creating letters, spreadsheets, and databases. All these handy programs for MS Windows have been bundled on a single disk by TheOpenCD Project for free download or purchase for a small fee. See Appendix E and check the OSSwin Project for a comprehensive list of all the free software available on Windows.

If you are willing to learn a new operating system, you can rejuvenate your old computer for a couple more years by installing GNU/Linux with an efficient window manager like Fluxbox or Icewm. Unlike most proprietary software which forces people to accept the entire bloated software package, people are not constantly forced to upgrade their hardware with GNU/Linux. It is designed so people may pick and choose the parts of the operating system which work best with their hardware. In this way old computers are preserved while allowing people to only update the necessary parts so they can continue interacting with the rest of the world even when computers get faster and formats change. With GNU/Linux, it is possible to keep updating old programs designed for outdated hardware so they can read the latest formats being used on the fastest, most powerful machines. Software companies such as Microsoft commonly discontinue their programs as they did with Visual Basic 6, forcing 18 million disgruntled users to abandon a simple program for a more expensive and complex one which didn't serve the needs of many.[69] Proprietary software companies commonly refuse to support or sell their old

software, again forcing people into expensive and wasteful upgrades which gobble more memory and processing power. In contrast, old versions of GNU/Linux and new stripped-down versions of GNU/Linux can continue being used without fear that a particular company will stop selling it. As long as people find a free software program to be useful, people will post it for download or sell it on CD. If enough people want support services for a particular program, any company can provide it, not just the company that originally created it. Because computers can run longer with GNU/Linux, the benefits of computers--enhanced communication and productivity--need not be sacrificed on the altar of environmental degradation and a consumptive lifestyle.

GNU/Linux--which is often referred to as simply Linux--offers an elegant solution for what to do with the millions of derelict computers sitting unused in attics and closets. They can be resurrected in thin-client networks in schools, businesses, and even people's homes. An old computer with as little as 50 MB of RAM can serve as a perfectly functional computer in a thin-client network. A ten-year old box can suddenly mimic a new CPU, because the only thing it is responsible for doing is receiving keyboard strokes and mouse clicks from the user and redrawing the screen. Most of the processing-intensive tasks are handled by a central server which has a modern processor. With 100 Mbit and even 1000 Mbit per second ethernet connections in local area networks, thin-clients receive information from the server very quickly so the the user sees little delay between punching a key and seeing the results on the screen. With one $1000 central server, the useful life of 10 to 30 old computers can be effectively doubled or tripled when hooked into a thin-client network. For bigger networks, a $4000 server can handle between 30 and 100 thin clients depending upon the processing needs. This kind of networks is possible because Linux is built around the idea of modularity, so tasks which are handled by only one monolithic program in MS Windows are broken into multiple tasks handled by different programs at the level of the kernel, command line, and graphical user interface. The server handles the processing intense tasks, while the clients handles the user interface.

While graphics intensive tasks and most modern games do not function well in thin clients, the word processing, internet surfing and spreadsheet calculations in most businesses and schools can be adequately handled by thin-client networks. Because thin-client software such as the Linux Terminal Server Project has been integrated into a number of Linux distributions, many Linux users are even setting up thin-client networks in their homes for their secondary computers. A modern PC has so many wasted processor cycles that it can easily handle the processing for a second or third computer in other rooms in the house.

SUN has long promoted the idea of thin-client computers or what it called “network computers” with its SUN-Ray line, but the product line never gained much acceptance because SUN's solution was based upon proprietary software, vendor lock-in, and wasn't well-marketed to the low-cost computing sectors. Now that MS Office can run reliably in Linux with Crossover Office (or WINE) and OpenOffice/Star Office has gained such broad acceptance, Linux thin-client networks can run the software that most businesses and schools want to use. The computer industry is abuzz with talk of these sort of networks in recent years as IBM, Novell, HP, and Red Hat have all begun promoting Linux-based thin clients, while chip companies such as AMD, VIA, and Transmeta are now touting processors for thin clients. Companies like Wyse, SmartFlex, and Neoware which specialize in thin-clients report booming sales;[70] and IDC predicts a 22.8% annual growth rate in the sector through the year 2007. This growth in thin client hardware could dramatically lessen the environmental costs of each computer. For instance, Fujitsu-Siemens' new Futro S line of solid-state thin clients use just 25 watts which is 80% less power than a conventional desktop PC and require a smaller case and fewer

chips and printed circuit boards since it embeds almost all the functionality in the motherboard.[71] Solid-state thin-clients should last longer with no moving parts like harddrives and DVD drives to potentially fail, so fewer parts are expended in their maintenance. If more companies produce these efficient client computers and more innovative companies like Symbio start specializing in the redeployment of old computers in thin-client networks, the environmental toll of computing could be significantly reduced in the future.

Not only do thin clients offer environmental benefits, they promise to dramatically lower the costs of bringing technology into the classroom. Teleplan estimates that Norwegian schools can reduce the total cost of ownership per computer by as much as 60% with thin-clients running free software.[72] Similarly, Steve Hargadon argues that the savings can be as high as 75%. After Hargadon set up a thin client network in Grace Lutheran School in Sandy, Utah, the school's principal estimated that his school saves $29,000 per year to maintain 60 PCs as Linux-based thin-clients.[73] Even without thin-client networks, the switch to free software offers substantial benefits. According to a 2005 study of 48 UK schools by Becta, the use of free software lowered the total cost of ownership per computer by 44% in primary schools and 24% in secondary schools.[74]

Linux not only offers a way to bridge the digital divide between rich and poor schools by lowering the costs, but its flexibility and open nature allow students to acquire more technological skills that better prepare them for the future information age. Unlike proprietary software which hinders attempts to learn what is happening under the hood, the freely available source code, documentation, bug reports, developer's email lists, and a helpful internet community facilitate the learning, experimentation, and growth in skills which are the basis of a scientific education. For reasons such as these, Schoolnet.na rejected donations of proprietary software to their project to wire all of Namibia's schools to the internet. Dr. Ben Fuller of Schoolnet.na explains:

> In the past we have refused offers of "free" software from commercial companies because this will tie us into a path of costly upgrades in the future. Using OSS [open source software] allows us to spend scarce resources on equipment and to keep our services up and running. We also feel that in a developing country it is very important to have young Namibians using software that allows them to "get under the hood." By doing so we are encouraging those who are interested to develop their programming/networking skills.[75]

Although the One Laptop per Child project hasn't stated it openly, it was probably similar concerns that led them to reject Microsoft's and Apple's offers to make the operating system for the $100 laptop which they want to get into the hands of 150 million school children.[76] To learn more about using free software in schools, School Forge is a central source of information.

A number of teachers have reported great success using free software in the classroom. Robert Pogson, a former teacher in northern Canada reported setting up a number of thin-client networks in schools where he has worked:

> I have spread the news of free software wherever I go. In one place, a stack of old PCs were piled up in a corner in a Mac school. None of the teachers knew what to do with them. They ran Windows 95 which crashed daily. I installed Linux and have never looked back. . . . It is great to have control of the one machine on which everything is happening. Teachers get to supervise the LAN as well as the classroom.

Unfortunately, more of these sorts of free software networks aren't being set up, partly because of a lack of know-how, but also because Microsoft and Apple have aggressively discounted their products for schools so students aren't trained in any other alternative. Pogson reports that he encountered a

great deal of resistance on the part of some school administrators who insisted on using Windows XP despite the extra cost, unpredictable performance, and frequent downtime. Pogson had to leave one school where the administration insisted on the use of Windows even after techs had to be brought in at great cost and long distances to service numerous problems. In Pogson's opinion, “the waste of labor, fuel, money and the second class education resulting could be added to the environmental costs of Windows.”[77]

Perhaps some of the resistance that Pogson encountered arises from GNU/Linux's reputation as an operating system best suited for computer hackers. Actually, some of the graphical windows environments used by Linux can be quite "user friendly", but the difficulty lies in learning how to configure Linux. Once the computer is properly set up, most people don't have any more trouble learning to use Linux than they did learning to use MS Windows. When Linux computers were set up in 120 “telecenters” to serve 250,000 people in some of the poorest neighborhoods in São Paulo, people who had never touched a computer in their lives were reported to be using email and surfing the web within minutes. Beatriz Tibiriçá, coordinator of Brazil's "Electronic Government" project, comments, "The perception that GNU/Linux is extremely complicated to understand and use turned out to be unfounded at the telecenters. Children, the elderly and individuals with minimal education have easily learned to use the systems".[78] Linux earns its reputation for being difficult because it is more difficult to install and alter settings. Unlike in Windows, many hardware manufacturers won't write software drivers for Linux and refuse to release the technical information on their products so drivers can be created by others. For this reason some types of hardware won't work or require special workarounds. In recent years, however, Linux installation has gotten remarkably easy, as tech companies like IBM, Novell, HP-Compaq, and Red Hat have poured millions of dollars into the development of Linux as the successor to proprietary flavors of UNIX. In many cases, the most difficult part of installing Linux today is deciding how much space should be allocated in the harddrive to install it.

To test whether Linux will work for you, download or buy a live CD version of Linux such as Knoppix. A live CD runs Linux without installing anything on your harddrive, you can simply eject the CD and reboot the computer if you decide that Linux won’t serve your needs. Linux will run on most desktop computers without a hitch, but some laptops have specialized components, so check linux-on-laptops.com to see whether Linux will run on your model of laptop. If you decide to use Linux but want a Windows-like experience with a minimum of hassle, pay a little bit of money for a distribution like Linspire or Xandros. For a more flexible and freer version of Linux with a broad community of users, try downloading for free and installing a distribution such as Fedora or Ubuntu. People who are committed to the ideals of free software often use Debian, because it is a democratic distribution maintained solely by volunteers. If you want to access many of the resources on the Internet with these community distributions, you will need to separately download proprietary programs such as SUN's Java Runtime Environment and codecs for multimedia formats such as MP3 and MPEG. To learn how install and maintain GNU/Linux, the Linux Newbie Administrator Guide by Peter and Stan Klimas provides a good introduction. For information about transitioning from proprietary to free software in a business or academic environment, read the comprehensive Open Source Migration Guidelines produced by the European Commission. The advantage of free software is the community of people who support it and help others learn to use it. If you run into problems installing Linux, ask some of these helpful people at internet sites like linuxquestions.org or find a Linux User Group in your area.

Software as an Anti-globalization Movement ▲

Many people see GNU/Linux as simply the latest high-tech buzzword or just a way to get cheap software, but its creation and use is part of a larger "free software" movement which bears profound ethical and political implications.[79] Although free software was commonplace before the rise of the mini and micro-computers in the late 1970s turned software into a shrink-wrapped commodity, by the early 1980s most software had become corporate property strangled in End User License Agreements, non-disclosure agreements, and copyrights (and even patents after 1981). Dismayed by the increasing privatization of software which prevented people from sharing their digital tools and helping their neighbors, Richard Stallman, a brilliant hacker at the MIT Artificial Intelligence Lab, assiduously began grinding out code in Fall 1983 for a free software UNIX clone which he playfully dubbed GNU for the recursive acronym "GNUs Not UNIX". The revolutionary idea of code which guaranteed the rights of users gradually caught fire among computer aficionados worldwide as more and more people began helping Stallman to create an entirely free operating system.

Fractious disagreements have arisen among many of the participants in the free software movement, as many programmers have objected to aspects of Stallman's original vision. In 1998, a faction of free software advocates who had just convinced Netscape to transform their code into free software, decided to redub their software as “open source” so it would be more attractive to the business community who distrusted the idea of calling their products “free.” Stallman refers to “free” as in “free speech” rather than “free beer”, but his rigid insistence on the rights and freedom of the user did not jive with the marketing of many commercial software companies. Drawing from libertarian and free-market principals, the Open Source Initiative has rejected much of Stallman's emphasis on the good of the community and distrust of corporate control.[80] Instead, OSI has touting the practical benefits of open source software such as superior quality, lower costs, wide code review, and a collaborative development model. The business press and the corporate crowd seized upon the notion of open source as the latest trendsetter and had a media field day with the concept in the heady days of the internet boom. Open source companies such as Red Hat, VA-Linux, Ximian, Cygnus, SuSE, and Mandrake were suddenly worth millions. Hacking lost its anti-corporate veneer in some quarters as many in the hacker community were hired away in these new companies. The growing division between the idealistic free software advocates and the business-oriented open source promoters, struck many in the non-English speaking world as pointless factionalism since they referred to the software as “libre” or “livre” without any confusion with “gratis” or free in price. In an effort to appease all factions, many now use the inclusionary terms FOSS or FLOSS to refer to Free/Libre/Open Source Software.[81] Despite the ideological divisions and the myriad terminology, Richard Stallman's ideas have formed the intellectual roots for a plethora of groups promoting FLOSS today such as the Free Software Foundations in North America, Europe, and South America, Software in the Public Interest, the Open Source Initiative, GNOME Foundation, Mozilla Foundation, Apache Foundation, and Electronic Freedom Frontier, Open Source Development Labs, and Creative Commons.

Although the corporate world only adopted the ideas of the free software movement once they were sanitized under the more palatable notion of "open source", free software is rapidly becoming the *de facto* standard in the workstation and server markets. Today, 78% of the world’s 500 fastest supercomputers run on GNU/Linux; 71% of websites are served up by the free software program, Apache;[82] and roughly 40% of web servers run on a free software operating system.[83] Proprietary flavors of UNIX such as AIX, Tru64, HP-UX, IRIX, SCO Unix, and SunOS are all being abandoned in

favor of GNU/Linux. IBM and HP are gradually switching all their UNIX boxes over to GNU/Linux, while proprietary UNIX companies such as SCO are heading toward oblivion. The only proprietary flavor of UNIX with any significant following, SUN's Solaris, was loosing so many users that SUN decided to stanch the wound by changing its license to be free software as well. When Apple decided to create its new operating system OS X, it chose to build its graphical front end on top of BSD, another free software version of UNIX.

Amidst all the hubbub over the way "open source" has revolutionized the software industry, the corporate press has largely failed to note the more fundamental revolution taking place under the banner of free software. People in the Global South distressed over the way that technology is used to increasingly impoverish and marginalize them are increasingly adopting free software in the fight to contest neoliberalism and the corporate ownership of their digital future. At the last World Social Forum in Brazil, the organizers insisted that all communications run on free software and devoted many of the presentations to how to use free software to create an alternative media and bridge the digital divide. In Latin America, a number of efforts are afoot to employ free software in the service of social change. Proyecto Chak Chupiq'aq' in Guatemala, Kumen Linux in Chile, PHP-Nuke in Venezuela, Sao Paulo telecentros, CodigoLivre at UNIVATES and Rede Escolar Livre RS in Brazil, UTUTO, BioLinux and Via Libre Foundation in Argentina, and INFOMED in Cuba are are not only efforts to better people's lives through the use of free software, but also a contestation of the dominant paradigm in programming, education, medicine, and media. As our lives are increasingly governed by what we do with computers, free software bears the promise of empowering people so they control the technology rather than allowing the technology to control them. Free software puts tools in ordinary people's hands so they no longer have to be passive consumers of the products of the Silicon Valley and Hollywood, but rather co-creators of subversive democratic technologies that permit local cultures and diversity to thrive and contest globalization. The use of free software is a means to challenge the restriction of digital rights and contest the pernicious intellectual property laws which threaten to impoverish the Global South. Instead of the globalization being promoted by Western governments and multi-national corporations, free software offers an alternative form of globalization which allows people to collaborate on a global scale, but also permits them to adapt and reshape the global into the local. The latest technology in the most advanced nation can be reworked to fit the needs of people in the most peripheral regions without the loss in human dignity or diversity

As the IMF, World Bank, and WTO have pressured poor countries to privatize and turn their economies over to the tender mercies of multinational corporations, they have also promoted the concept that ideas and information can be controlled and owned by corporate entities under patent and copyright law. In the past, poor countries believed that the only way to gain access to technology was to subordinate themselves to the demands of the Global North which controlled that technology. Free software, however, offers a more symmetrical model of technological development for the Global South where everyone has the right to use the technology and anyone can participate in its creation.

It is striking that many of the great innovations in free software have taken place on the technological periphery. When Linus Torvalds, began working on the Linux kernel in 1991, no one could have predicted that Finland would produce anything with the potential to dethrone Microsoft. Similarly, when Miguel de Icaza and Federico Mena started the GNU Network Object Modeling Environment (GNOME) in August 1997, few could have foreseen that two programmers from Mexico City's UNAM would create a window manager that today rivals Apple's OS X. The fastest growing flavor of GNU/Linux today is Ubuntu from South Africa and the best Integrated Development Environment is

Anjuta from India. Upon closer examination, GNOME, Ubuntu, and Anjuta are not wholly Mexican, South African, or Indian, since many of their contributors are from the US and Western Europe and they are built on top of code from GTK+, Debian, and gcc—programs which originated in the US but have turned into transnational efforts in their own right. The founders of GNOME, Ubuntu, and Anjuta are transcultural hybrids who navigate international hacker conferences and boardroom meetings of open source companies with aplomb.[84] What is important is not the staking of national claims to software, but rather the way that people from the periphery are collaborating with people from the core on an equal footing and building off each other's achievements. When we imagine a better world built on more equitable relationships rather than exploitative ones, free software offers a new model of how the Global South can participate and contribute without having to cede control or subsume itself to the Global North's vision.

It is notable the vision that a transplanted Mexican like Miguel de Icaza brings to free software. Perhaps it was his transcultural awareness of the need to bridge economic, digital, and cultural divides, that led de Icaza to insist that GNOME and its applications be multilingual and user friendly to everyone. Unlike many of the North American and Northern European hackers, who in the mid 1990s were focused on creating a suitable playpen for fellow programmers, de Icaza focused on the need to democratize technology and make it freer so everyone could use it. “I've got a global goal,” de Icaza commented in an interview. “I want to make Linux successful on the desktop for countries where people can't afford computers with proprietary software.” Coming from a country were few people had access to computers, de Icaza has consistently seen the need to translate Microsoft's products into a more democratic form that will remove the digital barriers for people in places like Mexico.[85]

Many of the same goals motivated South African Mark Shuttleworth to create a GNU/Linux distribution available in African languages that would be intuitive enough for everyone to use. What Shuttleworth did was hardly innovative, since other distributions like Xandros and Linspire had taken the codebase from Debian before and made a “user-friendly” desktop, but they have shown little respect for the ideals of free software by bundling proprietary add-ons into the distribution and by milking users every time they downloaded and installed new programs. Shuttleworth, on the other hand, wanted to make the democratic technology of difficult-to-use Debian accessible to the majority of the population. Shuttleworth writes, “I believe that free software brings us into a new era of technology, and holds the promise of universal access to the tools of the digital era. I drive Ubuntu because I would like to see that promise delivered as reality.”[86] Shuttleworth regards software as an extension of humanity and a fulfillment of the human potential. Thus, it should reflect all the character of humans, as Shuttleworth notes in explaining why Ubuntu chose brown as it desktop color:

> The overarching theme of the first set of Ubuntu releases is "Humanity". This drives our choice of artwork as much as our selection of packages and decisions around the installer. Our default theme in the first four releases of Ubuntu is called "Human", and it emphasises warm, human colours – brown.
>
> Yes, that's rather unusual in a world where most desktops are blue or green, and the MacOSX has gone kitchenware. Partly, we like the fact that Ubuntu is different, warmer. The computer is not a device any more, it's an extension of your mind, your gateway to other people (by e-mail, Voip, IRC, and over the Web). We wanted a feel that was unique, striking, comforting, and above all, human. We chose brown.[87]

What is notable in this attempt to portray humanity is the fact that Ubuntu is not white, but brown. As

the varying shades of brown on the desktop reveal, technology belongs to the diversity of peoples in the Global South as much as it is the domain of the white minority in Europe and North America. Although Shuttleworth asserts that "brown is the new black," Ubuntu is hardly an assertion of African nationalism, Black Power, or an attempt to create a dichotomous identity counterposing the Global North. Rather, Ubuntu's use of many shades of brown is a call for inclusion into the family of humanity, rather than exclusion.

Like many of the people involved in free software development, Shuttleworth is white and privileged, yet it was because he comes from a country were most aren't white and privileged, he has the vision of democratizing technology for the underprivileged. As de Icaza's own recounting of the history of the GNOME project makes clear,[88] there were many people in the international hacker community who could have initiated the project to make an alternative to Windows 95 under the banner of GNU, but it is notable that it was two Mexican programmers who laid forth the vision. Many of the Northern European hackers at the time had chosen to not affiliate with the GNU project and were working on the Kool Desktop Environment (KDE), a free software windows manager based upon proprietary libraries which was more geared to power users than ordinary people. Many have since criticized de Icaza for joining corporate Novell in 2003 and for watering down free software with clones of Microsoft's libraries, but de Icaza argues that Novell is giving him the needed resources to help create a user-friendly desktop with applications that match Microsoft's software and allow many programs to run on both Windows and Linux. While many in the hacker community rightly detest Microsoft and have sought to built a superior set of software tools, de Icaza has consistently tried to bring Microsoft's technology to the masses in a freer form. When he interviewed with Microsoft in 1997 for a job porting Internet Explorer to SUN Sparc, he sought to convince them to make Internet Explorer open source. At that interview de Icaza learned about the forthcoming ActiveX and COM specifications and determined that there needed to be a free software equivalent--a similar notion that led him to initiate the Mono project to implement Microsoft's .NET for network programming so that Windows programs would run in Linux as well.

GNOME, Ubuntu, and Anjuta exist because their creators didn't have to begin from scratch—a Herculean task for people from the periphery with few resources. Instead, free software allows people to pick and chose from the existing reservoir of work and create something new on top of others' contributions. This paradigm of broad collaboration and creative adaption of others' work has allowed the free software community to create a whole ecology of programs that are often better than (or at least as good as) the most expensive proprietary software. Despite the billions of dollars poured into proprietary software, free software has exceeded their quality at a fraction of the cost with programs such as GNU/Linux, Perl, PHP, BSD, BIND, Sendmail, Apache, GNOME, KDE, OpenOffice, FireFox, Thunderbird, MySQL, and PostgreSQL. Free software has turned on its ear the entire paradigm of Western intellectual property for the creation of knowledge and technology.

As multi-national corporations and wealthy nations such as the US rampage around the globe demanding that poorer countries pay forth billions for the right to use their "intellectual property", the Global South can challenge these demands and point to a new paradigm for the creation of technology and information based upon the open and collaborative concepts of free software. Groups such as the Free Software Foundation, the Electronic Frontier Foundation, and the Creative Commons have long charged that intellectual property laws are holding back the development of new technology. They point to numerous innovations that have been strangled by patents that do nothing to advance the state of the art. In the worst cases, intellectual property law has become what Vandana Shiva terms

"piracy," when traditional practices and common knowledge are privatized.[89] The FLOSS model is inspiring other fields such as open law, open source biology, open source mining, open publishing for science and medicine, MIT's opencourseware, Project Gutenberg and other e-book projects, free dictionaries and encyclopedias, open music, and even SUN's open hardware design for its T1 chip. With the ability of people to collaborate and share innovations over the internet, patents, trade secrets, and non-disclosure licensing have become a hindrance rather than a furtherance of human advancement. More often than not, these legal artifices are used to artificially restrict the development of knowledge and technology and to enrich a privileged few at the expense of the majority.[90]

Not only does free software help contest oppressive legal paradigms, it also creates a vital "digital diversity" which promotes the technological rights of the poorest and most marginalized. At the meeting of the World Summit on the Information Society (WSIS) in Geneva in 2003, Pierre Ouedraogo of the African Association of Free Software Users noted that commercial software companies have not served the needs of minority cultures and marginalized peoples. He warned, "If we leave the market to make choices for us it will choose to exclude many of us."[91] All around the globe, people such as Ouedraogo are responding to the failure of the market by using free software to create programs and character sets for minority languages such as Kinyarwanda, Tswana, Xhosa, Sotho, Sorbian, Zulu, Kannada, Gaelic, Basque, and Breton.

Many fear that modern technology is pressing the entire world into a mono-cultural mold. Fortunately people in the Global South are beginning to challenge this trend on the internet, the virtual realm where the entire world meets. In recent years, the number of non-English sites has exploded. Anti-globalization groups have discovered that the internet can be a tool to publicize and mobilize their cause. The internet allows people to access the wealth of information in the dominant world languages, yet also empowers them to adapt and reinterpret that information into their own languages and cultures. That empowerment is reflected in the way that people are adapting the web browser to their cultural demands. At the time that the Mozilla Suite hived off into Firefox and Thunderbird, there were 115 ongoing localization projects to translate the Mozilla Suite into languages other than English.[92] In South Africa, the translate.org.za initiative is making free software available in all 11 of South Africa's official languages. Dwayne Bailey of translate.org.za is frequently asked the question: "Why bother translating software into isiZulu?" People tell him. "Who needs it? English is the language of global business -- you'd be better off spending your energy teaching people English." Bailey responds, "Izixhobo kufuneka zisebenzele abantu, hayi abantu izixhobo. Isoftware sisixhobo ngoko ke kumele sisebenzele abantu ngolwimi lwabo lwasemzini!" To make a point, Bailey often declines to translate: "Tools adapt to people not people to tools. Software is a tool, so it must adapt to people and their language."[93] Whereas most technology has demanded that minorities adhere to the dictates of the dominant language and culture, free software promotes the opposite. It encourages people to remake their tools in their own image.[94]

As the various localization projects of free software for minority cultures show, marginalized people on the periphery like Pierre Ouedraogo have not wholly rejected the offerings of multi-national corporations such as IBM's Cloudscape, SUN's OpenOffice, and Novell's SuSE and Evolution. Free software provides people in the Global South the critical space to freely chose which parts of technology to accept or reject according to their needs--thus technology adapts to them, rather than forcing them to adapt to the technology. Because this technology comes with a free software license that permits everyone and no one to own it, it can't be leveraged against people by a corporation in the same way as proprietary technology. In a free software world, no tech company is granted the power to

coerce people to needlessly upgrade, seek monopolistic rents, demand licensing fees, or place arbitrary restriction's on people's use of the technology. Any attempt to use technology against people in this way is subverted by people rising up and forking the code to create a non-coercive version of the program. In the same way that people are empowered vis-a-vis their technology, they also gain control over the market, free to accept its offerings, but also empowered to fill in the gaps with their own adaptions when the market falls short.

Free Formats to Liberate Information ▲

Free software grants people the ability to challenge the software industry's efforts to promote endless upgrades and bloatware. Nonetheless, we will never have full control over the decision to upgrade as long as all the formats which we use are dictated by proprietary software firms. Software companies want to lock us into their particular formats, so we are forced to buy their products in the future. Every time we use proprietary formats to interchange and store data, we cede control of our computers to companies whose business plan is to induce frequent upgrades. Most proprietary software companies such as Microsoft and AutoDesk frequently alter their formats with each new version so we can't read files from others unless we buy the latest version. In this way our information is held hostage to the whims of proprietary software companies. This pernicious practice is clearly not necessary as shown by WordPerfect which has been backward compatible since version 6 came out in 1993. WordPerfect 6 can open documents created by WordPerfect 12, so people aren't forced to needlessly upgrade. All companies should write their software like WordPerfect to be able to open newer formats by simply ignoring codes which it doesn't support--it is a tenet enshrined in HTML and XML and every company could easily adhere to it.

Companies seek to prevent other software from using their formats by treating them as trade secrets despite the fact that most are hardly secret nor very difficult to decipher. They wrap them in trademarks, copyrights, and highly-dubious patents so everyone has to have a license to use them, despite the fact that many simply borrowed their formats from prior art. They force people to sign invasive End User License Agreements which prohibit the studying of a program so a format can't be reverse engineered. By restricting a format in these ways, the very promise of computers to facilitate the open interchange of information is undermined.

Not only does Microsoft leverage its proprietary formats to retain its monopoly, it seeks to drive competitors out of the market by remaking open standards and formats which all companies can use into its own proprietary versions which hamper the ability of competitors to use the format. Microsoft has used this policy known as *embrace and extend* to transform standard languages such as HTML, BASIC, C++, Javascript, and Java so that rivals can't compete very readily. For instance, Microsoft has refused to fully implement the standards for the internet created by the World Wide Web Consortium (W3C). Instead of supporting standard HTML and Cascading Style Sheets, Microsoft decided to implement its own proprietary extensions in Internet Explorer and FrontPage. Today, many websites don't comply with standard HTML and other free internet formats, because Microsoft corrupted these formats. When web designers attempt to make clean websites which comply with free formats, they often won't won't display correctly on Internet Explorer because Microsoft truculently refuses to fully implement a standard which it doesn't control. Similarly, Microsoft has embraced and extended the standard networking protocols used in Kerberos and SMB to lock us into their networks and prevent

other operating systems from interacting with Windows networks.[95]

Microsoft's underhanded shenanigans have aroused the wrath of citizens all over the world. A number of countries such as China, S. Korea, and Brazil have grown so concerned by the power that Microsoft's monopoly holds over their technological future, that they now promote the use of GNU/Linux to supplant Windows. Other countries are calling for greater governmental oversight and regulation of Microsoft's business practices. Unlike the Bush administration which revealed its disgraceful corporate obeisance by dropping the Justice Department's suit against Microsoft with a slap on the wrist, the EU fined Microsoft a record $610 million for its monopolistic practices. In addition, the EU court ordered Microsoft to open up its networking formats, so its competitors could access its networks. Microsoft shamelessly circumvented the directive by created a licensing scheme for using its network protocols which violates the General Public License (GPL), the license used by roughly 70% of free software programs. Even if a piece of software isn't legally prohibited from licensing the use of Microsoft's networks, Microsoft only released an incomplete set of networking specs, so implementation is extremely difficult. Not fooled by this dodge, the EU court is currently threatening to fine Microsoft $2.4 million for every day that Microsoft continues to hinder its competitor's access to its networks.[96]

To prevent future monopolistic abuse and stop software companies from leveraging their proprietary formats to induce needless upgrades, we must demand that the computer industry use *free* or *open formats* which aren't encumbered by patents and trade secrets and allow everyone to use them without licenses. We can not hold our information ransom to the restrictions of proprietary formats. Encourage the widespread adoption of free formats by insisting on their use whenever you have a choice. Instead of ripping your music as MP3 which is controlled by patents from Thompson Electronics and Fraunhofer Institute, rip in Ogg Vorbis format. It was developed by the Xiph Foundation, a group dedicated to creating free multimedia formats. Not only does Ogg Vorbis have superior playback quality, its use does not have to be licensed like MP3. Not only has Ogg Vorbis has been widely adopted among Linux enthusiasts, game makers such as Id Software, Rockstar Games, and Bungie Software now use it for the sound effects in familiar games such as Quake 4, Doom 3, Grand Theft Auto: San Andreas, and Myst. Samsung, iRiver, TEAC, and a number of other hardware companies make CD and flash memory music players that use the Ogg Vorbis format. Unfortunately, adoption of Xiph's video format, Ogg Theora, has not been nearly as widespread.

Since the rise of microcomputers in the late 70s created a mass market for commercial shrink-wrapped software, closed or proprietary formats have held sway in most of the industry. The internet, however, has created a realm where free software and free formats have predominated and challenged proprietary controls. The internet succeeded in linking together the whole world and bringing better communication and wider access to information to billions of people precisely because it was based upon free formats and free software. The visionaries like Ted Nelson, Vinton Cerf, Tim Berners-Lee and Jon Postel who helped make the internet possible were passionate proponents of the idea that information should be open to all and freely accessible. The protocols and technologies they propounded in hypertext, TCP/IP, HTML, the internet working group and its "request for comments" are the embodiment of these ideals. As the internet has become a corporate playground in recent years, many of the founders of the internet have become vocal proponents of the ideal the internet should remain open to all and can not be "owned". Accordingly, Robert Kahn, the coauthor of TCP/IP with Vinton Cerf, took Concord EFS to court when it tried to assert ownership over the word "Internet" and is currently suing the Agfa-Gevaert Group for trademarking the term "e-photo." Kahn insists that the

word "Internet"--like the thing it refers to--should remain public domain so it can not be controlled by any private group. For the same reason, Joseph Turow of the Annenburg School for Communication in the University of Pennsylvania has started a crusade to decapitalize of the "I" in "Internet". According to Turow, the internet "should not be owned by anyone", unlike terms like "Kleenex" and "Xerox" which are controlled by private corporations. The internet is the common experience and expression of the people and is "part of the neural universe of life."[97]

Today we take the open nature of the internet for granted, but it could have been implemented in a very different way with proprietary software and closed formats which would have hampered all the positive benefits which the internet has brought the world. Imagine having to sign a license agreement and paying a fee for the right to access the internet. In a proprietary world, every node on the internet would have to had to buy an expensive upgrade every other year because TCP/IP, the basic protocol of the internet, kept coming out with new versions which cost new licensing fees. People wouldn't be able to access web pages from certain sites without licenses for the latest version of HTML or PDF. If not for the fact that the original designers of the internet and bodies like the World Wide Web Consortium had insisted on free formats, fewer people would probably have access to the internet today. Because the internet formats require no licensing fees and are decided in open meetings, the entire globe was able unify in support of the free standards. Thus, the internet has become a place where the most privileged and wealthiest don't have any greater right to information than the least privileged and poorest. With the price of hardware falling so precipitously, we can foresee a future where the whole world participates in the information age--a vision only possible because of the democratic nature of the internet built on free formats.

In recent years the internet has become increasingly privatized and there are a number of proposals afoot to make the internet less free and build special privileges and "protections" into its protocols. We are being sold this snake oil under the false guise of "security". While it is true that spam, viruses, spyware, and other forms of malware have transforming the internet into a treacherous realm, the solution is not to be hoodwinked into plans to monetarize and privatize the internet and control our use of the internet. TCP/IP doesn't have to be transformed into a series of firewalls in order to control the epidemic of viruses and malware which plague our computers. Instead, the solution is to switch from the proprietary software which is causing the security problems to safer free software. Using operating systems like GNU/Linux or BSD (and its derivative Mac's OS X) and internet tools like FireFox, Thunderbird, Apache, Postfix and Nessus will eliminate many of the gaping holes in internet security. Unlike MS Windows which is riddled with holes for crackers and unsafe protocols like ActiveX and MS Office macros, UNIX was designed with security in mind. Only about 40 viruses are known to exist for GNU/Linux and none have been widely disseminated. In contrast, there are 60,000 viruses for Windows. According to a May 2003 study, 91% of broadband users have spyware on their computer, but spyware is virtually non-existent on GNU/Linux and BSD systems. In Windows, FireFox is 21 times less likely to pick up spyware than Internet Explorer when browsing the internet.[98] Roughly 60% of all email is spam,[99] but over 95% of that spam can be culled out with the Bayesian filters in Thunderbird and SpamAssassin.[100] Eighty percent of spam comes from "bots" which have taken control of computers with broadband access.[101] Seventeen out of a hundred businesses report that they have been attacked by bot networks. Switching to GNU/Linux or BSD would eliminate the vast majority of these bot networks because the UNIX architecture makes it much more difficult for a cracker to gain root access to set up a bot.[102]

Since the ICANN was created in 1998 to govern domain name assignments on the internet, control of

the internet has passed away from academics like Jon Postel who believed that domain names should be assigned in the public rather than private interest. While formally non-partisan and non-profit, ICANN has repeated made decisions in the interest of corporate America--not surprising since it is under the control of the US Department of Commerce. A report by the Centre for Global Studies at the University of Victoria, British Columbia found repeated instances when the ICANN was captured by special interests and its own rules of governance were violated in the making of decisions involving corporate interests.[103] To help keep the internet a democratic sphere where the underprivileged have equal access, support the work of the Electronic Frontier Foundation. Although the EFF tends to be more libertarian than socially minded, it has been a critical voice fighting against the secretive nature of the ICANN and its pandering to special interests.[104] Furthermore, it has fought the use of patents, licenses, Digital Rights Management, and other legal and technical chicanery by business to privatize what was formerly public domain and control our use of the internet.

The Clinton administration sold us the internet as the "information superhighway" to bring everyone greater access to news and education. Ironically, it was the same administration which allowed the internet to turn into a corporate playground geared more toward commerce rather than human enlightenment. Without doubt, the internet has served as an enabler of civic activism and anti-globalization movements. Howard Dean's 2004 presidential campaign, the World Social Forum and WTO protests would have been much smaller affairs without the internet. The internet has spawned the growth of the alternative media and progressive blog sites such as Independent Media Centers, Common Dreams, AlterNet, Z-Net, Democracy Now!, and Daily Kos, yet for most people, the internet has become one more means of marketing and corporate control over our minds. As the media industry increasingly concentrates in fewer hands and digital integration continues, we can expect our media to increasingly reflect the bias of big business. Edward Herman and Noam Chomsky argue that covert corporate censorship of the media in liberal democracies can be just as effective at shaping our opinions as overt state censorship in Communist countries.[105] Most people access the internet through portals such as MSN, Yahoo!, and Google which are more committed to selling us something rather than providing us with the tools to be good citizens. If our only news comes from MSNBC and New York Times online, our understanding of our world will be filtered through a corporate lens which obscures grassroot viewpoints and marginalizes alternatives which don't have powerful lobbies. Our corporate media seems largely unconcerned with the fact that the US has the highest income inequality of any developed nation[106] and the worst public health statistics of any developed nation yet the highest medical costs. Rarely does our mainstream press ask why the Bush Administration needs to gut our social programs to increase the military budget, when we already spend $522 billion on our military compared to the $561 billion spent by the rest of the world combined.[107] The Stakeholder Alliance estimated that the public cost of US private corporations in 1995 was $3,051 billion,[108] yet it is difficult to find criticism of corporate welfare in the mainstream press. We can regain a critical perspective by promoting alternative media on the internet and refusing to use email and internet portals which are conduits into consumerism and corporate bias.

Design used by the Cult of the Dead Cow to publicize how Microsoft, Google, Yahoo!, and Cisco were collaborating with the Chinese government to censor information and jail dissidents.

Our internet portals determine our blinders in the internet, so chose wisely. Internet search engines from Yahoo!, MSN, AOL, and Google help us locate valuable resources in the internet, but they also structure our searches so corporate advertising appears first on the list. We often don't notice the better alternatives relegated to the end of the list. To avoid this sort of commercial bias in your web searches, use the Anoox search engine which decides which search results appear first based upon people's votes, rather than corporate dollars. Not only is Anoox open source, it guarantees not to engage in other business activities (which distort the priorities of other search engines) and will donate 25% of its profits to charities and NGOs. Anoox makes a public commitment to place "the concerns of the community ahead of profit motivations and share prices."[109] Part of this commitment is encouraging each country to set up its own search engine so control won't be centralized in US hands. The German and French governments recently formed a joint venture to create a search engine known as Quaero to rival Google. Although the primary motivation is political and cultural, rather than commercial, it appears that Quaero is seeking ad revenue in much the same way as Google, so it may not be any better than its North American rival.[110]

Under the Bush administration, privatization and corporate control over the internet has increased apace. In 2002, the FCC under the leadership of Micheal Powell did away with the "common carrier" rules which required cable companies to provide non-discriminatory access to internet service providers who wanted to use their cable lines. The corporate controlled FCC recently rolled back the same rules for the DSL carriers as well, so most broadband providers don't have to provide access to their competitors and can lock their customers into a monopoly. Now telecoms like Verizon and AT&T can decide to reserve special bandwidth for their content, while limiting the bandwidth for other types of content. As digital integration increases and telecoms become media providers, your telecom may decide that its movies, music, commercials, and games should hog the majority of the bandwidth. Big businesses like Time-Warner, Sony, ebay, and Yahoo! will probably be able to pay enough to ensure that their content gets fast service, but content from NGOs, civic groups, alternative media, peer-to-peer networks, and small entities may get short shrift or even be blocked in the future. Verizon, Comcast, Bell South and other telecoms are developing plans to track and store our every move in cyberspace in a vast data-collection and marketing system. In this way, advertisers will know what to sell us and content providers can charge us for what we access. There are other plans afoot create subscription plans for "platinum," "gold" and "silver" levels of Internet access which would set limits on the number of downloads, media streams or even e-mail messages available at each level. In an article for *The Nation*, Jeff Chester raises the likely scenario under these sorts of rules where advertisements for 3rd party candidates and environmental campaigns are given little bandwidth while advertisements from mainstream candidates and polluting corporations receive the fastest service. Democracy and civil society are undermined and free speech stifled by these efforts to turn the internet into a purely commercial endeavor that caters to the deepest pockets. The prospect of a discriminatory internet is so alarming that Common Cause, Free Press, Media Access Project and Consumers Union have joined in a campaign calling for federal regulations ensuring "network neutrality", or the equal treatment of all content on the internet.[111] Without network neutrality, the internet may be privatized just like in the 1920s when federal regulation auctioned off the public airwaves, so radio was transformed from a vibrant medium for churches, unions, and civic groups into the monotonous mouthpiece of corporate America.[112]

The same telecom companies, which are promoting these plans for content discrimination and the privatization of the internet, are assiduously lobbying state governments across the country to limit

people's access to broadband internet. They are doing everything in their power to stop the adoption of community mesh networks which promise to bring broadband internet, VoIP, and other media to under-served rural and poor urban areas. According to the FCC, almost 20% of Americans live in places where no broadband is available and another 28% only have access to one provider. Because America chose to deregulate the industry in 1996 and the FCC and Supreme Court has repeatedly ruled in the interest of big business rather the citizenry, Americans pay more than most Europeans, Koreans, and Japanese for their broadband. In Japan, an internet connection that is 16 times faster than the typical American DSL line costs a mere $22 per month. Not only do Americans receive less bandwidth, but the internet has become highly discriminatory with the best broadband access in richer areas and no access in poorer and more rural areas. Only 1 out of 3 people in urban America and 1 out of 6 people in rural America have broadband internet.

Given how vital broadband internet is to the social and economic development of a community, many municipalities like San Francisco, Philadelphia, Chaska, Minnesota, and Granbury, Texas have responded to the failure of the market by setting up their own mesh networks with WiMAX. In a display of corporate avarice, the telecoms decided to put a stop to this challenge to their monopolistic grip on the market. They have twisted arms in states across the country to prevent community internet projects. In the last couple years, the telecoms have pressured 14 states into passing laws which ban or place limits on municipalities providing broadband access. Not only do these anti-community policies keep prices artificially high, hinder education, and limit internet access to the poor, they also are bad for the environment. Fast internet access allows more remote tele-commuting so people don't have to waste as much gas driving. A fast internet also allows old computers to run longer because it encourages the use of distributed processing, web-based applications, and the downloading of free software. Citizens are starting to waking up to the perils of letting the telecoms decide their digital future for them. Legislation which would have restricted community internet projects has been blocked in 7 states and delayed in 2 others because concerned citizens spoke up. To help make broadband accessible to all Americans, support John McCain's (R-Ariz.) and Frank Lautenberg's (D-N.J.) bill which overturns state legislation barring community internet projects and allows municipalities to provide internet service.[113]

Given what a poor job the US has done of bringing the internet to its own citizens, it is hardly surprising that the rest of the world doesn't trust it to manage the internet for them. When the World Summit on the Information Society gathered in Geneva in December 2003 under the auspices of the UN, it created a "plan of action" to bring information and communication technology "within the reach" of at least half of the world's people by the year 2015. As part of that plan, the WSIS called for "the international management of the Internet" which "should be multilateral, transparent and democratic". In the eyes of many around the globe, the ICANN's control of the internet is incompatible with the WSIS' goal to "build a people-centred, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge." In some eyes, the US's ardent support of neoliberalism, intellectual property rights, and the interests of multinational corporations has hindered the efforts to create the type of "Information Society" envisioned by the WSIS. Despite the fact that almost the entire world supported the WSIS proposal, the US government caused a scandal by arrogantly refusing this reasonable request that it turn control of the internet over to an international body. While some have noted that the importance of this issue is more symbolic than real, it does reveal how little sensitivity the US has for the need to bridge the global digital divide and democratize computer technology.[114] Internet Service Providers can help make the internet a more open and democratic sphere which respects international concerns by

switching their Domain Name Servers (DNS) to the Open Root Server Network (ORSN) which was founded in Feb. 2002 as an international alternative to ICANN.

Unlike the internet, desktop and local network computing has always been the demesne of proprietary formats. The biggest companies in the industry appeared to be colluding to keep it that way, when they backed the business-oriented Organization for the Advancement of Structured Information Standards (OASIS) in the place of the more democratic World Wide Web Consortium (W3C). Many in the business community, however, have come to recognize that they are being harmed by the lack of a good alternative to Microsoft's DOC, XLS, and PPT formats for office applications. Companies such as IBM, SUN, Novell, and Corel needed a standard format outside the Microsoft orbit. The OASIS which advertises itself as the "global consortium that drives the development, convergence and adoption of e-business standards"[115] became the scene of a protracted internal fight between proprietary and free formats. To the great surprise of many, OASIS formally adopted the OpenDocument format (ODF) in May 2005 as its official standard for documents, spreadsheets, and presentations. The door has been opened for widespread adoption of a free office format to liberate information from Microsoft's control.

Governments which are predicated upon the democratic ideal that information should be open to all its citizens have been among the first to adopt the new standard. Munich, Vienna, Bristol City, France's Ministry of Finance and its Ministry of Economy, Finance, and Industry, Brazil's Ministry of Health, and Singapore's Ministry of Defense all use OpenDocument.[116] When Massachusetts made similar motions to adopt OpenDocument as its official format for state documents, Microsoft became so concerned by this possible threat to its monopoly that it dramatically announced that it would release Open XML, its own free format for office applications. Having watched Microsoft's monopolistic antics in the past, many skeptics predicted that Microsoft is engaging in vaporware-style tactics to shutdown a potential competitor. They warn that Microsoft has no intention of offering a free format. They predict Microsoft will introduce proprietary restrictions to its XML format, once it has successfully derailed the adoption of a truly free format which could potentially undermine its lock on the market. Will Rodger, director of public policy for the Open Source and Industry Alliance expresses grave concerns about the openness of Microsoft's format and the unwillingness of Microsoft to share any control over the standard with outside groups. After examining Microsoft's written proposal for Open XML, Rodger commented, "The proposal falls short of what even pessimists expected. We thought we'd see at least a token surrendering of control in this document. Instead, we're told, Microsoft wants to retain all control ..."[117] Given Microsoft's long history of corrupting standard formats for its own benefit, we must stand up and demand truly free formats on the desktop which can't be manipulated or controlled by any one entity.

Use These Free Formats Whenever Possible

Format	Description	Suggested Applications
OpenDocument	The OASIS Open Document Format for Office Applications (ODF) was developed by OpenOffice for documents, spreadsheets, and presentations. It is stored as text to be readable by the human eye, unlike most formats which are binary.	In addition to OpenOffice 2, OpenDocument can be used by Abiword 2.4.2+ and Gnumeric in Windows and Linux. NeoOffice 1.2 supports it on MacOS X; KWord 1.4+ supports it in Linux; and Scribus 1.2.2+ can import it. It can be used with Microsoft Office with the O3 plugin. WordPerfect has make noises about supporting it in the future, but didn't include it in WP 12.

Use These Free Formats Whenever Possible

Format	Description	Suggested Applications
TXT	Unformatted text format recognized by all word processing programs.	In Windows, use Notepad++ in place of MS notepad. In Linux, gEdit, KEdit, and pico offer simple TXT editing, while vim and emacs offer more advanced options. All mail programs such as Thunderbird, SeaMonkey, and KMail can send email in TXT.
RTF	Rich Text Format is a formatted text format developed by Microsoft in 1987.	Abiword, OpenOffice, and KWord can open and save in this format.
HTML XHTML	HyperText Markup Language and eXtensible HyperText Markup Language are formats for web pages originally developed by Tim Berners-Lee and maintained by the World Wide Web Consortium (W3C).	(X)HTML can be displayed with Firefox or SeaMonkey on all platforms, Konqueror in Linux, and Camino on Mac. On all platforms, it can be edited with Nvu, SeaMonkey, Amaya, and OpenOffice. In Linux, the best editor is Quanta Plus.
PDF	Portable Document Format is a subset of PostScript developed by Adobe Systems for the display of precisely formatted documents.	It can be displayed by proprietary Adobe Reader on all platforms or free software programs like xpdf, kpdf, gpdf, and Evince in Linux. PDFCreator, Abiword, OpenOffice, pdfTeX, and pdfLaTeX can create PDF documents, but can't edit existing ones like Adobe.
TEX	TEX, pronounced "tekh", is a typesetting system developed by Donald Knuth in 1978 for math and science texts.	LATEX on all platforms.
PNG	Portable Network Graphics is a lossless compression for bitmap images created to replace the patented GIF format.	On all platforms, it can be displayed by Firefox and SeaMonkey, and edited by the GIMP and OpenOffice Draw. To retouch bitmap images in movies, use cross-platform CinePaint.
JPEG	Joint Photographic Experts Group is a lossy compression for photographic images. Since 2002 Forgent Networks has asserted that it has a patent covering JPEG, but the JPEG committee has shown that prior art invalidates the Forgent's patent, which expires in 2006 in any case.	In Windows and Linux, JPEG can be displayed by Firefox and SeaMonkey, and edited by the GIMP and OpenOffice Draw. Linux has a number of photo managers such as F-Spot, gThumb, and KSquirrel, but in Windows the best option is proprietary freeware Picasa.
SVG	Scalable Vector Graphics is an XML markup language created by the World Wide Web Consortium for describing unanimated and animated two-dimensional vector graphics. It can be used as a replacement for VML and Flash.	On all platforms, SVG can be displayed by Firefox1.5 and SeaMonkey and Amaya and edited by Inkscape. OpenOffice Draw (with this plugin), Skencil, and Scribus can import and export SVG.
FLAC	Xiph Foundation's Free Lossless Audio Compression is used to save music without any loss and for audio streaming.	For hardware and software that supports FLAC, see: flac.sourceforge.net/links.html
Musepack	Musepack (MPC) is an lossy audio compression format with a strong emphasis on high quality. There is one contested patent claim against Musepack at this time.	iRiver H100 series and Rockbox support Musepack. Development version of VLC and MPlayer also support it. See http://www.musepack.net for more info.

Use These Free Formats Whenever Possible

Format	Description	Suggested Applications
Ogg Vorbis	Xiph Foundation's Ogg Vorbis is a lossy audio codec with better playback quality than MP3.	For a list of hardware players see: wiki.xiph.org/index.php/portable players. For a list of software players, see: wiki.xiph.org/index.php/VorbisSoftwarePlayers. Ogg Vorbis files can be edited with Audacity.
Ogg Theora	Xiph Foundation's Ogg Theora is a lossy video codec comparable to MPEG-4.	For software players, see: http://wiki.v2v.cc/cgi-bin/trac.cgi/wiki/OggTheoraPlayer. Although no hardware makers support it at this time, it can be encoded in software with Thoggen or ffmpeg2theora.
Speex	Xiph Foundation's speech codec designed for use with Voice over Internet Protocol (VoIP) and speech files.	For a list of plugins and software, see www.speex.org/projects.html.

Recent Movements to Reform the Computer Hardware Industry ▲

Confronted with the problems of buying computers, many socially conscious people throw up their hands in frustration and despondency. Unlike coffee and clothes, there are no "fair trade" electronics to opt for a more socially-conscious and eco-friendly product. Nonetheless, there are a number of movements afoot to address the social and environmental impact of computing technology. Worldwide a growing chorus of people are striving to change the current state of the electronics industry. A critical consensus is growing in various sectors that our current practices are unsustainable and must be reformed.

Countries like Germany, Sweden, Norway, and the Netherlands have long maintained that industry practices must be brought in line with concerns for the safety and health of their citizens. This policy is being spread to Europe as a whole with the new Waste Electrical and Electronic Equipment (WEEE) Directive and Restriction of certain Hazardous Substances (RoHS) Directive which are scheduled to come into effect in July 2006. The WEEE mandates that consumers can return their electronics for recycling free of charge and sets targets for the collection, recycling, and recovery of electrical waste. Although each country is free to implement different systems for achieving the targeted 70% to 80% recovery rate, the WEEE directive is notable for encouraging equipment manufacturers to recycle their own products. Unlike most recycling legislation in the US, the WEEE encourages companies to design products which "facilitate the dismantling and recovery, in particular the re-use and recycling." Electronics which are designed to prevent reuse such as ink cartridges with use-once chips are prohibited. At the same time, the RoHS directive will restrict the use of lead, mercury, cadmium, hexavalent chromium, and brominated flame retardants PBB and PBDE in electronics sold in Europe. This European effort to

Look for the wheely-bin logo found on all WEEE compliant products.

eliminate the most problematic toxins and heavy metals from their electronics inspired California to pass its own RoHS which will come into effect 6 months after the European measure. Sadly, the computer industry has forced a number of critical exemptions, so the RoHS won't make the most hazardous part of the computer, the monitor, much safer. The leaded glass in CRTs won't be covered by the RoHS. Likewise, the mercury backlights for LCD and plasma displays are also exempt as long as they contain less than 5mg of mercury.[118]

In recent years, several Asian countries have also begun taking steps to reform their electronics industry. In 2000, Japan passed the Household Appliance Recycling Law to require that all television sets, air-conditioners, washing machines, and refrigerators be recycled instead of dumped in landfills. Green design is promoted by new mandates that appliances be 50% to 60% recyclable. The law encourages the Japanese to keep their appliances longer to avoid the hefty recycling fee and stimulates a market for used goods.[119] According to one survey, nine major Japanese electronics firms spent $1.5 billion on environmental compliance and design in 2001-2002.[120] Under the strong direction of their government, Japanese companies have been the among the first in the world to eliminate lead solder and several types of brominated flame retardants from their products.

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Manufacturers are devising their own RoHS and lead-free logos because there are no official logos.

Like its Asian neighbor, South Korea also passed legislation to require manufacturers to take back their appliances, computers, printers and peripherals for recycling/reuse. In 2005, cameras and cell phones were added to the list of products which had to be recycled. Taiwan has traditionally taken a callous attitude toward the environment in its quest to produce the majority of the world's motherboards, notebooks, and monitors. Nonetheless, Taiwan recently passed legislation to mandate the take-back of some types of electronics. In addition, Taiwan, South Korea and Japan are all drafting their own RoHS directives to restrict the use of dangerous substances in electronics.[121] Even China is in the process of instituting their own version of the RoHS, although no timetable has been set and parts per million levels haven't been established yet. Despite serious questions being raised about its implementation,[122] it is striking that China, the country which has the most to loose by implementing environmental regulations--which could potentially drive away multinational investment and jobs--sees the need to make the industry less toxic.

The RoHS will eliminate the use of leaded solder in most electronics, although the industry managed to get an exemption for servers and network switching equipment. China is also considering a similar restriction because it sees all the harmful effects of lead on its electronics assembly workers. A 2002

industry pamplet argues that manufacturers shouldn't make lead-free products, because switching from tin-lead solder to lead-free alternatives causes lower build quality, increases assembly costs between 4% to 15%, and requires higher soldering temperatures which use 15% to 25% more energy.[123] Raising the energy costs of manufacturing, creating more defective parts which are discarded, and decreasing the life expectancy of electronics are real environmental concerns; however, the benefit of eliminating a neurotoxin which poisons the environment outweighs these costs. In all likelihood, the extra assembly costs and the problems with build quality have significantly decreased as production of lead-free electronics has ramped up. Sony, Mitsubishi, Hitatchi, Fujitsu, and NEC were all scheduled to have eliminated lead solder from all their products by 2005.[124] These companies should be rewarded for their efforts, but instead, companies which chose to sell leaded products in the US will be rewarded because their lower assembly costs can undercut the greener competition.

Although these environmental measures only apply in Europe and parts of Asia, they will encourage greener design worldwide since all electronics makers will have to redesign their products so they won't loose the lucrative European, Asian, and California markets. There is great fear, however, that companies will practice a double standard with clean recyclable products in Europe and polluting throw-aways in the US. Iza Kruszewska of Greenpeace International in London observes how that double standard is being practiced in compliance with the WEEE directive. “In European countries with WEEE laws in place, companies like Sony and Panasonic and Sharp are already implementing 'producer takeback' programs for the products they sell in Europe and yet they are the same companies that are resisting this program in the United States.”[125] Despite the recent platitudes issued by HP about their concern for the environment, it would not be surprising if HP, along with Epson and Lexmark, will respond to the WEEE directive by designing refillable ink cartridges for market in Europe, while continuing to sell single-use cartridges in the US.

A number of European countries are raising concerns about other hazardous substances such as PVC and phthalates, not currently covered by the RoHS, leading many to predict that further restrictions will be forthcoming. With Europe and many Asian countries demanding safer products, tech companies are beginning to reexamine their polluting and toxic technologies and seek greener alternatives. Corning, the leading maker of LCD glass took note of the new environmental regulations coming down the pike over a decade ago and started working on an LCD glass which would be free of toxins and heavy metals. Most LCD glass contains halides like chlorine and fluorine. Barium is added in the glass expansion process and antimony or arsenic is added to eliminate oxygen bubbles. These additives not only make the glass hazardous, but also make it difficult to recycle. According to Peter Bocko, Corning’s director of display-technology research, Corning has been researching more eco-friendly glass technology because "Corning wanted to keep ahead of stricter environmental mandates arriving over the next few years". Corning recently announced its new Eagle XG ("extra green") LCD glass which is easily recycled and doesn't contain any barium, arsenic, antimony, or halides.[126]

This green innovation will be widely used worldwide, but many green products may not be for sale in the US because Americans aren't demanding them and our government isn't setting environmental priorities for the industry. Computer companies may chose to replace PVC and plastics containing brominated flame retardants in their European product lines, while continuing to sell more hazardous products to the US. Without Americans demanding that PVC plastics be eliminated, there is is no guarantee that PVC, which forms 26% of the plastic in computers according to a 1996 study,[127] will be replaced with safer ABS plastics in US computers. Similarly, monitor makers will probably continue to use Cold Cathode Florescent Lamp backlights for flat panel displays for the US market, while

switching to the mercury-free LED backlights for the European market. Because the new WEEE regulations will force computer manufacturers to recycle their products, laptop makers in Europe are more likely to decide it is worth paying 3 extra dollars for a LED backlight which doesn't contain any problematic mercury which is costly to remove at the end of a product's lifecycle. Because Europe is imposing carbon taxes, European laptops and flat panel displays are more likely to use LED backlights which consume less power, produce less heat, and last longer than traditional CCFL backlights. Because LED backlights are thinner, don't require bulky inverter circuitry, and suck less wattage, the most expensive laptops in the US will probably feature these backlights beginning in 2006,[128] but the bulk of US displays probably won't switch unless Americans raise a ruckus.

Unlike the US government, the Japanese government set rigorous environmental targets for its tech industry and its companies have since been on the forefront of green innovation. Unlike US industry associations, the Japan Electronics and Information Technology Industries Association (JEITA) and the Green Purchasing Network (GNP) in Japan have set eco-friendly standards for the industry. For these reasons, NEC developed NuCycleT, a 100% recyclable flame retardant plastic made of polycarbonate and a silicone compound, and Terramac, a heat resistant organic plastic made of polylactic acid[129] and kenaf fibre. In Japan, these more environmental plastics are being incorporated into green products such as the Foma N701iECO cell phone[130] and the NEC PowerMate eco PC. The Silicon Valley Toxics Coalition has identified 34 hazardous substances in the typical PC. See Appendix D for the complete list. The NEC engineers eliminated all 34 of those substances plus a few extras like barium, boron, and cobalt in designing the PowerMate EcoT, a fanless all-in-one desktop PC with a built-in 15" LCD.[131] NEC attempted to market this innovative green machine to businesses and governments in the US, but sales were so bad that the American product line has been pulled. Although it continues to be sold as the NEC Mate NX in Japan, the failure of NEC's green computer in the US is hardly surprising considering the fact that we don't have mandatory recycling of appliances as in the case in Japan and we have subsidized cheap electricity so there is little incentive to buy a 30 watt computer instead of the 300 watt behemoths that are commonplace. A Gartner analyst commented that it would be a "major challenge" to get US businesses and government agencies to pay extra for green computing in the same way that they pay extra for more processing power or disk capacity.[132]

Because Europe and many Asian countries has prioritized the reduction of greenhouse gases, tech companies are starting to respond with products that cause less global warming. As part of the Climate Partner initiative, Averatec recently announced that all its European laptops would be "climate neutral." For every laptop that Averatec sells in Europe, it promises to buy a ton of carbon credits to offset the greenhouse gases generated by the operation of a laptop for 3 years.[133] We can cavil over the fact that Averatec didn't include the energy to manufacture the laptop in its calculations and Averatec is buying its carbon credits from a Norwegian hydro-electric power company rather than a more beneficial wind or solar power company. Nonetheless, Averatec is taking positive steps to address global warming and showing real corporate leadership. Unfortunately, the most progressive laptop maker in the industry sees no need to offer Americans the same "climate neutral" laptops as it sells in Europe. It would have cost Averatec very little to offer the same deal to Americans, since carbon credits are selling at $1.60 per ton in Chicago versus $25 per ton in Europe.[134] Because US citizens have been so quiescent about environmental issues, Averatec sees little call for green laptops in the American market.

Not all the global tech companies operating in America have ducked global warming issue. Geneva-based STMicroelectronics, the fifth largest semiconductor company in the world, has set a public goal of reducing its world-wide CO2 emissions down to its 1990 levels by the year 2010. Despite the fact

that STMicroelectronics expects to produce 40 times the number of chips that it produced in 1990, it doesn't see growth and environmental policy as being incompatible like many US companies. In the mid-1990s, ST overhauled its Singapore fab so energy costs per silicon wafer were reduced by 60%. In the late 90s, ST retrofit 8 of its fabs in Europe and America to reduce the heating, venting and air conditioning costs by 30% to 50%. In less than two years, ST recouped the cost of retrofitting with decreased electricity bills.[135] It is striking the difference between these sorts of green innovations and the innovations being touted by American-based semiconductor companies like Intel and AMD. When they talk about making more environmental products, they only discuss operational energy efficiency, rather than production energy efficiency.[136] In other words, they are only addressing the global warming caused by the consumer when using the computer, not the global warming they cause when producing their chips. Intel publicizes how its uni-axial strained silicon produces more energy-efficient chips with less electricity leakage,[137] but that new technology does little to reduce Intel's own energy usage. In fact, it's new strained silicon chips may require more energy to produce since they raised production costs by 2% and electricity is the biggest single input cost of producing a silicon chip.[138] In a recent article, Intel touts its environmental foresight: "Years ago, Intel anticipated this trend [toward global warming mitigation] and took action. Intel engineers drove a first-of-its-kind worldwide agreement to voluntarily reduce chemicals with high global warming potential throughout the global semiconductor industry." In the article Intel makes no mention of its increasing energy usage which causes far more global warming than the chemicals used in silicon manufacturing.[139]

As a general rule, US-based companies have historically resisted reforms which would make them more responsible for what they sell in America. When the WEEE directive was passed in the European Parliament in 2002, the Calvert Group and As You Sow, socially-responsible mutual funds, asked why the same companies that will be recycling their products in Europe, shouldn't do the same in the US. In 2002, the Calvert Group introduced resolutions at Apple, IBM, Gateway, HP, Compaq, and Dell stockholder meetings to assess the feasibility of creating a product-take-back and recycling program for each company. Despite the fact that US computer makers are implementing product-take-back programs abroad, they all refused to be responsible for their own e-waste inside the US. Only 7.5% of Gateway stockholders and 8.3% of HP stockholders voted to study the feasibility of such a program; the other companies refused to even vote on the measure.[140] Similarly, when the California legislature was debating the Electronic Waste Recycling Act of 2003, all the computer makers (except Apple) and their trade industry representatives came out in opposition to the act.

Alarmed by the growing e-waste problem, a coalition of activist, community, and labor groups launched the Computer TakeBack Campaign in Spring 2001 to demand that computer manufacturers must be responsible for recycling their own products. The campaign promotes the idea of *Extended Producer Responsibility*, a policy developed by Sweden in the 80s to hold manufacturers accountable for the entire lifecycle of a product--including its disposal and recycling. EPR has been widely adopted in the EU's WEEE directive and in recent recycling laws in several Asian countries. Currently, 15 countries have passed EPR legislation requiring the take-back of batteries and 12 countries require the take-back of various types of electronics.[141] Despite the initial opposition on the part of computer makers in the US, there are signs that the Computer TakeBack Campaign is beginning to change opinions in the industry. The industry has begun to wake up to the fact that their toxic products are a potential public relations disaster and liability. In a moment of candor, Larry Miller, a NEC vice president, commented: "When you hear about children getting lead poisoning from rummaging through landfills in developing third world countries searching for spare computer parts to sell, you realize the industry has a responsibility to address these problems."[142] Now that the WEEE and RoHS are a

reality, practical computer makers are starting to realize that opposition will only generate more bad PR, while promoting eco-friendly products and recycling services will make them more competitive in the new green economy.

Not surprisingly, the two US computer makers who have adapted the best to this new reality are Dell and HP, the two market leaders with the most resources to invest in recycling services and green design. The Computer TakeBack Campaign first targeted Dell which controls 30% of the US market as the industry leader whose practices would set the standard for rest of the industry. When Dell was exposed for exporting e-waste and using prison wages through UNICOR,[143] protesters started showing up at trade shows to denounce Dell.[144] The bad press was particularly embarrassing for Dell since it touts the fact that it had eliminated PBB and PBDE from its products and markets the eco-friendly OptiPlex line of computers with a 100% recyclable case designed for easy upgrades. In the face of mounting criticism, Dell cut its contract with UNICOR[145] and redoubled its PR efforts to promote itself as an socially responsible and eco-friendly company.[146] Dell has embraced recycling as part of their disposal management services which give customers the options to trade in, upgrade, auction off or donate to charity their old computers. These convenient services give Dell a competitive advantage, especially when competing for large contracts. While some remain skeptical about Dell's commitment to the environment, the EPA was so impressed by Dell's recycling policies that they awarded them the contract to lease 100,000 computers for the next three years.[147]

Like Dell, HP has begun promoting recycling services as part of its business plan. In 2004, HP offered a six-week trial to recycle old computers which were brought into Home Depot stores. The response from this trial proved to HP that their customers want recycling services. Although computer companies won't make money on recycling *per se*, it will gain customers by offering a service which helps them easily dispose of the 300 million old PCs which the SVTC estimates are sitting in American garages, attics, and backrooms. Surveying American consumers, HP found that 68% stockpile used or unwanted computer equipment in their homes and need a way to get rid of it. When HP and Dell dramatically reversed their opposition to the Computer TakeBack Campaign in Spring 2004 and signed on to its Statement of Principles on Producer Responsibility for Electronic Waste, they cited business opportunities as much as environmental concerns. In line with this new commitment, HP announced on Earth Day 2005 that it had already recycled 616 million pounds of e-waste since 1987 and would be setting the goal of recycling a billion pounds of e-waste by the end of 2007.

As HP has promoted its eco-credentials, it has come under increased scrutiny from environmentalists. Although the SVTC gave HP the highest score on its 2003 report card, Greenpeace accuses HP of being a “toxic tech giant,” because it continues using polyvinyl chloride (PVC) plastic and brominated flame retardant tetrabromobisphenol A (TBBPA) when its competitors are phasing out their use. TBBPA was originally on the list of hazardous substances to be restricted under the RoHS, but the electronics industry raised a hue about the cost of removing TBBPA, since it is widely used in printed circuit boards and electronic housings. TBBPA represented 59% of all the brominated flame retardants used in 1999.[148] In the end, industry pressure succeeded in removing TBBPA from later drafts of the RoHS,[149] so that only two minor types of brominated flame retardants which aren't widely used would be restricted. Unlike the European Parliament, Greenpeace has decided to hold manufacturers accountable for creating products with TBBPA. When HP did not respond to public demands that it remove TBBPA from its products, Greenpeace dumped a ton of HP's toxic products in front of their offices in Geneva and blocked entrances to their offices in Utrecht. Greenpeace asked why HP can't make the same commitments to the environment as its competitors. Greenpeace praised Sony-Ericsson,

Nokia, and Samsung for taking steps to reduce or eliminate the amount of PVC and brominated flame retardants they use in their products. Sony-Erikson promised to remove brominated flame retardants from all their product lines by the end of 2005; and Nokia committed to do the same by the end of 2006.[150] Under mounting public pressure, HP sought a half-way measure and promised to eliminate the use of TBBPA in external casing in any new product lines released after Dec 2006 and reduce PVC and mercury usage. Because HP refuses to set a deadline for removing TBBPA, PVC, and mercury from their current product lines, Greenpeace accuses HP of promulgating "greenwash" or false claims of eco-credentials to hide its polluting practices. In early December 2005, Greenpeace activists converged on HP's Palo Alto headquarters to demand a stronger commitment from HP.[151]

Computer TakeBack Campaign protesting Apple's refusal to recycle the iPod in Jan 2005 at MacWorld.

Environmental and health advocacy groups have raised public awareness on the dangers of brominated plastics to such a degree that other computer companies are starting to react. Dell recently announced a 10 year plan to eliminate all brominated plastics by 2015 and proudly notes that they (unlike HP) have already removed all PVC, TBBPA, and hexabromocyclododecane (HBCD) from their computer chassis parts.[152] Public pressure campaigns on one company force other companies to clean up their practices, so they won't also be targeted next.

HP isn't the only company whose eco-friendly claims have been come under fire. Apple likes to publicize how it has developed greener designs for greater energy and resource efficiency. In Apple's case, these pronouncements ring hollow when Apple is busily churning out iPods as throw-away fashion accessories. Apple designed the perfect consumer product without expansion slots, so it will be frequently trashed in favor of newer models. Apple didn't create separate modules for the music player and the flash memory, so the memory can't be switched out and expanded. Unlike Zen or Dell MP3 players, iPod batteries can not be replaced so the whole unit has to be thrown away when the battery fails after a lifespan of roughly 18 months. Of course, people could send the unit back to Apple for recycling for a $30 fee or they could replace the battery for a *mere* $105, but most would chuck their dead iPods in the trash where the lead in the battery can leach out into the environment.

Apple likes to promote itself as a progressive company that appeals to an alternative crowd, but it certainly doesn't "think different" from the average US company when it comes to recycling. When Maine and Minnesota debated bills in 2003 and 2004 that would hold the manufacturer responsible for recycling CRTs and flat panel displays, Apple covertly hired lobbyist Dan Riley to oppose the measures. After Apple rebuffed repeated requests that it offer free recycling of its iPods, the Computer

TakeBack Campaign mobilized activists to protest at Apple events. When a number of embarrassing questions were raised at an Apple stockholder meeting, Steve Jobs denied that Apple had lobbied against the Maine recycling law. Jobs called it "inexcusable" that the SVTC termed the iPod "a time-bomb for our health" because of the lead in the battery. Jobs went on to deny that Apple used prison labor to recycle and exported their e-waste abroad. Much to the consternation of Apple, these denials were immediately refuted with proof by the SVTC and widely reported in publications like MacWorld.[153] The bad publicity mounted until Apple finally acceded in June 2005 to public demands that it recycle old iPods for free. Apple even promised to knock $10 off the price of a new iPod if the customer would bring in their old iPod for recycling.[154] The SVTC, however, continues its campaign, calling on Apple to recycle all its products, not just the one product that generates the most bad publicity.

The Importance of Government in Mandating Change ▲

In recent years, the US federal government has been a derelict guardian of public health and the environment, so the task of regulating the computer industry has fallen increasingly on the shoulders of private citizens. Clearly computer makers such as Dell, HP, and Apple recognize that their brand reputations and future sales rest on being perceived as environmentally responsible companies. Because tech companies are sensitive on this point, recent history shows that they can be moved to act more responsibly when we come out in force to demand that they change their business practices. While activist campaigns have forced a number of companies to change their practices, these changes are piecemeal and partial at best. Widespread change requires our government take a hand, so that every manufacturer is involved, not just whichever company happens to be targeted by activists this month.

Sadly, the Bush administration seems to be ideologically opposed to any form of environmental regulation which is mandatory, may raise costs, or sets firm targets. In effect, manufacturers have been given a pass to pollute from our government. The EPA's faith that voluntary recycling will effectively solve the looming e-waste problem is misguided. Although Dell and HP should be commended for promoting recycling (albeit under pressure), their recycling programs will probably only be used by a small fraction of their customers. Dell reports that their 2003 recycling rate for individual consumer products equaled 3% to 5% of their total consumer sales. Most computer makers report rates around 2%. Even if these rates improve in the coming years, the number of PCs being dumped in US landfills every year will still continue rising because of the rapid growth in new PC sales every year. Clearly, we can't depend upon voluntary recycling programs by manufacturers to solve the e-waste problem. Experience in places like Norway, where there is a 90% recycling rate for e-waste, shows that the most effective recycling programs which reduce waste are mandatory so that no manufacturer can gain a competitive advantage by not participating.[155] HP probably lobbied in support for Maine's new mandatory recycling law for CRTs and flat panel displays, because HP doesn't want to be the only manufacturer shouldering high recycling costs when its competitors can undercut it by not recycling.

Not only will mandatory recycling laws distribute costs more fairly, they will lower the high cost of recycling. Efficient and safe recycling requires automization and large-scale shredders, sorters, and smelters. These sorts of investments are only warranted with the large volumes and security which comes with widely-implemented mandatory recycling programs–not the voluntary programs promoted

by the EPA. Large volumes will encourage the creation of efficient collection and transportation systems and open up markets for recycled materials. Mandatory recycling laws will also encourage computer makers to design products which are easily disassembled and separated into reusable elements. It is often too costly to remove components from today's electronics and difficult to separate out the individual metals and plastics for recycling. Engineering more recyclable computers won't happen overnight, but computer makers won't make the initial investment in green engineering if they don't get clearer direction from government. Similarly, recyclers won't make the investment in recycling technology unless the government bans the export of toxic e-waste, so that clean recycling at home won't be undercut by unsafe recycling abroad.

Unlike the Japanese, South Korean, Taiwanese, and European governments, the US government has been missing at the helm on the e-waste issue. In the absence of clearer guidance on the federal level, a number of states have decided that they will have to take matters into their own hands. According to the Computer TakeBack Campaign, 26 states in the last 2 years have considered legislation to manage or study e-waste. A survey of 35 state recycling managers in late 2004, found that a third expected electronic waste legislation to be passed in their state within 3 years.[156] Illinois, New Mexico, Louisiana, and Washington are currently conducting studies or forming task forces with the goal of making recommendations for dealing with e-waste. California, Maryland, and Maine have gone a step farther and are implementing e-waste recycling systems. In 2003, California passed the Electronic Waste Recycling Act which charges consumers between $6 and $10 when they buy CRTs and flat panel displays larger than 4 inches. The money collected from this tax pays recyclers 48 cents a pound to recycle these devices. In Maryland, a state fund has been created to pay to counties which decide to collect and recycle CRTs, flat panels, and CPUs.

Why Extended Producer Responsibility is Needed ▲

While the recent measures in California and Maryland are commendable efforts, they aren't based upon the principals of Extended Producer Responsibility, nor do they allocate the kind of funds needed to adequately fund recycling. The Computer TakeBack Campaign estimates that if the California recycling system were extended across the US, recycling CRTs and flat panels between 2006 and 2015 would cost a total of $7.5 billion more than the funds collected. These measures ask Maryland taxpayers and California consumers, rather than the equipment manufacturers, to foot the bill for e-waste. Not only is the government of California making itself liable to pay the unpredictable costs of recycling products which it has little control over, it will also be forced to create a new bureaucracy to manage the fund and contract with recyclers. These activities could be handled more effectively in the private sector by the original manufacturer. A recent report by Raymond Communications found that Extended Producer Responsibility programs that hold the original manufacturers responsible for recycling their products do a more efficient job than the government. Countries with mandated industry-run collection systems for old electronics appear to reach higher recovery rates than countries where the government is the recycler.[157]

Without making manufacturers responsible for what they create, they will have little incentive to design greener products which are less toxic and less costly to recycle. When manufacturers are required to take back their products at the end of their lifecycle, they are provided with a feedback loop about the quality of their own products. Data can more easily be collected on failure rates, and parts

that break can be re-engineered or replaced. For instance, harddrive failure rates are one of the best kept secrets in the industry, but computer makers who recycle their own computers would be able collect data on bad drives, rather than relying on the word of drive makers and data recovery firms.

If recycling costs are not built into their business plans, computer makers will continue to create products which become obsolete rapidly, so they can sell more in the future. A recycling program which holds manufacturers responsible, however, would encourage computer makers to built longer lasting products which are easily upgradeable and more compatible with preexisting technology. Today, computer makers encourage software companies to create programs which hog more memory and processing time so people will buy new hardware, but in an economy based upon Extended Producer Responsibility, Dell and HP would be calling up Microsoft and Adobe to demand they write leaner, more efficient programs so they won't have to recycle their equipment as often. In an EPR economy, computer makers and software firms would get out of the business of rapid sales and planned obsolescence and move toward lease and support contracts which provide a steady income while maintaining equipment longer. When a computer company's revenue is based upon supporting and maintaining equipment, bloatware and bugs in software will no longer be treated as a way to get people to buy the next upgrade or a mere problem for the tech support department.

Ultimately, EPR does not have to cost significantly more, although it does require large initial investments in collection systems, recycling equipment, and redesigning existing toxic equipment. Industry associations claim that compliance with the WEEE directive will cost the industry $40 billion,[158] but most estimates place compliance costs in Europe between $10 and $20 billion for the WEEE and RoHS directives combined and estimate that they will only raise the price of electronics 1% to 3%. According to AMR Research, the RoHS will add roughly 1% to the cost of a PC and 2% to the cost of a mobile phone, while the WEEE will add roughly $10 to the price of each PC sold in Europe.[159] The extra costs of EPR are balanced by the long-term reduction in future liabilities, health problems, and toxic waste storage costs. Rather than treating green standards as rules to bend or costs to avoid, companies who adopt EPR principals will gain advantages in selling to countries like the Netherlands. They will never have to worry like Sony when it lost $110 million in revenues because its PlayStation contained unacceptable levels of cadmium for the Dutch market. Industry analysts, such as Eric Karofsky of AMR Research, note the “competitive advantage” of “green compliance” and urge companies to follow the example of Fujitsu which invested early in redesigning its products for recycling and energy efficiency. They warn that “laggards” will face “potential unquantifiable costs such as market share loss and branding implications.”[160]

When Maine passed its television and computer monitor recycling law in Spring 2004, it followed the European model and based its recycling program on the principals of EPR. The law mandates that the original equipment manufacturer (OEM) will be responsible for recycling all CRTs and flat screen displays over 4 inches. Local consolidators will catalog how many CRTs and flat panel displays they have collected and then charge the OEM for part of the cost of collection and the whole cost of transportation. The OEM will then be in charge of recycling their products or paying a firm to do it for them.[161]

The electronics industry as a whole is watching what will happen in Maine and California with bated breath. The fight over this legislation divided the industry as different companies took sides. IBM strongly opposed Maine's legislation, pointing to the California model as a better alternative. This stance was hypocritical, since Big Blue had joined the rest of the industry in opposing California's

legislation when it was being debated in 2003. As the only major computer maker which hadn't opposed California's bill, Apple could more legitimately campaign against Maine's recycling law. Still, Apple campaigned covertly by hiring an outside lobbyist to oppose the bill. Perhaps Apple feared what their famously loyal clientèle would think of their company when it advertises with images of the Dali Lama, yet showed such little desire to live in harmony with nature. Both IBM and Apple have a large number of legacy systems that they would be responsible for recycling. Considering the high costs of recycling their old monitors, it is hardly surprising that these two companies opposed the legislation. What is surprising, however, is the fact that both Dell and HP, the two giants which together controlled 48.7% of the US PC market in 2004, came out so strongly in support of the Maine bill. IBM and Apple with only 4.7% and 3.2% of the current market, respectively, were minor weights in this fight. When Apple was subsequently embroiled in its own debacle over the recycling of the iPod, it denied that it had campaigned against the Maine legislation. Perhaps Apple has come to see the benefits of EPR, since it recently announced plans to pick up its own e-waste in Maine, rather than pay an outside recycler to deal with its products. Apple now says that it wants to determine what happens to its equipment "at the end of life."[162]

Activists should take great inspiration from what happened in Maine in Spring 2004. Two years earlier the computer makers universally rejected the Calvert Group's proposition that they study the feasibility of voluntary recycling through a product-take-back program. Just one year after the California bill of 2003, the computer industry has moved from a position of general opposition to any mandatory recycling legislation to arguing in favor of various recycling programs. Computer makers seem to have woken up to the fact that states are going to implement some form of recycling, so they better have a voice in deciding which form is implemented.

What seems to alarm the industry the most is not the prospect of the extra costs of recycling, but rather the prospect of fifty states implementing fifty different programs which would be even more costly.[163] When Dave McCurdy, the president of the Electronic Industries Alliance, testified before the U.S. House Subcommittee on Environment and Hazardous Materials on Sept. 8, 2005, he was clearly anxious that the federal government intervene and standardize recycling nationwide:

> Absent a consistent national approach to electronics recycling, manufacturers, retailers and recyclers will be confronted by an expensive, inefficient and unworkable confusion of state laws and regulations. If this state-by-state pattern continues, it will impose an enormous administrative and logistical burden on the system that will ultimately result in increased prices to consumers for new products.
>
> There is clearly a role for the federal government to play in bringing national consistency to this emerging field. Federal action should strive to keep costs to consumers as low as possible, create a level playing field for market participants, and *ensure that products are being recycled in an environmentally sound manner*. Federal action can also help promote safe and appropriate recycling by creating a streamlined and uniform *regulatory framework* that removes artificial barriers and instead encourages the free flow of used products for proper management.[164]

An industry calling on the federal government to create a "regulatory framework" is hardly the normal message business gives to congress. The idea that business wants big government to create more federal regulation and to intervene in local government decisions goes against the orthodoxy of the Republican Party. McCurdy delivered a very unwelcome message to a Republican-controlled committee, especially when he was calling for the government to "ensure that products are being being recycled in a environmentally sound manner." Government regulation for the protection of the

environment is hardly on the Republican list of priorities these days, as they focus on doling out corporate welfare and slashing social programs for the poor to give tax breaks to the rich. If this request for federal regulation were coming from the American Association of New Age Healers, it could easily be laughed away by Congress, but the Electronic Industries Alliance represents 1300 firms which account for 80% of the electronics sold in America.

When the EPA banned the dumping of monitors in 2001, the EIA promoted voluntary recycling programs to forestall government regulation—a line consistent with the EIA's stout support for free trade and minimal governmental interference. The EIA's call the federal government to establish a national "regulatory framework" for recycling is certainly a welcome change, but the EIA is not promoting recycling based upon the principals of Extended Producer Responsibility. In its stead, the EIA is calling for "shared responsibility," or what others have called "shared stewardship" or "product stewardship."[165] According to McCurdy, "EIA supports efforts to establish a viable recycling infrastructure in which all the major stakeholders – manufacturers, retailers, government, non-governmental organizations (NGOs) and recyclers – participate based on their unique expertise and capabilities."[166] The devil lies in how much "shared responsibility" will fall upon taxpayers who pay for the "government" and subsidize the "recyclers" on McCurdy's list of stakeholders. If the EIA has its way, the original manufacturer may have very little "shared responsibility" and probably won't have much incentive to redesign its polluting products.

Given the pro-business attitude inside the Washington Beltway today, any federal legislation which created a national recycling framework based upon "shared responsibility" would probably be a setback for the Computer TakeBack Campaign and all the groups working for clean, socially responsible recycling. Legislation passed by the Republican controlled congress would probably be so weighed toward minimizing costs for business, that it would hinder efforts to promote green design and safe recycling. It would also forestall the efforts of progressive states to set up better recycling programs based upon EPR. Despite the Republican orthodoxy against governmental regulation and interference in business, the Bush administration and the current congress is very amenable to the demands of the business community, whether it be greater protection for US steel or deficit spending to give subsidies to the oil industry. For this reason, the number of registered lobbyists in Washington has doubled since 2000 to over 34,750 and lobbyist fees have increased as much as 100 percent. Times are so good for lobbyists that Republican uber-lobbyist Robert L. Livingston exclaims, "There's unlimited business out there for us."[167]

Fortunately, the electronics industry and retailers are heavily divided over the management of e-waste and probably won't be able to form a solid front to create a national recycling plan based upon "shared responsibility." HP, Dell, Target, and Best Buy are supporting EPR and product-take-back policies. IBM, Sony, Panasonic, and Sharp, on the other hand, are vocal opponents to product-take-back legislation,[168] while others such as Apple would probably pay lobbyists covertly to defeat such legislation. In the stead of EPR, IBM supports a California-style tax on all new products to pay for recycling, but companies without a lot of legacy products oppose this sort of plan because it raises the price on electronics being sold today.

Now is the Time to Get Involved ▲

As the e-waste mounts and the evidence grows that the chemicals and heavy metals in electronics disrupt our hormones, poison our bodies, and alter our offspring,[169] the efforts to change the industry have reached a critical mass. Countries across the globe are now implementing producer take-back laws and mandating that their electronics should be made with less toxic materials. Likewise, global efforts are afoot to reduce the production of greenhouse gases. As countries strive to implement the Kyoto Protocols, they will increasingly look askance at the tremendous amount of fossil fuels which are being expended in chip and printed circuit board manufacturing. People all over the world are beginning to realize that they have tremendous power as citizens and consumers to force industries to change. In this context, the time is ripe to get involved and demand change.

Recent EPR legislation in the Europe, Japan, Tiawan, and South Korea which forces electronics manufacturers to take back their products for recycling has created a unique opportunity to push for change here at home. Because computer makers will be forced to participate in these programs abroad, it will be much easier to demand they do likewise at home. The state legislatures across the nation are abuzz with new bills to promote EPR and producer take-back policies. In August 2005, the Computer TakeBack Campaign reported that waste recycling legislation with “producer takeback” provisions was being currently being debated in Massachusetts, New Jersey, and in New York City. In the coming year, "producer takeback" bills are expected to be introduced in state legislatures in Oregon, Minnesota, Michigan, Wisconsin, Rhode Island, and Washington State.[170]

With a growing consensus worldwide that e-waste is a looming crisis, citizens' voices on this issue are more likely to be heard in state legislatures in the coming years. A few companies like HP and Dell might support this legislation because they fear the alternatives, but they will be counterbalanced by opposing industry voices. These bills won't be passed unless a growing number of ordinary people like you and me get involved and raise our voices.

The more EPR legislation which is passed on the state and local level, the more pressure will grow for a good national e-waste recycling policy. A state recycling manager surveyed by Michele Raymond notes, "The establishment of state policies will exert pressure on the manufacturers and the federal government to continue to work toward a solution."[171] For this reason, it is critically important is to get more programs like Maine's in states and municipalities across the country. As more localities implement producer take-back laws, the electronics industry will come to see the wisdom of having a national producer take-back program so it can avoid the heavy costs of complying with hundreds of local recycling programs.

In order to find out about legislative efforts in your locality, go to the Computer TakeBack Campaign's Legislation and Policy webpage and sign up for email updates which regularly sends out notices about pending legislation. If you want to get involved, email CTBC and ask what is happening in your area and what local groups are working in on e-waste recycling.

At the same time that we press for recycling laws, we must insist that the recycling be done at home. The option to export our hazardous wastes abroad for recycling undercuts our domestic recycling programs because they can't compete on price. The critical investment in expensive recycling equipment won't happen as long as recyclers have a more economical alternative. For this reason it is critical that we demand that our local recycling program do clean recycling at home and press our national government to sign the Basel Convention outlawing the export of hazardous waste. To send a letter to the EPA demanding that the US not export hazardous waste, fill out this form.

In addition to supporting local legislative efforts, it is important to support the groups which are spearheading the efforts to make the computer industry produce non-toxic products and take them back for recycling. The Silicon Valley Toxics Coalition has been working to make the production of computers less hazardous since 1982. It has a good track record of investigating the industry practices and pressuring computer companies to change their policies. SVTC helped launch the Computer TakeBack Campaign which now counts on the support of the following groups:

Group Name	URL	Phone Number	Contact	Email Address
Basel Action Network	www.ban.org	206.652.5555	Sarah Westervelt	swestervelt@ban.org
Clean Production Action		514.484.8647	Beverly Thorpe	BevCPro@aol.com
Clean Production Action		716.655.1860	Alexandra McPherson	alexandra@cleanproduction.org
Center for Environmental Health	www.cehca.org	510.594.9864, ext. 109	Mamta Khanna	mamta@cecha.org
Clean Water Fund	www.cleanwateraction.org	608.338.8131	Kara Reeves	kreeve@cleanwater.org
Communications Workers of America	www.cwa-union.org	202.434.1187	George Kohl	gkohl@cwa-union.org
ecopledge.com	www.ecopledge.com	213.251.3690		
Environmental Advocates of New York		518.462.5526	Dave Higby	dhigby@eany.org
Environmental Health Strategy Center		207.827.6331	Mike Belliveau	mbelliveau@preventharm.org
Friends of the Earth	vwww.foe.org	202.783.7400	Mark Helm	mhelm@foe.org
GrassRoots Recycling Network	www.grrn.org	608.270.0940	David Wood	david@grrn.org
INFORM	www.informinc.org	212.361.2400	Sarah O'brien	obrien@informinc.org
Institute for Local Self-Reliance	www.ilsr.org	202.232.4108	Neil Seldman	nseldman@ilsr.org
Natural Resources Council of Maine		207.622.3101		jhinck@nrcm.org/
Silicon Valley Toxics Coalition	www.svtc.org	408.287.6707	Ted Smith Sheila Davis	tsmith@svtc.org sdavis@igc.org
Society Promoting Environmental Conservation			Helen Spiegelman	hspi@telus.net
Texas Campaign for the Environment	www.texasenvironment.org	512.326.5655	Robin Schneider	robin@texasenvironment.org
Vermont Public Interest Research Group		802.223.6855	Paul Burns or Susanne Miller	paul@vpirg.org susanne@vpirg.org
Washington Citizens for Resource Conservation	wcrc2001@yahoo.com	206.723.0528	Maureen Newby	mnewby@w-link.net.

In addition, *Stockholder Proponents* coordinate e-waste dialogues with companies, as well as shareholder resolutions. These include:

Group Name	URL	Phone	Contact	Email Address
As You Sow Foundation	www.asyousow.org	415.391.3212	Conrad MacKerron	mack@asyousow.org
Calvert Group	www.calvert.com		Julie Frieder	julie.frieder@calvert.com
Paxworld	www.paxworld.com		Anita Green	agreem@paxworld.com
ISIS	www.isisam.com>		Claudia Kruse	claudia.kruse@isisam.com or elizabeth@isiam.com
US Trust	www.ustrust.com		Ken Scott	kscott@ustrust.com
Green Century Fund	www.greencentury.com		Michael Leone	mleone@greencentury.com
Dreyfus Fund	www.dreyfusfund.com		Paul Hilton	hilton.pa@dreyfus.com

This broad coalition of partners in the Computer TakeBack Campaign has effectively pressured companies like Dell and Apple to change their recycling policies. Of these partners, the Basel Action Network has been vital in linking the e-waste problem at home with the international trade in e-waste abroad. The Basel Action Network investigated what happens to e-waste in China and Nigeria and brought this issue to international attention. Greenpeace has also investigated what happens to e-waste in China and has helped to publicize the problem. In addition, Greenpeace has brought pressure to bear on companies like HP to make their products with less toxic materials. Although you can't support all these groups, consider joining one and giving your time and money to support their work.

Finally, you can do your part at home by using your computer as long as possible so you aren't responsible for destroying more of the earth's resources and contributing to an exploitative and polluting industry. If possible, upgrade or buy used, rather than buying new. If you do buy new, try and buy ethically from a company that has a take back policy for recycling and does the final assembly at home rather than in China where workers have few rights. Otherwise, buy from a local mom and pop store or build your own. When you do buy, challenge the consumptive values of our society and always ask yourself whether you are buying to fulfill true needs. By buying from companies which take back their products for recycling and lobbying the government to pass Extended Producer Responsibility legislation, we can put a stop to the unenvironmental practices of the computer industry.

The benefits of computing do not have to come at the price of a Faustian bargain which trades our modern information age for environmental degradation, abuse of workers, and self-destructive overconsumption. To avoid this dark future, we must work together collectively and demand that the computer industry no longer be predicated upon a business model that promotes unending cycles of upgrades by means of bloatware and planned-obsolescence hardware. In the place of a computer industry which is hogging the world's resources from the world's majority and destroying our planet, we can create a more environmentally-sustainable industry whose profits are predicated upon green design and low consumption without the abuse of people abroad.

Suggested Reading: ▲

"The Digital Dump: Exporting Re-use and Abuse to Africa", The Basel Action Network, Oct. 24, 2005, http://www.computertakeback.com/docUploads/TheDigitalDumpWeb.pdf

"Environmental Report Card on Computers, 2005: Computer Waste in Australia and The Case for Producer Responsibility", Environment Victoria, June 2005, http://www.envict.org.au/file/Computer_waste_finalversion.pdf

"Exporting Harm: The High-Tech Trashing of Asia," Basel Action Network and Silicon Valley Toxics Coalition, Feb 25, 2002, http://www.ban.org/E-waste/technotrashfinalcomp.pdf;

"Fifth Annual Computer Report Card," Silicon Valley Toxics Coalition and Computer TakeBack Campaign, May 19, 2004, http://www.svtc.org/cleancc/pubs/2003report.htm

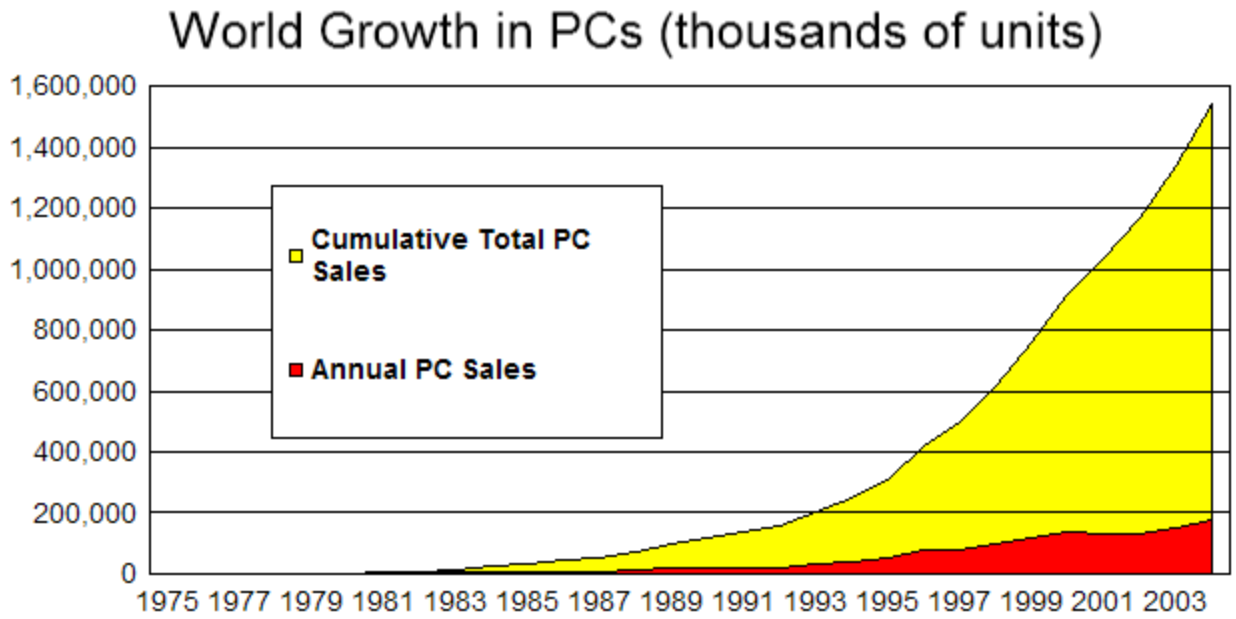
"Fourth Annual Computer Report Card," Silicon Valley Toxics Coalition and Computer TakeBack Campaign, May 19, 2004, http://www.svtc.org/cleancc/pubs/2003report.htm

K. Brigden et al.,"Recycling of Electronic Wastes in China & India: Workplace & Environmental Contamination," Greenpeace International, Aug 2005, http://www.greenpeace.org/raw/content/international/press/reports/recycling-of-electronic-waste.pdf

Niranjan Rajani et al., "Free as in Education: Significance of the Free/Libre and Open Source Software for Developing Countries", Ministry for Foreign Affairs - Finland, 2002-3, http://www.itu.int/wsis/docs/background/themes/access/free_as_in_education_niranjan.pdf

Appendix A: Growth in Personal Computers ▲

The growth in PCs is both a blessing for the positive benefits that computers can provide and a curse for the enormous amounts of resources they require and the pollution they create. It is difficult to gage the exact impact of all these PCs on our planet, in part because the various analyst groups which track the computer industry have widely varying estimates about the number of PCs produced every year. Gartner Dataquest's number of PCs annually shipped are much higher than eT Forecast's number of PCs sold annually. Presumably more PCs are shipped than sold or Gartner has a different criteria for what constitutes a PC than eT Forecast. The Computer Industry Almanac has a third set of numbers in between Gartner's and eT Forecast's calculations. For the breakdown between different types of computers see: http://www.pegasus3d.com/total_share.html



Source: Data from eT Forecasts, compiled by Jeremy Reimer, "Personal Computer Market Share: 1975-2004,"accessed Dec 15, 2004, http://www.pegasus3d.com/total_share.html

Gartner Dataquest: Number of PCs shipped (in thousands)

Year	US PCs per Year	US Annual Growth	World PCs per Year	World Annual Growth
1997	30.334		80.608	
1998	36.050	18,8%	92.925	15,3%
1999	44.811	24,3%	117.626	26,6%
2000	49.432	10,3%	134.738	14,5%
2001	44.513	-10,0%	128.931	-4,3%
2002	46.474	4,4%	132.350	2,7%
2003	57.515	23,8%	169.058	27,7%
2004	62,443	8.6%	189,539	12.1%
2005	0	7.5%	0	15.3%
2006			234,500*	7.3%*
Total	**371.408**	**11,4%**	**1.045.214**	**13,5%**

Note: Data includes desk-based PCs, mobile PCs & X86-32 servers
* Projected
Source: Gartner Dataquest,
http://www.gartner.com/press_releases/asset_117925_11.html
http://www.gartner.com/press_releases/pr17jan2003a.html
http://www.gartner.com/5_about/press_room/pr19990129a.html
http://www.gartner.com/press_releases/asset_143584_11.html
http://www.gartner.com/press_releases/asset_146531_11.html

Computer Industry Almanac: Growth of PCs in millions of units

	1985	1990	1995	2000	2002	2007
USA:						
PCs-in-use (#M)	19,8	48	86	177	206	255
PCs-in-use per 1000 people	82,9	192,2	323,9	629,5	712	831,3
Cumulative PC Sales (#M)	21,4	64,5	139	317	403	661
Worldwide:						
PCs-in-use (#M)	31,4	98	226	523	663	1069
PCs-in-use per 1000 people	6,5	18,7	40	86,2	106,4	161,8
Cumulative PC Sales (#M)	35,6	129	329	815	1077	1952

Source: "Worldwide Cumulative PC Sales Exceed 1 billion: PCs-In-Use tops 200M in USA. Cumulative PC Sales Surpass 400M," Feb 28, 2003, *Computer Industry Almanac*, http://www.c-i-a.com/pr0203.htm

World PC Sales (in thousands of units)

Year	Annual PC Sales	Cumulative Total PC Sales
1975	2	2
1976	10	12
1977	150	162
1978	258	420
1979	535	955
1980	724	1.679
1981	1.400	3.079
1982	2.800	5.879
1983	4.920	10.799
1984	6.322	17.121
1985	7.560	24.681
1986	9.000	33.681
1987	9.200	42.881
1988	15.000	57.881
1989	21.000	78.881
1990	20.000	98.881
1991	18.750	117.631
1992	20.800	138.431
1993	31.050	169.481
1994	41.000	210.481
1995	50.000	260.481
1996	78.000	338.481
1997	81.000	419.481
1998	100.000	519.481
1999	120.000	639.481
2000	138.000	777.481
2001	128.000	905.481
2002	132.000	1.037.481
2003	150.800	1.188.281
2004	175.700	1.363.981

Source: Data from eT Forecasts, compiled by Jeremy Reimer, http://www.pegasus3d.com/total_share.html

Appendix B: Computer Energy Use

▲

The amount of energy being used by computers continues to increase, mainly due to the increasing numbers of computers in use and the high amounts of energy to create computers with a short life-cycle. Much of this recent growth in the US is due to the rise of secondary computers which serve very different roles from the traditional primary computers. The switch to laptop computers and recent advances in energy efficiency technology may help mitigate energy consumption to some degree, but the increasing numbers of computers will drive up the total power usage. Although the average laptop has grown more energy-efficient, most desktop computers

haven't adopted the energy saving features used by laptops and the average desktop has upped its wattage requirements in recent years to accommodate greater processing and graphics and additional accessories. In 2003, the average residential home on Long Island used 9,312 kilowatt-hours per year, an increase of 1,575 kWh or 20.4% since 1997. Roughly 233 kWh or 16% of that increase is due to greater use of PCs and 73 kWh or 5% is due to greater use of printers.[172] According to the National Resources Defense Council, computers and monitors account for 85 billion kWh per year, or approximately 2.8% of total US electricity.[173]

National Resource Defense Council: Operational Energy Use per Computer per Year

Product	Active		Sleep		Standby		Total kWh/yr
	kWh/yr	%	kWh/yr	%	kWh/yr	%	
Analog TV	105.1	75.7%	0	0%	33.8	24.3%	138.9
Office Computer	296.1	92.2%	18.0	5.6%	6.6	2.1%	321.0
Office Monitor	291.5	91.6%	19.4	6.1%	7.5	2.4%	318.4

Source: Chris Calwell and Travis Reeder, "Power Supplies: A Hidden Opportunity for Energy Savings," National Resource Defense Council and Ecos Consulting, May 22, 2002, http://www.efficientpowersupplies.org/pages/NRDC_power_supply_report.pdf

EfficientProducts.org: US Operational Energy Cost per Computer per Year

Computer Type	Annual Energy Use (kWh)	Electricity Cost (USD)*	CO2 Emissions (lbs.)**	US PCs in Use (millions)	US Total Annual Energy Use (gWh)	US Total Annual CO2 Emissions (millions of lbs)
Desktop	200 - 400	$16 - $32	268 - 536	150	30,000 - 60,000	40,230 - 80,460
Laptop	80 - 140	$6 - $11	107 - 188	50	4,000 - 7,000	5,364 - 9,387
Server	1500	$120,00	2012	10	15,000	20,115

* Assume average utility rate of $0.08 per kWh of electricity. See www.eia.doe.gov

** Assume 1.341 lbs. CO2 emissions per kWh of electricity. See U.S. Department of Energy, U.S. Environmental Protection Agency, Carbon Dioxide Emissions from the Generation of Electric Power in the United States, Washington D.C., July 2000, p 2.

Source: "Computers", EfficientProducts.org, accessed Mar 15, 2006, http://www.efficientproducts.org/computers

Jem Matzan: Monthly Energy Cost per Computer

System	Watt hours	Average monthly KWh*	Average monthly cost**	Min/Max watts	Configuration
Apple PowerMac G5	68.8 (56.4)	198 (162)	$15.84 ($12.95)	247/407	Two G5 2.0GHz, 5.5GB RAM, two 250GB 7200RPM SATA HD, wireless, ATI Radeon 9800, 20" LCD (CPU power), OS X 10.4.3
Apple PowerMac G4	43.3 (34.5)	125 (99)	$10.00 ($7.95)	168/220	Two G4 800MHz, stock DVD writer, 80GB HD, 384MB RAM in two modules, Nvidia GeForce2, 17" LCD (USB power)
Sun Java Workstation w2100z	60	175	$14.00	227/287	Two Opteron 252, 4GB RAM, 72GB 10000RPM SCSI-360 HD, 180GB 7200RPM SATA HD, Nvidia Quadro FX3000, Gentoo for AMD64
Intel Pentium D 820	42.6 (37.6)	123 (118)	$9.84 ($8.69)	156/264	Asus P5WD2 motherboard, 1GB DDR2-533 RAM, Seagate SATA-V 180GB HD, Matrox G550 1X PCIe, Lite-On 52X CDRW/DVD-ROM, Antec TrueBlue 480 PS, Knoppix 3.9 for x86
AMD Athlon 64 X2 3800+	28.4 (23.4)	81 (76)	$6.48 ($5.34)	95/168	Asus A8N-E motherboard, 1GB DDR400 RAM, Seagate SATA-V 180GB HD, Matrox G550 1X PCIe, Lite-On 52X CDRW/DVD-ROM, Antec TrueBlue 480 PS, Knoppix 3.9 for x86
Apple 17" LCD	8,8	25,6	$1,87	N/A	
Samsung SyncMaster 997DF 19" CRT	18,4	53	$3,87	46/82	

* Comparison between the different types of computers is problematic because not measuring the same configuration. The PowerMac totals include power for their LCDs, but other computers power their displays separately. The PCs using Knoppix are running their OS off a CD-ROM which Matzan estimates to add an additional 5 Wh to the total. Numbers in parenthesis are guesstimates to allow for better comparison.
** Electricity cost recalculated at $0.08 per kWh so can compare with EfficientProducts data. (Matzan calculated original at $0.0731 per kWh).
Source: Jem Matzan, "Computers, electricity, and you," Hardware in Review, Dec. 29, 2005, http://www.hardwareinreview.com/cms/content/view/33/29/

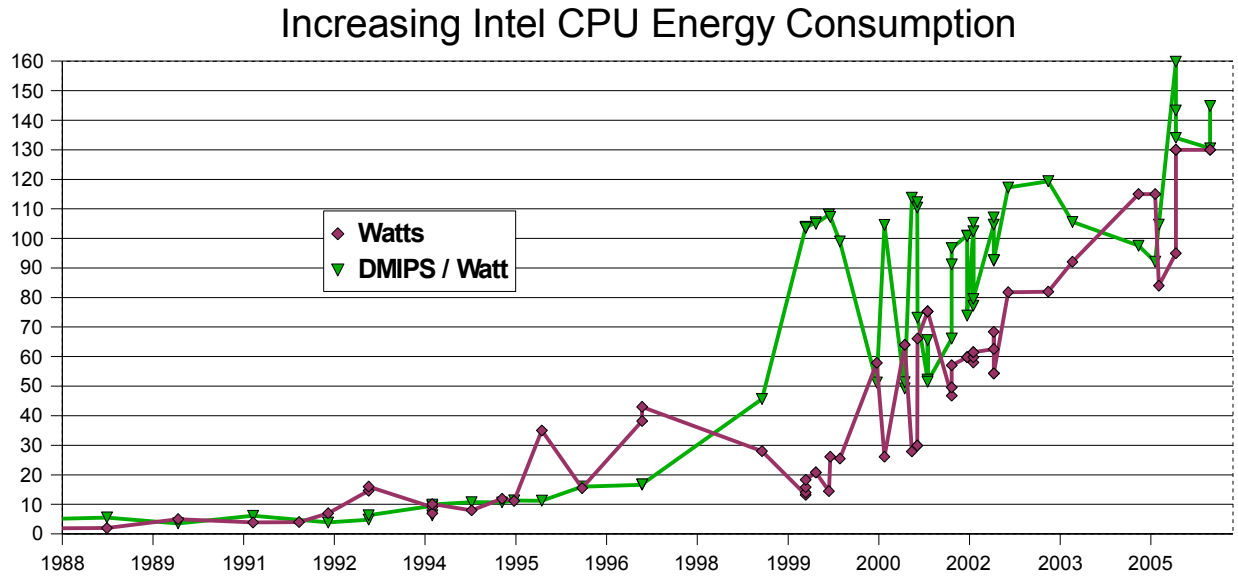
Average Wattage per Computer Type

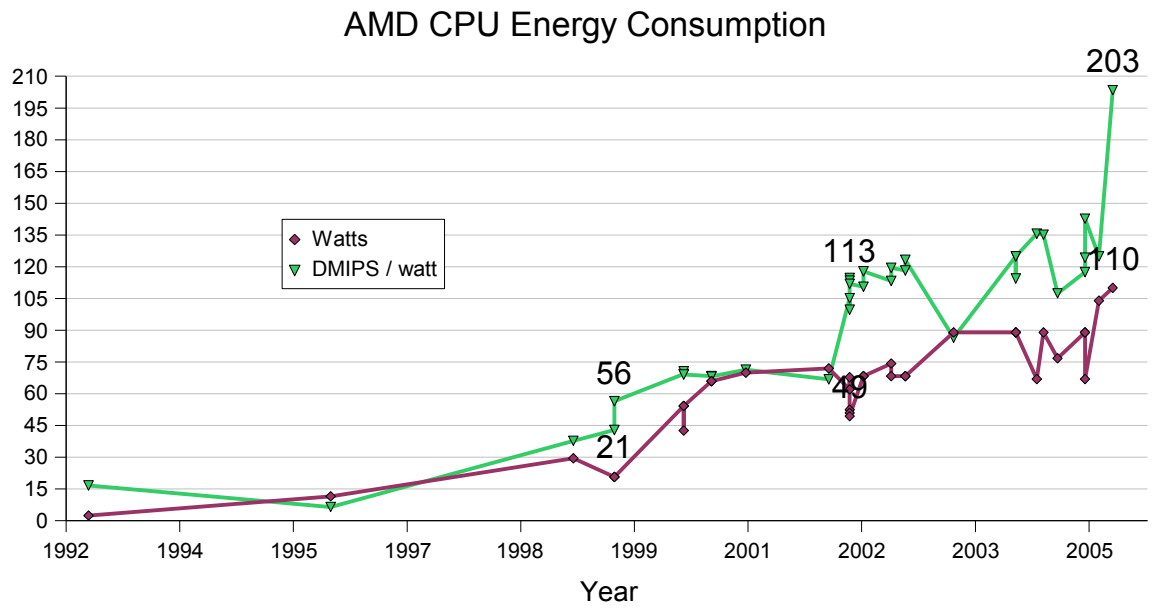
	CPU		Measured On Power (w)	
Count (n)	Type	Speed Range	Range	Average
4	Intel Pentium 3	733-1000 MHz	28-47	38
6	Intel Pentium 4	1300-1800 MHz	59-94	67
4	AMD Athlon	1000-1400 MHz	93-117	104
9	Laptop		14-25	19

Source: Judy A. Roberson et al. "Energy Use and Power Levels in New Monitors and Personal", Energy Analysis Department, University of California-Berkeley, July 2002, p. 21-23, http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1567&context=lbnl

The electronics industry likes to claim that its products are growing more energy efficient. While this may be true for laptops and some low-end computers like iMacs and thin-clients, desktop computers have generally increased their power requirements. Intel has put out some misleading figures claiming that their CPUs have grown more efficient.[174] While the number of transistors per mm2 has increased, this improved efficiency has been counterbalanced by the skyrocketing number of transistors per CPU. Moreover, the amount of wattage per chip and wattage per mm2 has increased. Chip makers often try and measure their performance with the Dhrystone Millions of Instructions Per Second (DMIPS ver. 2.1) and gauge efficiency by DMIPS per watt. By these measures, Intel CPUs for desktop computers have improved over time.

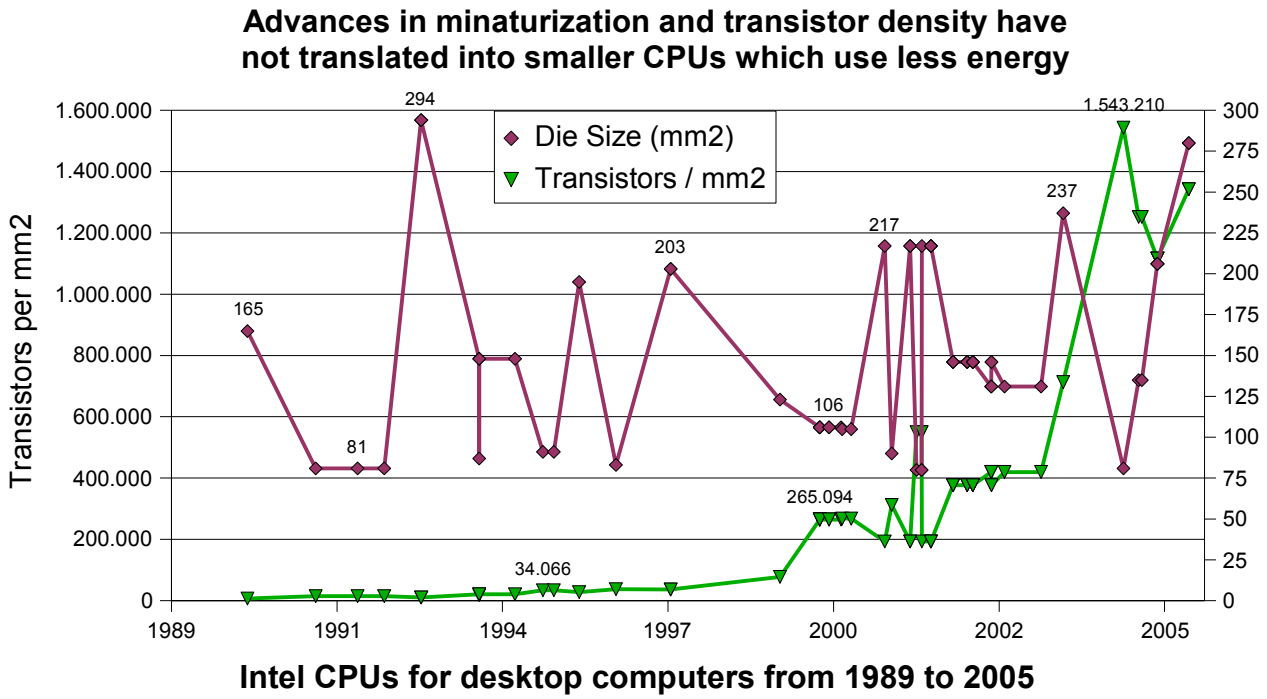
Nonetheless, these measures could rise without a corresponding rise in total wattage per CPU if the industry prioritized efficiency rather than sheer processing power. As processors try to force higher clock rates through tinier circuits, the amount of electricity leakage in the silicone has risen from roughly 4% in 2000 to 25% in 2004. Today some of the highest clocked processors loose almost 40% of their electricity due to leakage. At the same time, an increasing amount of electricity has to be expended to cool these overclocked burners. The modern Pentium processor consumes 85 times more energy than the 8088 in the first IBM PC. In the minds of many, this extravagant use of energy is justified by pointing to the fact that the modern processor is 90,000 times more powerful than the original 8088, but most of that increase in processing power could have happened without consuming significantly more energy. Most of the energy in the modern processor is burned in the fool's quest to gain a marginal improvements in power by running the computer as fast and hot as the silicon will allow. For instance in the new Cell processor which is being used in the PlayStation 3, increasing the clock frequency in a SPE cell from 3GHz to 5GHz increased the power consumption from 2 to 11 watts.[175] In other words, to get a 67% increase in processing power required a 450% increase in energy consumption. Simply running the clock rate at a reasonable speed will significantly reduce the wattage and eliminate most of the energy leakage in the silicon and the need for cooling measures. Chips such as the Pentium M and Turion show that a modern processor can run on 25W and still do most of the tasks of a 130W Pentium D. Does having a processor which consumes 5 times as much energy make people any more productive or help them get their work done any faster? In a few specialized types of applications, energy-hogging processors are justified, but for most people, their word processing, email, and spreadsheet use won't be significantly different on a 12 watt Efficeon MT8800 1.8GHz than on a 130 watt Pentium D, except for the fact that it won't be accompanied by the constant whirring of overworked fans. Because we have heeded the hype of a industry built on planned obsolescence and the marketing of power, we haven't opted for more efficient and environmental solutions.





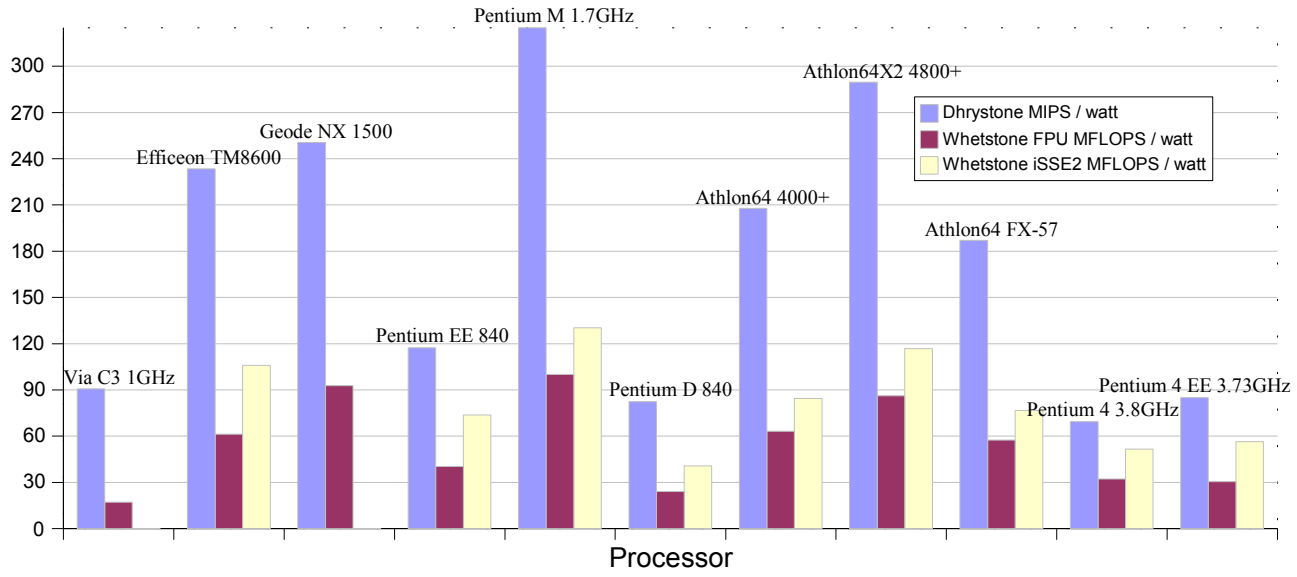
Although AMD CPUs weren't very efficient before 2002, their move to Silicon on Insulator (SOI) manufacturing and their focus on performance per watt and per clock cycle has made them more efficient than Intel CPUs for desktop computers. AMD's Dhyrstone MIPS per watt is rising rapidly while the wattage has risen more slowly.

The dramatic increase in operational energy is important, yet even more critical is the energy to produce a new CPU. Despite the many advances in the silicon industry, the energy to produce the CPU has probably not fallen to any significant degree over the last 3 decades. Smaller transistor size and miniaturization doesn't necessarily mean a corresponding reduction in the energy and raw materials to produce a chip. Most of the energy and materials are lost in the successive substances which are added and removed from the surface of the chip. In the last three decades, the number of metal layers per chip has increased from 1 to 8[176] and the number of different substances being added to Intel chips has risen from roughly 5 to 20. The number of processes which have to be performed on each wafer has increased dramatically and each process represents more energy and materials. Transistors today are 45 times smaller than they were in the original 8086 CPU, but there are 13,000 times more transistors in today's Pentium D.[177] Because there are so many more transistors, the physical size of the CPU die has not shrunk. The industry likes to tout the fact that its move from 200 mm diameter wafers to 300 mm diameter wafers will reduce the amount of energy and water consumed per chip by 40%.[178] This new efficiency, however, is outweighed by fact that the industry is moving to dual core CPUs which more than doubles the size of the modern CPU. Even with 65nm line widths and very high density, the latest Pentium D needs a 280 mm^2 die size to hold its 387 million transistors. Since chip fabrication costs rise along an exponential curve as a function of die size, it can be expected that the latest dual core CPUs have a much larger environmental impact in terms of energy and raw materials consumed than the old single core chips. Despite all the advances in silicon manufacturing, it is unlikely that the energy to produce each CPU has fallen because the increasing material complexity, larger die size, and skyrocketing number of transistors drives up the total material and energy inputs.[179]



In recent years the computer industry has begun to talk about improving its performance per watt. AMD has focused on making its chips more energy efficient and Intel recently designed its new Core architecture which is used in the new iMac. Still most mainstream PCs have not become more energy efficient, and it is doubtful that they will become more efficient as long as we prioritize processing power over efficiency. Hopefully, the Kyoto Protocols will induce governments and businesses to start demanding 100 watt computers like the iMac instead of the 300 watt computers which are commonplace today.

Nonetheless, the biggest energy cost of the CPU lies in its production, rather than its operation. Choosing an energy-efficient Transmeta Efficeon TM8600 may not be any more environmental since its large die size means that it costs more to produce than alternatives with smaller die sizes such as the Pentium M or Turion MT.[180] Since electricity is the largest single cost of a chip fab, a large die represents higher energy inputs and more global warming. While operational energy efficiency is important, the greatest focus should be placed upon increasing production energy efficiency as is being done by STMicroelectronics and increasing the lifespan of computers. For an estimate of the production costs of each chip, look it up in this spreadsheet [Excel format] [OpenDocument format]. From the production cost, you can get a rough idea of how much energy, water, and raw materials were consumed to make a chip. For more info, read this explanation of how to estimate the production cost of a CPU.



On the desktop, Athlon 64 chips are significantly more efficient than Pentium D and Extreme Edition, but the most efficient CPUs are mobile chips such as the Pentium M and Turion MT. Low powered options like the Efficeon and Core Solo are also not bad choices.

Comparing Low-Power Processors to Mainstream Desktop Processors

Processor	MHz	nm	Die Size (mm^2)	Transistors (millions)	Listed Max Watts	*Avg. Watts	Transistors per watt	Transistors per mm2	Watts per cm2
Athlon 64 3200+ Winchester	1000	90	84	68.5	67	32,2	2.127.329	815.476	3,83
Athlon 64 3200+ Winchester	2000	90	84	68,5	67	46,1	1.485.900	815.476	5,49
Via C3 ††	1000	130	47	20,5	15	17,4	1.178.161	436.170	3,70
Transmeta Efficeon TM8600	1000	130	119	?	5,0	13,6			1,14
AMD Geode NX 1500	2800	130	85	22	9 †	16,4	1.341.463	258.824	1,93
Pentium 4 2800E Prescott	1400	90	81	125	89	58,4	2.140.411	1.543.210	7,21
Pentium 4 2800E Prescott	2800	90	81	125	89	117,1	1.067.464	1.543.210	14,46
Pentium M 735 Dothan	1000	90	87	144	21	18,7	7.700.535	1.655.172	2,15
Pentium M 735 Dothan	1700	90	87	144	21	21,3	6.760.563	1.655.172	2,45
‡Athlon 64 4000+	2400	90	115	114	89	53,2	2.142.857	991.304	4,63
‡Athlon 64 X2 4800+	2400	90	199	233	110	77,3	3.014.230	1.170.854	3,88
‡Athlon 64 FX-57	2800	90	115	114	104	69,5	1.640.288	991.304	6,04
‡Pentium 4 670 Prescott	3800	90	135	169	115	135,4	1.248.154	1.251.852	10,03
‡Pentium D 820	2800	90	206	230	95	115,8	1.986.183	1.116.505	5,62
‡Pentium D 840	3200	90	206	230	130	158,2	1.453.856	1.116.505	7,68
‡Pentium 4 Extreme Ed.	3733	90	135	169	115	129,2	1.308.050	1.251.852	9,57
‡Pentium Extreme Ed. 840	3200	90	206	230	130	160,6	1.432.130	1,116,505	7,80

Measuring Efficiency (Higher is better)

Processor	Dhrystone ALU MIPS	Whetstone FPU MFLOPS	Whetstone iSSE2 MFLOPS	DMIPS per watt	FPU-MFLOPS per watt	iSSE2-MFLOPS per watt
Athlon 64 3200+ Winchester	4539	1623	1466	141,0	48,9	63,4
Athlon 64 3200+ Winchester	9089	3263	2074	197,2	66,9	87,4
Via C3 ††	1576	304	n/a	90,7	17,1	n/a
Transmeta Efficeon TM8600	3179	900	900	233,5	61,2	105,9

AMD Geode NX 1500	4105	1596	n/a	250,6	92,8	n/a
Pentium 4 2800E Prescott	4018	1626	2914	68,8	25,7	50,1
Pentium 4 2800E Prescott	8199	3231	5803	70,0	27,0	50,5
Pentium M 735 Dothan	4082	1382	1779	218,6	69,4	94,0
Pentium M 735 Dothan	6933	2346	3012	325,1	100,1	130,3
‡Athlon 64 4000+	11050	3800	4885	207,9	63,2	84,4
‡Athlon 64 X2 4800+	22380	7643	9890	289,6	86,2	116,7
‡Athlon 64 FX-57	12993	4436	5701	187,1	57,5	76,7
‡Pentium 4 670 Prescott	9391	4368	6694	69,4	32,1	51,6
‡Pentium D 820	10592	4019	5630	91,4	32,4	48,6
‡Pentium D 840	13017	4594	6912	82,3	24,0	40,7
‡Pentium 4 Extreme Ed.	10972	4537	7789	84,9	30,4	56,4
‡Pentium Extreme Ed. 840	18853	7744	13358	117,4	40,4	73,8

* Average power consumption when executing Sandra's Dhrystone ALU test.
† The Geode NX's listed wattage is 6 W typical and 9 W max. for both the 667MHz and 1GHz versions, but the listed wattage for the 1GHz version should probably be higher since the 1.4GHz version is listed as 14W typical and 25 W max.
†† Assuming this is the Nehemiah version, but it could be the older Ezra version with 15.5M transistors, 47mm^2 die, 1.35V.

Notes: Results from Ohara Oscai using SiSoft's Sandra 2005. The Athlon 64 3200+ and Pentium 4 2800E were measured at full speed and half speed. Unfortunately, the new AMD Turion wasn't included in this study. If marked with ‡, then using Sandra 2005 Service Release 1.
Dhrystone ALU *(Arithmetic and Logic Unit)* ***MIPS*** *(Millions of Instructions per Second)* is a theoretical measure of how many simple operations the computer can handle in a second.
Whetstone FPU *(Floating Point Unit)* ***MFLOPS*** *(Millions of Floating Point Operations Per Second)* is a measure of the number of complex calculations in a second, usually involving graphics or math with decimals.
Whetstone iSSE2 *(internet Streaming SIMD (Single Instruction Multiple Data) Extensions2)* ***MFLOPS*** is a measure of how many advanced data and multimedia operations can be done in a second.
Source: [181]

Intel Desktop CPU Efficiency over Time

Release Date	Processor**	Clock MHz	nm††	Die Size (mm2)	Transistors (000s)	Watts §§	Dhry. MIPS	Transis-tors/watt	Transis-tors/mm2	watts /cm2	DMIPS / Watt	MIPS / iCOMP
15 Nov71	4004	0,108	10000	13.5	2,25				167			0.06 / ?
Apr72	8008	0,200	10000	15.2	3,5				230			0.05 / ?
Apr74	8080	2,15	6000	20.0	6,0				300			0.64 / ?
8 Jun78	8086 (avg 3)	8	3000	28.6	29	1,5	0,42	19	1014		0,28	0.66 / ?
8 Jun78	8086	10	3000	28.6	29	1,5	0,61	19	1014		0,41	0.75 / ?
Jun79	8088 (avg 5)	4,77	3000	28.6	29	1,5	0.20	19	1014		0,13	0.33 / ?
Feb82	80286 (avg 9)	6	1500	68.7	134		0,62		1951			0.9 / ?
10 Apr89	(AMD?) 80386 DX (avg 2) (ver?)§	40	1000	104	275	1,95	10,8	141	2644		5,5	11.4 / 68
7 May 90	80486 DX (avg 30)	33	1000	165	1.200	5 / 3.5	17,66	240	7.273	0,30	3,5	27 / 166
24 Jun91	80486 DX (avg 3)	50	800	81	1.200	3,875	23,7	310	14.815	0,48	6,1	41 / 249
3 Mar92	80486 DX2	50	800	81	1.200	4/1.67		300	14.815	0,49		41 / 231
10 Aug92	80486 DX2 (avg 15)	66	800	81	1.200	7 / 4.875	26,95	171	14.815	0,86	3,9	54 / 297
22 Mar93	Pentium (avg 4)	60	800	294	3.100	14,6	70.3	212	10.544	0,50	4,8	100 / 510
22 Mar93	Pentium	66	800	294	3.100	16,0	101,2	194	10.544	0,54	6,3	112 / 567
7 Mar94	Pentium (avg 4)	90	600	148	3.100	9,0	85.08	344	20.946	0,61	9,5	? / 735
7 Mar94	i80486 DX4 (avg 4)	100	600	87	1.600	7/4.29	44,1	229	18.391	0,80	6,3	70.7 / 435
7 Mar94	Pentium (avg 5)	100	600	148	3.100	10,1	100.3	307	20.946	0,68	9,9	? / 815

Release Date	Processor**	Clock MHz	nm††	Die Size (mm2)	Transistors (000s)	Watts §§	Dhry. MIPS	Transis-tors/watt	Transis-tors/mm2	watts /cm2	DMIPS / Watt	MIPS / iCOMP
10 Oct94	Pentium (avg 3)	75	600	148	3.100	8,0	86,03	388	20.946	0,54	10,8	? / 610
27 Mar95	Pentium (avg 2)	120	350	91	3.100	11,9	126,8	261	34.066	1,31	10,7	? / 1000
Jun95	Pentium (avg 3)	133	350	91	3.100	11,2	126.9	277	34.066	1,23	11,3	? / 1110
Nov95	Pentium Pro (avg 3)	200	350	195	5.500	35	392.9	157	28.205	1,79	11,2	? / 2126*
10 Jun96	Pentium (avg 2)	200	350	83	3.100	15,5	248,2	200	37.349	1,87	16,0	? / 1372*
7 May97	Pentium II	266	250	203	7.500	38,2	636	196	36.946	1,88	16,6	? / 2928*
7 May97	Pentium II (avg 2)	300	250	203	7.500	43,0	722	174	36.946	2,12	16,8	? / 3208*
26 Feb99	Pentium III	500	250	123	9.500	28,0	1278	339	77.236	2,28	45,6	? / 6642†
25 Oct99	Pentium III E Coppermine	500	180	106	28.100	13,2	1371	2.129	265.094	1,25	103,9	
25 Oct99	Pentium III EB Coppermine	533	180	106	28.100	14,0	1455	2.007	265.094	1,32	103,9	
25 Oct99	Pentium III EB Coppermine	600	180	106	28.100	15,8	1637	1.778	265.094	1,49	103,6	? / 7910†
25 Oct99	Pentium III S-370	700	180	106	28.100	18,3	1898	1.536	265.094	1,73	103,7	? / 8557†
20 Dec99	Pentium III EB Coppermine	800	180	106	28.100	20,8	2194	1.351	265.094	1,96	105,5	? / 9602†
20 Dec99	Pentium III E Coppermine	800	180	106	28.100	20,8	2183	1.351	265.094	1,96	105,0	? / 9602†
Mar00	Pentium III E	600	180	106	28.100	14,5	1567	1.938	265.094	1,37	108,1	? / 7910†
8 Mar00	Pentium III (ver?)	1000	180	105	28.100	26,1	2800	1.077	267.619	2,49	107,3	? / 12015†
May00	Pentium III	933	180	105	28.100	25,5	2523	1.102	267.619	2,43	98,9	? / 10945†
20 Nov00	Pentium 4 Willamette	1500	180	217	42.000	57,9	2965	725	193.548	2,67	51,2	1700 / ?
Jan01	Pentium III EB Coppermine	1000	180	90	28.100	26,1	2729	1.077	312.222	2,90	104,6	? / 12015†
23 Apr01	Pentium 4 i845	1700	180	217	42.000	64,0	3150	656	193.548	2,95	49,2	
23 Apr01	Pentium 4 i850	1700	180	217	42.000	64,0	3284	656	193.548	2,95	51,3	
Jun01	Pentium III Tualatin (ver?)	1133	130	80	44.000	27,9	3175	1.577	550.000	3,49	113,8	
Jul01	Pentium III Tualatin	1200	130	80	44.000	29,9	3301	1.472	550.000	3,74	110,4	
Jul01	Pentium III Tualatin	1200	130	80	44.000	29,9	3358	1.472	550.000	3,74	112,3	
2 Jul01	Pentium 4 Willamette	1800	180	217	42.000	66,1	4838	635	193.548	3,05	73,2	
27 Aug01	Pentium 4 i850 (ver?)	2000	180	217	42.000	75,3	3930	558	193.548	3,47	52,2	
27 Aug01	Pentium 4 Willamette	2000	180	217	42.000	75,3	4940	558	193.548	3,47	65,6	
27 Aug01	Pentium 4 i845 (ver?)	2000	180	217	42.000	75,3	3880	558	193.548	3,47	51,5	
7 Jan02	Pentium 4 Northwood	1600	130	146	55.000	46,8	3094	1.175	376.712	3,21	66,1	
7 Jan02	Pentium 4 A Northwood	1800	130	146	55.000	49,6	4523	1.109	376.712	3,40	91,2	
7 Jan02	Pentium 4 Northwood	2200	130	146	55.000	57,1	5521	963	376.712	3,91	96,7	
2 Apr02	Pentium 4 A Northwood	2400	130	146	55.000	59,8	6037	920	376.712	4,10	101,0	6500 / ?
2 Apr02	Pentium 4	2400	130	146	55.000	59,8	6025	920	376.712	4,10	100,8	6500 / ?

Release Date	Processor**	Clock MHz	nm††	Die Size (mm2)	Transistors (000s)	Watts §§	Dhry. MIPS	Transis-tors/watt	Transis-tors/mm2	watts /cm2	DMIPS / Watt	MIPS / iCOMP
	Northwood											
2 Apr02	Pentium 4 400MHz Bus	2400	130	146	55.000	59,8	4418	920	376.712	4,10	73,9	6500 / ?
6 May02	Pentium 4 Northwood	2266	130	146	55.000	58,0	5941	948	376.712	3,97	102,4	
6 May02	Pentium 4 533MHz Bus	2400	130	146	55.000	59,8	4617	920	376.712	4,10	77,2	6500 / ?
6 May02	Pentium 4 Northwood	2533	130	146	55.000	61,5	6474	894	376.712	4,21	105,3	
6 May02	Pentium 4 533MHz Bus	2533	130	146	55.000	61,5	4891	894	376.712	4,21	79,5	
26 Aug02	Pentium 4 Northwood	2600	130	131	55.000	62,6	6555	879	419.847	4,78	104,7	7200 / ?
26 Aug02	Pentium 4 Northwood	2800	130	131	55.000	68,4	7327	804	419.847	5,22	107,1	7900 / ?
27 Aug02	Pentium 4 A Northwood	2000	130	146	55.000	54,3	5023	1.013	376.712	3,72	92,5	
27 Aug02	Pentium 4 A Northwood	2000	130	146	55.000	54,3	5032	1.013	376.712	3,72	92,7	
14 Nov02	Pentium 4 Northwood	3060	130	131	55.000	81,8	9589	672	419.847	6,24	117,2	
23 Jun03	Pentium 4	3200	130	131	55.000	82,0	9787	671	419.847	6,26	119,4	9300 / ?
3 Nov03	Pentium 4 EE	3200	130	237	169.000	92,1	9726	1.835	713.080	3,89	105,6	
Nov04	Pentium 4 570 Prescott	3800	90	81	125.000	115,0	11219	1.087	1.543.210	14,20	97,6	
Feb05	Pentium 4 660 Prescott	3600	90	135	169.000	115,0	10589	1.470	1.251.852	8,52	92,1	
21 Feb05	Pentium 4 630 Prescott	3000	90	135	169.000	84,0	8793	2.012	1.251.852	6,22	104,7	
26 May05	Pentium D 820	2800	90	206	230.000	95,0	15184	2.421	1.116.505	4,61	159,8	
26 May05	Pentium EE 840 Smithfield (ver?)	3200	90	206	230.000	130,0	18629	1.769	1.116.505	6,31	143,3	
26 May05	Pentium D 840 Smithfield	3200	90	206	230.000	130,0	17427	1.769	1.116.505	6,31	134,1	
Dec05	Pentium D 940 Presler	3200	65	280	376.000	130,0	16967	2.892	1.342.857	4,64	130,5	
Dec05	Pentium D 950 Presler	3400	65	280	376.000	130,0	18828	2.892	1.342.857	4,64	144,8	

Notes: Die Size is the size in mm2 of the silicone chip itself, not including the surrounding package.
DMIPS or Dhrystone Millions of Instructions per Second is a theoretical measure of CPU processing power which is designed to be machine independent. For more on DMIPS and the source of the scores, see endnote [182].
MIPS is Millions of Instructions per Second or the number of simple non-floating point operations which can be processed in a second. With today's computers, this measure is largely meaningless. iCOMP was a measure used by Intel for its CPUs from the 386 to the Pentium III.

** If multiple versions of that type of processor or unsure which exact processor was used, then noted with "(ver?)". When there were multiple DMIPS scores for the same type of computer, the average was taken and the number of computers averaged is noted in the Processor column.
†† nm is the width in nanometers of the thinnest circuit leads in a chip. Sometimes chips were made with multiple semiconductor processes. For instance the 8088 and 8086 was made with both NMOS 3000nm and CMOS 2000nm. When unsure, the earlier semiconductor process size is listed.
§§ The wattage for the early CPUs was not always listed in the documentation, and many sources disagree. When

disagreement, both wattages are given with the more probable maximum wattage listed first. Sometimes the disagreement is whether measuring maximum versus typical wattage or in the case of the 486DX2 and 486DX4, whether measuring an earlier or later version of the chip.

* iCOMP 2 score multiplied by 9.66 for an adjusted score comparable to iCOMP 1.
† iCOMP 3 score multiplied by 24.88 for an adjusted score comparable to iCOMP 1.
§ DMIPS score from a machine that was possibly an AMD 386DX 40MHz or an overclocked Intel 386DX 33MHz. Rest of the stats are for the Intel 386DX 33MHz.

Source: [183]

Increasing Desktop PC Power Requirements according to PC Power and Cooling

Old Power Requirements		**New Power Requirements**	
Component	**Watts**	**Component**	**Watts**
AGP video card	20 to 30W	AGP video card	30W – 50W
		PCI Express video card	50W – 100W
PCI card	5W	Average PCI Card	5W – 10W
50X CD-ROM drive	10 to 25W	DVD/CD	20W – 30W
5200 RPM IDE hard disk drive	5 to 11W	Hard Drive	15W – 25W
7200 RPM IDE hard disk drive	5 to 15W		
Motherboard (w/o CPU or RAM)	20 to 30W	Motherboard (w/o CPU or RAM)	50W – 100W
RAM	10W per 128M	RAM	15W per 1GB
550 MHz Pentium III	30W	Pentium III Processor	38W
733 MHz Pentium III	23.5W	Pentium 4 Processor	70W – 100W
300 MHz Celeron	18W		
600 MHz Athlon	45W	AMD Athlon Processor	70W – 100W
		Case/CPU Fans	3W (ea.)
SCSI PCI card	20 to 25W		
floppy disk drive	5W		
network interface card	4W		

Source: Old PC Power and Cooling wattage requirements found at "Power Supply Wattage", accessed Mar 23, 2006, http://computer.howstuffworks.com/power-supply3.htm. New power requirements at "Power Supplies: How Much Power Do You Need?", accessed Mar 23, 2006, http://www.pcpowercooling.com/technology/power_usage/.

Increasing Processor Energy Use

Processor	Wattage	Voltage
Intel Processors		
8086 8MHz (original 4.77MHz)	1.5	5.0
80836 DX 20 - 33MHz	1.30 - 1.95	5.0
80846 DX 50MHz	3.875	
80486 DX2 50MHz	4(early), 1.67(later)	3.3
80486 DX4 100MHz	7(early), 4.29(later)	3.3
Pentium 60 - 66MHz	17 / 13*	5
Pentium Pro 150 - 200MHz	29.2 - 37.9	3.3
Pentium II 266 - 450MHz	18.6 - 34.8	2.0 - 2.8

Pentium III 370 pin 250nm 450 - 600MHz	25.3 - 34.5	2.000
Pentium III 370-FCPGA 180nm 500 - 700MHz	13.2 - 18.3	1.60 - 1.7
Pentium III 370-FCPGA 180nm 733 - 933MHz	19.1 - 27.3	1.650
Pentium III 370-FCPGA 180nm 1000 - 1130MHz	26.1 - 33.0	1.700 - 1.750
Pentium III 370-PGA2 130nm 1000 - 1400MHz	27.9 - 32.2	1.500
Pentium 4 478PGA 180nm 1300 - 2000Mhz	48.9 - 75.3	1.75
Pentium 4 478PGA 130nm 1600 - 3060Mhz	46.8 - 81.8	1.500
Pentium 4 130nm 3.2GHz	82.0	
Pentium 4 130nm 3.4GHz	89.0	1.25 - 1.400
Pentium 4 90nm 2.8 - 3.0GHz	89.0	1.25 - 1.400
Pentium 4 90nm 3.2 - 3.4GHz	103	1.287 - 1.400
Pentium 4 90nm 3.8GHz	115	1.250 - 1.400
Pentium D 2.66GHz	95.0	1.250 - 1.400
Pentium D 3.0GHz - 3.4GHz	130	1.250 - 1.400
Pentium Extreme Edition 3.20 - 3.46GHz	130	1.25 - 1.400
Pentium 4 Extreme Edition 478 pin 130nm 3.2 - 3.4GHz	92.1 - 102.9	
Pentium 4 Extreme Edition 775 pin 130nm 800MHz Bus 3.4GHz	109.6	0.956 - 1.052
Pentium 4 Extreme Edition 775 pin 130nm 1066MHz Bus 3.4GHz	110.7	1.287 - 1.400
Pentium 4 Extreme Edition 775 pin 90nm 1066MHz Bus 3.73GHz	115.0	1.25 - 1.388
AMD Processors		
Duron 600 - 1400	24.5 - 64.7	
Athlon 900 - 1400	45.8 - 64.7	
Athlon XP 180nm 1500+ - 2100+	60.0 - 72.0	1.75
Athlon XP 130nm 1700+ - 3000+	49.4 - 74.3	1.65
Athlon 64 2800+ - 4000+ 130nm (1.8 - 2.4GHz)	89.0	1.500
Athlon 64 3000+ 754-µPGA 90nm (2.0GHz)	51.0	1.400
Athlon 64 3000+ - 3500+ 939-µPGA 90nm (1.8 - 2.2GHz)	67.0	1.350 - 1.400
Athlon 64 3700+ - 4000+ 939-µPGA 90nm (2.2 - 2.4GHz)	85.3	1.350
Athlon 64 FX51 - FX53 (2.2 - 2.4GHz)	89.0	1.5
Athlon 64 FX55 (2.6GHz)	104.0	1.5
Athlon 64 FX55 - FX57 (2.6 - 2.8GHz)	104.0	1.350 - 1.400
Athlon 64 X2 3800+ - 4200+	89.0	1.300 - 1.350
Athlon 64 X2 4400+ - 5000+	110.0	1.300 - 1.350
Apple-IBM-Motorola(Freescale) PowerPC Processors		
PowerPC 603 80MHz	3 ‡	3.3
PowerPC 750FX 400Mhz	7.9	1.5
PowerPC 750FX 600Mhz	8.7	1.5
PowerPC 750FX 700Mhz	9.3	1.5
PowerPC 750FX 800Mhz	9.7	1.5
PowerPC 750GX 733MHz	9.45	1.45
PowerPC 750GX 800MHz	10.15	1.45
PowerPC 750GX 933MHz	12.5	1.5
PowerPC 750GX 1GHz	14.0	1.5
MPC7455 (G4) 180nm 1.0GHz	22 / 15 *† 30W at 1.6V ‡	
MPC7455 (G4) 180nm 1.33GHz	40 / 30 *†	
MPC7447A (G4) 130nm 1.42GHz	30 / 21 *†	
PowerPC 970 (G5) 130nm 1.8GHz	(90 - 100) / 51 * 42W at 1.3V ‡	
PowerPC 970 (G5) 130nm 2.0GHz	66 **	

PowerPC 970FX (G5) 90nm 2.0GHz	(< 50) / 24.5 *	1
PowerPC 970FX (G5) 90nm 2.3GHz	55	(1.1)
PowerPC 970FX (G5) 90nm 2.5GHz	(90 - 100) / (50) * (80) / (59) * 62 ‡	
PowerPC 970FX (G5) 90nm 2.7GHz	(80) ‡	
PowerPC 970MP dual core 2.5GHz	100	

Numbers in parenthesis are estimates. * Maximum / Typical wattage. ** Typical wattage under normal use.
‡ Probably typical wattage, rather than maximum wattage, but source doesn't distinguish.
† Motorola/Freescale's numbers, which are generally less than Apple's published wattage.
Source: [184]

Low-End PC Processor Energy Use

Processor	Wattage	Voltage
Intel Processors		
Celeron 370-FCPGA 180nm 566 - 850MHz	19.2 - 25.7	
Celeron 370-PGA2 130nm 900 - 1400MHz	26.3 - 34.8	
Celeron 370-PPGA 0.2Xu? 333 - 533MHz	19.7 - 28.3	
Celeron 478PGA 180nm 1.7 - 1.9GHz	63.5 - 72.8	
Celeron 478PGA 130nm 1.9 - 2.8GHz	50.1 - 68.4	1.25 -1.525
Celeron D 775 pin 90nm 2.53 - 3.06GHz	84.0	1.25 - 1.400
Celeron D 775 pin 90nm 3.33GHz	73.0	1.25 - 1.400
Celeron D 478 pin 90nm 2.13 - 3.2GHz	73.0	1.25 - 1.400
AMD Processors		
Sempron 1400+ - 2000+	59.0	1.400
Sempron 2200+ - 2800+ Model 8 (1500 - 2000MHz)	62.0 / 55.9 *	1.60
Sempron 3000+ Model 10 (2000MHz)	62.0 / 49.4 *	1.60
Sempron 2200+, 2800+ Model 10 256K L2 Cache (1500MHz, 2000MHz)	62.0 / 49.4 *	1.60
Sempron 64 2500+ - 3400+ (1400 - 2000MHz)	59.0	1.40

* Maximum / Typical wattage
Source: [185]

Mobile and Low Power Processor Energy Use

Processor	Wattage	Voltage
Intel Processors		
Celeron M 479 pin 130nm 800MHz	7	1.004
Celeron M 479 pin 90nm 900MHz	5.0	0.956 - 1.052
Celeron M 479 pin 90nm 1.0GHz	5.5	1.25 - 1.400
Celeron M 479 pin 130nm 1.2 - 1.5GHz	24.5	1.356 - 0.956
Celeron M 479 pin 90nm 1.3 - 1.4GHz	21.0	1.260
Celeron M 478 pin PPGA 90nm 1.7GHz	27.0	1.25 - 1.400
Pentium M 130nm 900MHz	7.0	1.004
Pentium M 130nm 1.1 - 1.2GHz	12.0	1.180
Pentium M 130nm 1.3 - 1.4GHz	22.0	1.388
Pentium M 130nm 1.5 - 1.7GHz	24.5	1.484
Pentium M 90nm 1.1GHz	5.0	0.956 - 1.052
Pentium M 90nm 1.4GHz	10.0	1.16
Pentium M 90nm 400MHz Bus 1.5 - 2.1GHz	21.0	1.276 - 1.400
Pentium M 90nm 533MHz Bus 1.6 - 2.26GHz	27.0	1.287 - 1.400

Mobile Pentium 4 M 478 pin 130nm 1.1 - 1.3GHz	22.0	1.25 - 1.400
Mobile Pentium 4 M 478 pin 130nm 1.4GHz	25.8 / 20.8 †	1.300
Mobile Pentium 4 M 478 pin 130nm 1.5GHz	26.9 / 20.8 †	1.300
Mobile Pentium 4 M 478 pin 130nm 1.6 - 2.0GHz	30.0 / 20.8 †	1.300
Mobile Pentium 4 M 478 pin 130nm 2.2 - 2.6GHz	35.0	1.300
Core Solo 478 pin 65 nm 1.66GHz	27.0	1.25 - 1.400
Core Duo 478 pin 65nm 1.66 - 2.16GHz (used by new iMac)	31.0	1.25 - 1.400
AMD Processors		
Low Power Sempron 2600+ 130nm (1833GHz)	25.0	
Turion 64 ML-30 - ML-37 (1.6 - 2.0GHz)	35.0	
Turion 64 MT-30 - MT-34 (1.6 -1.8GHz)	25.0	
Mobile Athlon 64 2700+ - 3000+ (1.6 - 2.0GHz)	35.0	
IBM-Apple-Motorola/Freescale PowerPC Processors*		
PowerPC 970MP 1.4GHz	13 **	
PowerPC 970MP 1.6GHz	16 **	
Other Processors		
Transmeta Efficeon TM8600 130nm 1GHz	7	
Transmeta Efficeon TM8800 90nm 1GHz 1.0 –1.1GHz	~3	
Transmeta Efficeon TM8800 90nm 1GHz 1.4 –1.6GHz	~7	
Transmeta Efficeon TM8800 90nm 1GHz 1.6 –1.8GHz	~12	
Transmeta Efficeon TM8800 90nm 1GHz 1.8 –2.0+ GHz	< 25	
Via C3 1.0GHz	15 / 11.25 ‡	1.4
Via C7 1.5GHz	12.0	
Via C7 1.8GHz	15.0	
Via C7 2.0GHz	20.0	

† Maximum / Low wattage. ‡ Maximum / Typical wattage.
* Most Apple laptops use the G4, so see the stats for those chips under the previous table.
** Typical wattage. IBM doesn't publish its chip's maximum wattage like Intel and AMD. Apple has decided to switch to Intel chips, so it is unclear if anyone with make laptops with the PowerPC 970MP, although it will probably be widely used in servers at higher speeds.
Source: [186]

Server Processor Energy Use

Processor	Wattage	Voltage
Intel Processors		
Itanium 418 pin PAC 133MHz Bus 733MHz	130	1.25 - 1.40
Itanium 418 pin PAC 133MHz Bus 800MHz	116	1.25 - 1.40
Xeon 603 pin 180nm 400MHz Bus 1.4 - 1.7GHz	56.0 - 65.8	1.750
Xeon 603 pin 180nm 400MHz Bus 1.4 - 1.6GHz MP	64.0 - 72.0	1.750
Xeon 603 pin 130nm 400MHz Bus 1.7 - 3.0GHz	65.8 - 85.0	1.750
Xeon 603 pin 130nm 400MHz Bus 1.9 - 3.0GHz MP	55.0 - 85.0	1.750
Xeon 604 pin 130nm 533MHz Bus 2.0 - 3.2GHz	58.0 - 92.0	1.500 - 1.525
Xeon 604 pin 90nm 667MHz Bus 2.66GHz	165	1.250 - 1.400
Xeon 604 pin 90nm 667MHz Bus 2.83 - 3.33GHz	129	1.250 - 1.400
Xeon 604 pin 90nm 667MHz Bus 3.66GHz	110	1.250 - 1.400
Xeon 604 pin 90nm 800MHz Bus 2.80 - 3.80GHz	103.0 - 110.0	1.250 - 1.400
Dual-Core Xeon 771 pin 65nm 667MHz Bus 2.5 - 3.0GHz	95.0	1.25 - 1.40
Dual-Core Xeon 771 pin 65nm 1066MHz Bus 3.2GHz	95.0	1.25 - 1.40
Dual-Core Xeon 771 pin 65nm 1066MHz Bus 3.46 - 3.73GHz	130.0	1.25 - 1.40
AMD Processors		
Opteron 140 - 144 Rev CG (1.4 - 1.8GHz)	82.1	1.500
Opteron 146 - 150 Rev CG (2.0 - 2.4GHz)	89.0	1.500
Opteron 144, 146 Rev E (1.8 -2.0GHz)	67.0	1.350 - 1.400

Opteron 148, 150 Rev E (2.2 -2.4GHz)	85.3	1.350 - 1.400
Opteron 246/846, 148/248/848, 250/850 Rev E (2.0 - 2.4GHz)	54.7	1.350 - 1.400
Opteron 152, 154 Rev E (2.6 - 2.8GHz)	104.0	1.350 - 1.400
Opteron 254/854 Rev E (2.8GHz)	92.6	1.350 - 1.400
Opteron Dual Core 165/265/865, 270/870, 275/875, 280/880 Rev E (1.8 - 2.4GHz)	95.0 *	1.300 - 1.350
Opteron Dual Core 165, 170, 175, 180 Rev E (1.8 - 2.4GHz)	110.0 *	1.300 - 1.350
Opteron Dual Core 260/860, 165/265/865, 270/870 Rev E (1.6 - 2.0GHz)	55.0 *	1.150 - 1.200
Other Processors		
SUN UltraSPARC IIi 650MHz	17.6	1.7
SUN UltraSPARC III 1.2GHz	53 †	1.6
SUN UltraSPARC IV 130nm 1.2GHz	108 **	1.35
SUN UltraSPARC IV+ 90nm 1.5GHz	90 †	
SUN UltraSPARC T1 90nm 1.0 - 1.2GHz (GPL License!)	79 / 72 ‡	
IBM Power4 180nm 1.1GHz	~115 †	1.5
IBM Power4+ 130nm 1.2GHz	~70 †	
IBM Power5 (dual) 1.8GHz	160	

* The AMD data sheet gives a number of different wattages for the Opteron 165 and other similar model numbers. The wattage depends on the chip's part number and voltage.
‡ Maximum / Typical wattage. † Unclear if maximum or typical wattage.
** Tom Krazit states that the dual-core UltraSPARC IV only consumes 23 W at 1.2GHz. Possibly he was referring to the UltraSPARC IV+ and only one core.
Source: [187]

National Resources Defense Council: Laptop Energy Efficiency

Laptop Model	Type of Laptop	Power Manage-ment	MobileMark Performance Score	MobileMark Battery Life (hr)	Energy to Charge Battery (Wh)	System Efficiency* (MobileMark/w)
IBM T23 (Intel P3 Mobile)	Thin and Light	No	111	3,3	58,8	6,3
IBM T40 (Intel Centrino)	Thin and Light	Yes	95	4,2	66,1	6.0
Sharp MM-10 (Transmeta Crusoe)	Ultra Potable	Yes	60	2,5	35,2	4,3
Fujitsu S-Series Lifebook (AMD Athlon 64)	Thin and Light	Yes	94	2,4	58,6	3,9
MiTAC (AMD Athlon 64)	Thin and Light	No	66	2,2	77,1	1,9
Toshiba Tecra 8100 (Intel P3)	Desktop Replacement	N/A	50	2,4	67.0	1,8

* System Efficiency = (MobileMark Performance Score) * (MobileMark Battery Life) / (Measured Energy to Charge Battery)
Source: Suzanne Foster and Chris Calwell, "Laptop Computers: How Much Energy Do They Use, and How Much Can We Save?", National Resources Defense Council and Ecos Consulting, Sept. 2003, p 37, http://www.efficientpowersupplies.org/pages/SeptNRDCLaptopSummary_digital.pdf.

Monitor Energy Use

Monitor Type	Size	Count (n)	Off (W)	Deep Sleep (W)	On (W)*	in^2	On (W/in^2)

All Monitors	All	35	1	2	53	128	0,45
CRT	15"	4	0	3	55	94	0,58
	17"	5	0	2	58	123	0,47
	19"	5	0	2	86	156	0,55
	21"	5	0	2	100	192	0,52
	All	19	0	2	75	144	0,53
LCD	15"	9	2	2	16	94	0,17
	17"	4	2	2	31	123	0,25
	18"	3	1	2	53	139	0,38
	All	16	2	2	27	110	0,23

* Numbers not provided. Calculated from W/in2 and estimated in^2, so wattage may be slightly off from original measure.
Source: Judy A. Roberson *et al*. "Energy Use and Power Levels in New Monitors and Personal", Energy Analysis Department, University of California-Berkeley, July 2002, p. 17, http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1567&context=lbnl

Hardware Power Values and Duty Cycle Assumptions

Type	On	Monitor Sleep	Hardware Sleep	Off	Unplugged
Power consumption of 17" LCD (watts)	40	4	3	1	0
Power consumption of 17" CRT (watts)	76	8	4	3	0
Power consumption of laptop using internal screen (watts)	23	14	2	2	0
Power Consumption of laptop using external screen (watts)	14	14	2	2	0
Power consumption of desktop (watts)	61	61	34	3	0
Usage Time of computer system (hours/year)	2762	2369	375	3254	0

Source: "Laptop Computers: How Much Energy Do They Use, and How Much Can We Save?", National Resources Defense Council and Ecos Consulting, August 2003, p. 12, http://www.efficientproducts.org/reports/computers/NRDC_Laptops_FINAL.pdf.

Energy Consumption of Five Hardware Configurations

Configuration	Operational Energy (kwh/yr)	On Mode Energy Consumption (kwh/yr)	Low Power Mode Energy Consumption (kwh/yr)	Percent of Total Energy Spent in On Mode
Laptop	104	64	40	61%
Laptop w/ external 17" LCD	203	182	21	90%
Laptop w/external 17" CRT	319	282	37	88%
Desktop w/ external 17" LCD	460	423	36	92%
Desktop w/ external 17" CRT	576	523	53	91%

Source: "Laptop Computers: How Much Energy Do They Use, and How Much Can We Save?", National Resources Defense Council and Ecos Consulting, August 2003, p. 12, http://www.efficientproducts.org/reports/computers/NRDC_Laptops_FINAL.pdf.

PC Mark Efficiency for Six Laptops and Two Desktops

Computer Tested	PC Mark Scores (no units)			Energy Consumed (watt-hours)	Efficiency Score (sum PC Mark/whrs)
	CPU	Memory	HDD		
IBM T40 (Intel Centrino)	4916	4622	520	2,72	3698
Fujitsu S-Series Lifebook (AMD Athlon 4)	4148	2165	439	3,55	1902
IBM T23 (Intel P3-M)	3578	2186	367	3,94	1556
Sharp MM-10 (TM Crusoe)	1646	1472	222	3,24	1031
MiTAC (AMD Athlon 4)	2230	1259	399	5,62	692
Toshiba Tecra 8100 (Intel P3)	1844	1220	224	6,18	532
NEC PowerMate eco desktop (TM Crusoe)	1688	1487	328	6,75	519
Custom desktop (AMD Athlon)	2953	2826	1314	24	295

Source: "Laptop Computers: How Much Energy Do They Use, and How Much Can We Save?", National Resources Defense Council and Ecos Consulting, August 2003, p. 38, http://www.efficientproducts.org/reports/computers/NRDC_Laptops_FINAL.pdf.

Appendix C: Computer Recycling

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Very little of the typical computer in the US is recycled (although some countries such as Denmark do have a very high recycling rate). The highest revenue from computer recycling comes from reselling old computers and their components such as hard drives. The most valuable part of an old computer are the printed wiring boards which contain precious metals.[188] The non-metallic parts of the computer have little market value and are difficult to recycle.[189] Many of the hazardous materials in computers such as lead and mercury are difficult to extract and often aren't recycled, so they are free to leak into our environment and harm our health.

Materials in a typical PC weighing 60 lbs in mid-1990s

Material	Content (% Total Weight)	Weight of material in computer (lbs.)	Recycling Efficiency (current recyclability)	Use/Location
Plastics	22,99	13,8	20%	includes organics, oxides other than silica
Lead	6,3	3,8	5%	metal joining, radiation shield/CRT, PWB
Aluminum	14,17	8,5	80%	structural, conductivity/housing, CRT, PWB, connectors
Germanium	0	< 0.1	0%	Semiconductor/PWB
Gallium	0	< 0.1	0%	Semiconductor/PWB

Iron	20,47	12,3	80%	structural, magnetivity/(steel) housing, CRT, PWB
Tin	1,01	0,6	70%	metal joining/PWB, CRT
Copper	6,93	4,2	90%	Conductivity/CRT, PWB, connectors
Barium	0,03	< 0.1	0%	in vacuum tube/CRT
Nickel	0,85	0,51	80%	structural, magnetivity/(steel) housing, CRT, PWB
Zinc	2,2	1,32	60%	battery, phosphor emitter/PWB, CRT
Tantalum	0,02	< 0.1	0%	Capacitors/PWB, power supply
Indium	0	< 0.1	60%	transistor, rectifiers/PWB
Vanadium	0	< 0.1	0%	red phosphor emitter/CRT
Terbium	0	0	0%	green phosphor activator, dopant/CRT, PWB
Beryllium	0,02	< 0.1	0%	thermal conductivity/PWB, connectors
Gold	0	< 0.1	99%	Connectivity, conductivity/PWB, connectors
Europium	0	< 0.1	0%	phosphor activator/PWB
Titanium	0,02	< 0.1	0%	pigment, alloying agent/(aluminum) housing
Ruthenium	0	< 0.1	80%	resistive circuit/PWB
Cobalt	0,02	< 0.1	85%	structural, magnetivity/(steel) housing, CRT, PWB
Palladium	0	< 0.1	95%	Connectivity, conductivity/PWB, connectors
Manganese	0,03	< 0.1	0%	structural, magnetivity/(steel) housing, CRT, PWB
Silver	0,02	< 0.1	98%	Conductivity/PWB, connectors
Antinomy	0,01	< 0.1	0%	diodes/housing, PWB, CRT
Bismuth	0,01	< 0.1	0%	wetting agent in thick film/PWB
Chromium	0,01	< 0.1	0%	Decorative, hardener/(steel) housing
Cadmium	0,01	< 0.1	0%	battery, glu-green phosphor emitter/housing, PWB, CRT
Selenium	0	0	70%	rectifiers/PWB
Niobium	0	< 0.1	0%	welding allow/housing
Yttrium	0	< 0.1	0%	red phosphor emitter/CRT
Rhodium	0		50%	thick film conductor/PWB
Platinum	0		95%	thick film conductor/PWB
Mercury	0	< 0.1	0%	batteries, switches/housing, PWB
Arsenic	0	< 0.1	0%	doping agents in transistors/PWB
Silica	24,88	15	0%	glass, solid state devices/CRT,PWB

Source: "Electronics Industry Environmental Roadmap," Microelectronics and Computer Technology Corporation, Austin, TX, 1996. Reprinted in "Poison PCs and Toxic TVs: E-waste Tsunami to Roll Across the US: Are We Prepared?", revised Feb 10, 2004, Computer Takeback Campaign and Californians Against Waste, p. 14, http://www.svtc.org/cleancc/pubs/ppcttv2004.pdf

The heaviest single component in a typical desktop computer is glass which makes up 25% of a typical PC by weight. It costs more to recover the silica in the printed wiring boards and the glass in the CRT than it is worth.

Because the glass in the CRT is contaminated with lead, a number of countries have subsidized the recycling of leaded monitor and TV glass to avoid having to store it as toxic waste. Hopefully, California's initiative in this area will encourage more recyclers to reuse leaded monitor glass.

The second most common component in computers is plastic which makes up 23% of a typical PC by weight. A 1996 study by the Microelectronics and Computer Technology Corporation (MCC) estimated that total electronics plastic scrap amounts to 580,000 tons per year[190] and that total has probably increased judging from the growing proportion of consumer electronics in the US waste stream. Plastic is generally difficult to recycle and there is currently little market for many types of recycled plastics in the US. Only 5.5% of the plastic in the US waste stream gets recycled,[191] and the percentage of plastic being recycled in a typical US computer is probably even smaller. Although some types of plastic such as PET are readily recycled, the majority of the plastic used in a PC is more difficult to recycle.

Market share of computer plastics and the percentage of each found in recent recycling studies[192]

Polymer Type	Market Share	Study 1	Study 2	Study 3
HIPS (high impact polystyrene)	22.7%	25%	10%	5%
ABS (acrylonitrile butadiene styrene)	20.5%	39%	34%	57%
PC (polycarbonate)	19.2%	4%	5%	-
PC/ABS blend	11.7%	6%	29%	2%
PPO (polyphenylene oxide)	6.5%	17%	12%	36%
Other	19.4%	9%	10%	>1%

Source: E. Masanet *et al*. "An Assessment and Prioritization of "Design for Recycling" Guidelines for Plastic Components," Apple and UK Berkeley, accessed Mar 2006, p. 3, http://images.apple.com/environment/design/pdf/EM_IEEE_plastic_022002.pdf

In the mid-1990s, 26% percent of the plastic used in a typical PC was PVC (type 3) plastic and many of the old PCs being thrown away today still contain a large proportion of this hazardous plastic. When burned, PVC releases deadly dioxins and furans. Flexible PVC such as the protective sheathing on wires leeches phthalates which cause birth defects and disrupt hormones. Some of the heavy metal additives to PVC are harmful as well. Although 3% the typical American house is constructed with PVC, some activists are now calling for a complete ban on this harmful substance. Not only is PVC hazardous, it is also the bane of recyclers, since only a small amount of PVC will corrupt other plastics and make them unrecyclable.[193]

Today roughly 55% of the plastics used in the computer industry today are modified forms of polystyrene (type 6) plastic or polystyrene blended with polycarbonate. Many manufacturers are switching to ABS (acrylonitrile butadiene styrene) and HIPS (high impact polystyrene) to avoid using PVC in their casings. From an environmental point of view this switch is only marginally better since polystyrene is considered the second most hazardous type of plastic after PVC. Burning polystyrene releases 57 chemical byproducts and some of them are considered quite hazardous. Polystyrene can irritate eyes, nose and throat and can cause dizziness. It bioaccumulates in body fat, and has been linked to elevated rates of lymphatic and hematopoietic cancers for people who work around it. It is also a suspected endocrine disruptor. Toxic chemicals such as benzene and ethylene are commonly used in the production of polystyrene.[194] Unfortunately, there are few economical alternatives which have the same strength and heat resistant properties as ABS and HIPS.[195] Polycarbonates are a relatively strong type of plastic which could substitute for ABS or HIPS, but polycarbonates often contain bisphenol A, which is a known endocrine disruptor.

According to the EPA statistics on the US solid waste, there was no significant recycling of PVC or polystyrene

(including HIPS) in the US in 2001. Despite MacDonald's claims to be able to create park benches out of polystyrene foam, very little polystyrene is actually recycled because it requires more energy than to simply generate virgin polystyrene. ABS, polycarbonate, and ABS/polycarbonate blends, however, may be more economical to recycle than standard polystyrene because these are high value polymers which are relatively expensive to create. The problem is that recycled ABS must be at least 99% pure in order to be reused in an ABS electronic part and it can't contain more than 15% recycled content before its material properties start to degrade.[196] At this point there is a small market for recycled ABS (mostly to be shipped to China)--one ad offers to buy old ABS at $400 per ton.[197] Aside from PVC and HIPS, most of the plastics used in computers such as ABS, polycarbonate, and PPO (polyphenylene oxide) weren't given a recycling number. Only 6.8% of these "other resins" were recycled in the US in 2001 and most of that recycled material came from industrial sources rather than post-consumer sources. In other words, it is very unlikely that the 14 pounds of plastic in your computer will be recycled, unless American citizens start demanding mandatory recycling programs as is happening in Europe, Japan, and S. Korea.

Plastics in Municipal Solid Waste in the US, 2001 (in thousands of tons)

Product Category	Generation	Recovery	% Recovery	Discards
PET (#1)	2580	470	18,20%	2110
HDPE (#2)	4920	430	8,70%	4490
PVC (#3)	1420			1420
LDPE/LLDPE (#4)	5880	15	2,60%	5730
PP (#5)	3460	10	0,30%	3450
PS (#6)	2290			2290
Other resins (#7)	4830	330	6,80%	4500
Total Plastics	25380	1390	5,50%	23990

Source: "Characterizations of Municipal Solid Waste in the United States: 2001 Update," US Environmental Protection Agency, Office of Solid Waste, http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/msw2001.pdf.

Even when components are made of recyclable plastics, the different types of plastic are often mixed and difficult to separate, so the plastic isn't worth recycling. Plastic which isn't labeled or is painted is also difficult to recycle, as are plastic parts with molded in metal and metallic coats. A number of design reforms have been proposed to facilitate easier recycling.

Plastic "Design for Recycling" Guidelines Suggested by Eco-labels

#	Design for Recycling	TCO '99	Blue Angel	Apple's Design Priority
1	Plastic components > 25 g labeled per ISO 11469	R	R	High
2	Large plastic parts limited to one polymer type	R		Low
3	Large plastic parts must not be painted such that weight is increased by more than 1%	R		High
4	No molded-in or glued-on metal parts	R		High
5	All plastic parts of same polymer type shall be same color		S	Low
6	Use of snap fits wherever possible		S	Medium

R = Required for eco-label certification, S = Suggested

Source: E. Masanet *et al*. "An Assessment and Prioritization of "Design for Recycling" Guidelines for Plastic

Components," Apple and UK Berkeley, accessed Mar 2006, p. 1, http://images.apple.com/environment/design/pdf/EM_IEEE_plastic_022002.pdf

After studying the difficulty of recycling plastics and the many health problems associated with plastics, Paul Goettlich questions whether we should be designing products with plastics in the first place. Surveying the public health problems, Goettlich argues that plastics should only be reused and recycled in applications which will have no contact with food, animals, or people. For many years, the Berkeley curb-side recycling program refused to pick up plastics since such a small percentage was actually being recycled and most of it was downcycled into lower-grade plastics with little market value. Goettlich argues that plastic recycling has diverted attention and resources from more ecological solutions. Instead, focus should be directed toward more ecologically-friendly materials and longer use and greater reuse.[198]

Unfortunately there are few good alternatives to virgin plastic made from petroleum, especially as the market switches from heavier desktops to lighter notebooks and handheld computers. Many recycled plastics are too low in quality to be used in electronic parts. Organic plastics require more energy than petroleum-based plastics and are unsuitable for use in electronics where heat resistance is critical. Designing laptops with light metal casings such as magnesium alloy will consume more energy and cause more environmental damage than ABS casings, especially if those metal parts aren't designed to be reused and/or recycled. Currently, the most environmental solution is to make your equipment last as long as possible. In the meantime, we should lobby for greener design to facilitate recycling.

Recycling, however, is of limited importance compared to the vast amounts of energy and resources which goes into the original manufacturing, especially of silicon chips and printed circuit boards. Even more critical than recycling is lobbying for standardized laptop form factors to facilitate the reuse of parts and promote the fixability and upgradability of portable computers. Currently there are few organized efforts to push for standardized form factors which would substantially lengthen the lifespan of portable computers and substantially reduce the amount of computer manufacturing which causes the most harm to the environment.

Appendix D: Hazardous substances ▲

The Silicon Valley Toxic Coalition has identified 34 hazardous chemicals used by the high tech industry in the Silicon Valley. Of these, 17 have EPA cancer benchmarks (for the 1 in 1,000,000 risk). Others have benchmarks for chronic and/or acute effects.

HAP Chemical	CAS No.	HAP Threshold	Cancer	Chronic	Acute	NPI Health / Environment Score*
Acetaldehyde	75-07-0	X	X	X		1.2 / 1.7
Allyl chloride	01/05/07	X	X	X		
Antimony compounds	7440-36-0					1.0 / 1.3
Arsenic compounds	7440-38-2	X	X	X		2.3 / 1.7
Beryllium compounds	7440-41-7	X	X	X		2.3 / 1.7
Bis(2-ethylhexyl)phthalate	117-81-7	X	X	X		1.3 / 1.2
cadmium compounds	7440-43-9	X	X	X		2.3 / 2.0
Chromium compounds	18540-29-9	X	X	X	X	2.5 / 3.0
Cyanide compounds	05/12/57					1.8 / 2.2
dioxane(1,4)"	123-91-1	X	X	X		
Epichlorohydrin	106-89-8	X	X	X		
Ethylene glycol	107-21-1					1.2 / 0.8
Formaldehyde	50-00-0	X	X	X		1.5 / 1.2
Glycol ethers	107-21-1					1.2 / 0.8
Hydrochloric acid	7647-01-0	X		X		1.5 / 0.7
Hydrofluoric acid	7782-41-4	X		X	X	1.5 / 1.8
Lead compounds	7439-92-1	X	X	X		1.7 / 1.5
Maleic anhydride	108-31-6	X		X		
Mercury compounds	7439-97-6					1.7 / 2.0
Methanol	67-56-1	X		X		1.5 / 1.2
Methyl chloroform	67-56-1	X		X		1.5 / 1.2
Methyl ethyl ketone	78-93-3					1.2 / 1.0
Methyl isobutyl ketone	01/10/08					0.7 / 1.8
Methyl methacrylate	80-62-6	X		X		1.3 /1.7
Methylene chloride	02/09/75	X	X	X		1.5 / 1.3
various Nickel compounds (1)	13463-39-3	X	X	X		2.5 / 1.5
various Nickel compounds (2)	12035-72-2	X	X	X		2.0 / 1.7
p-dichlorobenzene	106-46-7	X	X	X		
Phenol	108-95-2	X		X		1.7 / 0.8
Phthalic anhydride	85-44-9	X		X		
Tetrachloroethylene	127-18-4	X	X	X		1.2 / 2.5
Toluene	108-88-3	X		X		1.3 / 1.3

trichloroethane(1,1,2)	79-00-5	X	X	X		1.2 / 1.2
Trichloroethylene	06/01/79	X	X	X		1.3 / 2.0
Xylene	1330-20-7	X		X		1.3 / 1.0
Other hazardous substances (not listed by the Silicon Valley Toxics Coalition)						
Boron	7440-42-8					1.7 / 0.8
Zinc	7440-66-6					0.8 / 2.0
Manganese	7439-96-5					1.3 / 1.3
Selenium	7782-49-2					1.7 /1.8
Styrene (ethenylbenzene)	100-42-5					1.5 / 1.0
Vinyl Chloride	75-01-4					2.2 / 1.0
Barium	7440-39-3					
Sulfuric Acid	7664-93-9					2.3 / 1.3
Brominated flame retardants (TBBPA, HBCD, PBDE, PBB)	79-94-7 25637-99-4 36483-60-0 13654-09-6					
Vanadium compounds						
Bisphenol A.	80-05-7					

* Human health score / Environment score. The Australian National Pollutant Inventory (NPI) scores 400 pollutants on a scale from 0 to 3 on their hazard to human health and the environment. A score of 0 indicates the least hazard and 3 is the most hazard.
Source: "SVTC Cumulative Exposure Project (CEP) Maps", Silicon Valley Toxics Coalition and Clary-Meuser Research Associates, 1999, http://www.svtc.org/ecomaps/svtc_cep/hitech.htm.

Appendix E: Free Software in MS-Windows ▲

People often assume that free software is only for the programmers and the computer cognoscenti who want to learn how to use GNU/Linux or BSD. Perhaps free software was difficult to use a decade ago, but today free software can be used by anyone with a computer and an internet connection to download it. For the majority of proprietary programs that currently dominate the software market, a free software alternative is being developed for MS-Windows. Anyone can install these programs and transform their computer from a proprietary space into a declaration of technological freedom and statement of social justice.

A decade ago there was almost no free software that ran in MS Windows. Even a couple years ago, the selection of free software in Windows was very limited, but the situation has radically changed in the last couple years since a number of programs based upon the cross-platform libraries GTK+ and wxWidgets have been ported to Windows. In addition, SUN decided to release a free software version of Star Office known as OpenOffice.org, thus providing a number of vital desktop applications. The number of free software alternatives is rapidly growing and you can encourage this trend by helping free software become better so that others have a true technological choice. Anyone can get involved as a free software user, bug tester, or documentation writer. Many people who have never touched a compiler in their lives are promoting free software by answering questions on support lists and helping others install it on their machines. The more people who use and help spread free software, the better it gets.

In many cases, such as Mozilla Firefox, Thunderbird, Apache, SendMail, MySQL, PostGreSQL, 7-Zip, and

OOo Writer, free software is arguably superior to their proprietary competitors. In categories such as personal databases, media players, and SVG editors, free software programs like OpenOffice Base, VLC, and InkScape are developing very rapidly to close the gaps. Below is a list comparing available free software in Windows to the dominant proprietary software for each category.

Comparison of Proprietary and Free Software in MS-Windows

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
Web Navigator	MS Internet Explorer Netscape Opera	Mozilla FireFox	Internet Explorer is a security nightmare and should only be used when a webpage has been programmed to only work with Microsoft's proprietary extensions of the standard internet formats. Most spyware and other forms of malware has been designed to take advantage of the gaping security holes in Internet Explorer. According one test, an Internet Explorer user will receive 21 times more malware than a FireFox user.	Win, Linux, Mac
		SeaMonkey	SeaMonkey uses the same codebase as FireFox but is a complete suite that uses less memory and has more tools than FireFox, although it doesn't support as many extensions as FireFox.	Win, Linux, Mac
E-Mail	MS Outlook Eudora	Thunderbird	MS Outlook is a security hazard which can be a vector for dangerous scripts in email. Thunderbird has built-in spam filters and doesn't allow dangerous scripts to run.	Win, Linux, Mac
		SeaMonkey Mail	Very similar to Thunderbird but supports a couple more advanced options.	Win, Linux, Mac
Internet Instant Messenger	AOL Instant Messenger MS Windows Live Messenger Yahoo! Messenger Jabber	Gaim	Unlike the proprietary internet chat programs which can only communicate in their own chat protocol, Gaim can handle all protocols so you don't have to switch between programs if you want to talk to people using MSN, Yahoo, Google, IRC, ...etc. It even supports spell-checking.	Win, Linux, Mac
FTP Client	FTP Commander Secure FTP	FileZilla	A fully featured FTP client based on the PUtty command-line tool. It is very useful for long uploads and downloads when you want to pause and later resume.	Win
		WinSCP	WinSCP is an FTP client also based upon PUtty with a simpler interface than FileZilla.	Win
Peer-to-Peer (P2P)	EDonkey2000 KaZaA (FileTrack) Napster	BitTorrent	For almost all the P2P networks, there are free software clients available. Use aMule for eDonkey networks, Gnucleus for Gnutella networks, and KCeasy for FileTrack networks. In place of Napster, use OpenNap. BitTorrent, however, is the best of the P2P clients in the opinion of many free software users. Many free software projects prefer that their software be downloaded by BitTorrent.	Win, Linux, Mac
Podcast Receiver	PodFeeder nimiq Doppler	Juice	Juice is a handy program for receiving podcasts automatically from many different sources. Essential for people who follow the alternative news on the internet from shows like Democracy Now! and CounterSpin.	Win, Mac, Linux (in the future)
Internet Telephone	Skype Quarterdeck Web Talk Third Planet	Speak Freely	Speak Freely is dificult to configure, but if both the sender and receiver have it installed, they can talk to each other for free, unlike Skype which charges for each phone call. In order to use Speak Freely, both the sender and receiver need an IP number,	Win

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
	Pub. Digiphone FreeTel VocalTec Internet Phone		which can be tricky if the IP number is automatically assigned and can change.	
Plain Text Editor	MS Notepad	Notepad2	Quite frankly MS Notepad is a very inadequite as a bare text editor. Notepad2 is far superior, yet maintains a simple design. Unfortunately Notepad2 like MS Notepad can only open one document at a time.	Win
		Notepad++	Notepad++ has so many options that many programmers use it in place of the text editors found in Integrated Development Environments. It recognizes and properly highlights almost every programming language. A real delight to use, although the non-programmer probably won't ever need most of its options.	Win
		emacs xemacs	This programmable text editor that can do everything, including check your email and run LISP. It has a steep learning curve and is almost a culture within itself, but it can do some amazing things--it has accumulated a lot of functions over the last 25 years.	Win, Linux, Mac
Word Processor	MS Word WordPerfect Lotus Word	OpenOffice.org Writer	OOo Writer is better than MS Word according to many reviewers. In my opinion, WordPerfect is slightly better than OO Writer, but WordPerfect is more liable to unexpected crashes. OO Writer runs in Windows, Linux/UNIX, and OS X, unlike MS Word and WP. It can export documents as PDF and saves in a text format, so documents can easily be recovered or exported. It exports to HTML better than any of the other major word processors. Its only major drawbacks are a lack of reveal codes like in WP and its non-intuitive search features which are designed for people used to UNIX regular expressions. OO Writer can also open and save in many formats including MS Word's DOC format.	Win, Linux, Mac
		AbiWord	AbiWord is small, fast word processor. The upcoming version 2.5 will support internet collaboration editing like Writely does. AbiWord runs on all platforms and can open and save in many formats including DOC format. Its major drawback is that occasionally the formatting on screen will appear out-of-whack until the screen is redrawn.	Win, Linux, Mac
Presentations	MS PowerPoint	OpenOffice.org Impress	Impress is just as user-friendly as PowerPoint and creates nice presentations, but Powerpoint has a few more advanced options than Impress. Occasionally you will need to reformat imported PowerPoint documents in Impress.	Win, Linux, Mac
Spreadsheet	MS Excel Quattro Pro Lotus 123	OpenOffice.org Calc	OOo Calc is just as good as the proprietary spreadsheets, although graph manipulation is slightly better in MS Excel.	Win, Linux, Mac
		Gnumeric	Gnumeric uses the R statistics language, so its statistical and scientific functions are better than those found in the proprietary spreadsheets. Its graph manipulation, however, is rather limited..	Win, Linux
Personal Finance/ Accounting	MS Money Quicken	*Currently none*	In GNU/Linux, GnuCash is a good alternative, but only preliminary attempts have been made to port it to Windows.	

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
Statistics	SAS SPSS	JGR (**J**ava **G**ui for **R**) R Commander	JGR (pronounced as "jaguar") and R Commander are graphical user interfaces for the R statistics language, which is a free software implemention of S. Although the SAS and SPSS are nicer GUIs, many statisticians like R better that the languages which come with SAS and SPSS. In addition, Gnumeric provides an easy way to use R functions inside of a spreadsheet.	Win, Linux, Mac
Web Page Editor	MS FrontPage Dreamweaver	Nvu	Nvu is a web page editor with a nice user interface, but fewer options than FrontPage and DreamWeaver. Its table editing needs improvement and there is no option to see both the HTML code and the web page at the same time while editing. Nvu is prone to frequent crashes and still has a number of annoying bugs, but I still prefer Nvu to FrontPage, because it adds less garbly-gook to my html code. In GNU/Linux, many use Quanta Plus, but its interface is much less intuitive than Nvu.	Win, Linux, Mac
		OpenOffice.org Writer	Writer has a web page mode so you can edit web pages, but you can't see the HTML code, so it is rather limited in its web editing capabilities.	Win, Linux, Mac
PDF (Publishing Format)	Adobe Acrobat (full version)	OpenOffice.org	Although there is not free software program for editing existing PDF documents like Adobe Acrobat, you can edit your documents in OpenOffice and save them as a PDF. OpenOffice PDFs support hyperlinks, but do not support forms and the other advanced features of Adobe Acrobat.	Win, Linux, Mac
		PDFCreator	PDFCreator converts documents in a print format such a postscript into PDFs. It doesn't support hyperlinks, forms, and other advanced PDF features	Win
		xpdf	Although the main xpdf viewer doesn't run under Windows, its command line tools to extract images from PDF files and to convert PDF files into postscript or text do run in Windows.	Linux, (tools: Win, Mac)
Desktop Publishing	MS Publisher Adobe Pagemaker QuarkXPress	Scribus	Scribus is fast approaching the utility of Pagemaker and has already bypassed Publisher, although it isn't as user-friendly. Before installing Scribus, make sure to first download and install Ghostscript for viewing postscript files.	Win, Linux, Mac
Simple Graphics	MS Paint	OpenOffice.org Draw	OpenOffice Draw is better than MS Paint by all measures. It also supports basic diagramming. It's only drawback is its poor export quality to other image formats like png and jpeg.	Win, Linux, Mac
Diagramming	MS Visio	Dia	Dia lacks some of the advanced features of Visio, but will handle the diagram drawing that most people want. For its code size, it is an amazing program.	Win, Linux, Mac
Advanced Graphics	Adobe PhotoShop Corel Draw PaintShop Pro	GIMP (GNU Image Manipulation Project)	Some people say that the GIMP is more difficult to use than PhotoShop, although it may just be that they are used to PhotoShop. In any case, the GIMP has the same graphical editing capabilities of the PhotoShop, although some things like red-eye removal are harder to do.	Win, Linux, Mac
Vector-based drawing	Adobe Illustrator	InkScape	InkScape is a vector image editor. It doesn't support all the features of the proprietary SVG editors, but it is rapidly improving.	Win, Linux, Mac

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
Animation	Macromedia Flash	Blender	Blender is a 3-D modeling program which can be used to create animations, although it is harder to use than Macromedia, especially for creating web page animations. It has steep learning curve, but you can make animated movies with it.	Win, Linux, Mac
		GIMP with extension (See above)	GIMP supports SVG animation with an extension, but is significantly harder to use than Macromedia.	Win, Linux, Mac
Drafting & Graphic Design	AutoDesk AutoCAD RibbonSoft QCad Professional	RibbonSoft QCad Community Edition	QCad is a 2 dimensional drafting program and circuit board designer which is easier to learn to use than AutoCAD. Although it doesn't offer the 3-D modeling and some of the advanced features of AutoCAD, it will serve for most drafting needs. RibbonSoft has released a free software edition of its software which is the same as QCad Professional except for support for the scripting and polyline modules. QCad is widely available in Linux, but to use it in Windows, you have to download the source code and compile it with the Qt library which isn't free in Windows. Although other Qt programs for Windows such as Scribus are available for download, I have been unable to find a compiled version of QCad for Windows. If you have access to Qt in Windows, please compile it for the rest of us who can't afford Qt licensing fees.	Win?, Linux, Mac?
Photo Manager	iPhoto Picasa	*Currently none*	Picasa is decent *freeware* (not *free software*) for Windows. In GNU/Linux, F-Spot, gThumb and KSquirrel are nice photo managers, but they haven't been ported to Windows.	
Multimedia Player	RealPlayer MS Media Player QuickTime	VLC (VideoLAN Client)	VLC has a couple of novel features that no other media players support. As good as RealPlayer and Media Player for watching movies, it falls short as a music player. VLC doesn't support ripping, and its play list features aren't very user-friendly. It uses normal menus and buttons, unlike some annoying media players which try to imitate physical stereos and VCRs, but users who like skins may find its selection limited. If a video has multiple sound tracks, VLC won't always auto-select the correct sound track--you have to select it from the menu.	Win, Linux, Mac
		MPlayer	The Hungarian answer to RealPlayer, but it doesn't have a GUI interface in Windows yet. Some free software advocates don't like it because it supports a lot of proprietary formats, but it will play just about every format imaginable.	Linux, Mac; Command line: Win
		MediaFrame	A nice Java-based media player, but it should be avoided since it supports Digital Rights Management, an industry plan to restrict your digital rights.	Win, Linux, Mac
Music Player	Winamp	MusikCube	MusikCube is an excellent music player and ripper with a very intuitive interface and nice play list features. It supports MP3, but is uses Ogg Vorbis by default which is a superior sound format. MusikCube doesn't support “skins”, which some may see as a drawback. Unfortunately its GUI is programmed in Visual Basic, so it isn't portable to other operating systems.	Win
Sound Editor & Mixer	Sony Sound Forge Steinberg Wavelab Adobe Audition	Audacity	Audacity is a well-designed and easy-to-use sound editor, but it doesn't have track indicators, so you can only do very basic multi-track mixing. There are better proprietary sound editing programs but they priced beyond the reach of most amateur musicians and redubbers.	Win, Linux, Mac

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
Video Editor	Adobe Premiere Pro Apple Final Cut Pro Studio Ulead MediaStudio Pro Pinnacle	VirtualDub	There is no free software replacement for the proprietary movie editors, but VirtualDub is a handy video capture/processing utility designed for AVI video. It can read, but not write, MPEG 1 video as well. If you want a freeware movie editor, check out Zwei-Stein Video Editor.	Win
		CinePaint	CinePaint edits bitmap images for tradition movie formats which use frames.	Win, Linux, Mac
DVD player	InterVideo WinDVD	See VLC above.	VLC occasionally has problems with DVD menus and doesn't deal very gracefully with bad spots in DVDs, but it will play most movies just as well as proprietary DVD software. The big problem is that there are ridiculous legal restrictions on decoding MPEG formats and decrypting the CSS (Content Scrambling System). If you believe as I do that most forms of intellectual property are morally wrong or if you believe that you should have the legal right to watch a movie which you paid for, then watch movies with a clear conscience with VLC. If you believe that big media companies should have the right to charge you for the act of decoding and decrypting information in their proprietary formats, then don't use VLC.	Win, Linux, Mac
CD/DVD Burner	Nero Ahead Sonic DigitalMedia Plus	*Currently none*	CDBurnerXP Pro is a decent *freeware* CD burner for Windows, although it is not *free software.* Annoyingly, it defaults to ISO 1, so you have to select ISO 2 if you don't want shortened filenames. In GNU/Linux, K3B is an excellent CD/DVD burner, but it hasn't been ported to Windows.	
First-person Shooter Game	ID Doom & Quake Duke Nukem	Cube	Cube doesn't have any artificial intelligence, so you can only play against other human beings in internet multi-person play, but the graphics engine is rather nice.	Win
War Strategy Game	Warcraft Age of Empires	Wesnoth	Not as slick as some of the commercial games, but definitely an enjoyable battlefield strategy game.	Win
Personal Database	MS Access Novel Paradox Visual FoxPro FileMaker Pro	OpenOffice.org Base	OOo Base is currently only a limited replacement for a visual database like Access, but it is rapidly improving. Although there are a number of excellent free software databases, none have as good of a GUI interface as the proprietary databases. There is certainly no visual programing database program like Visual FoxPro in free software.	Win, Linux, Mac
Enterprise Database (Server)	MS SQL Server Oracle IBM DB2 SAP	MySQL	MySQL is a small and quick database that outperforms most propriety databases in small and medium scale server applications. Before version 5 it didn't support many of the functions used by large enterprise databases.	Win, Linux, Mac
		PostGresQL	According to test data, PostGresQL is faster than Oracle. It supports all the advanced database functions and is an excellent large-scale enterprise database.	Win, Linux, Mac
Web Page Server	MS Internet Information Server	Apache	Apache is faster, more secure, and has more configuration options than IIS. Roughly 70% of webpage servers use Apache.	Win, Linux, Mac

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
C/C++ Programming	MS Visual C/C++ (in Visual Studio) Borland C++ Builder Freescale CodeWarrior	Bloodshed Dev-C++	Bloodshed Dev C/C++ is an integrated development environment (IDE) like Visual C/C++ in Visual Studio. It uses the MinGW (or alternatively Cygwin compiler which is based upon the gcc (GNU compiler collection). Bloodshed can only compile C/C++ code, but in GNU/Linux there are nice multilingual IDEs like KDE Developer and Anjuta DevStudio which are comparable to MS Visual Studio. For cross-platform programs, write C/C++ programs using free libraries like GTK+ and wxWidgets which will run in almost any operating system.	Win
		MGWin Developer Studio	MGWin Developer Studio is an IDE for the MinGW compiler. It comes with a nice resource editor for creating visual components for your programs.	Win, Linux
C# Programming	MS C# (in Visual Studio) Borland C# Builder	Mono	Mono is a free software implementation of C# that runs in both Windows and Unix-like systems. It hasn't implemented all of the MS C# libraries yet and doesn't come in IDE like Visual Studio.	Win, Linux, Mac
Pascal Programming	Borland Delphi[199]	Bloodshed Dev-Pascal	Bloodshed Dev-Pascal is an IDE which can use either the Free Pascal or GNU Pascal compilers. Although it doesn't have the rapid development and visual programming features of Delphi, it is a good tool for teaching programming.	Win
BASIC Programming	MS Visual Basic	GNU/Liberty Basic Compiler Collection (GLBCC)	There are a number of free Basic interpreters/ compilers available. Probably the best for general use is the GLBCC, although it doesn't come with an IDE. The next version of wxBasic for wxWidgets programming looks promising, although the current version is incomplete and difficult to use. Mono's Basic.NET Compiler also bears watching for people who program in MS Visual Basic, although it is currently not a complete implementation.	Win, Linux
Java Programming	MS Visual J++ SUN Java Borland JBuilder	GCJ (GNU Compiler for Java) + ClassPath	Although programmers can develop Java programs without paying licensing fees, SUN has been roundly criticized for not releasing Java as free software. It appears that SUN will give Java a free software license in the future, but in the meantime, the GNU Compiler for Java (GCJ) and Classpath can replace SUN's Java. Unfortunately, Classpath hasn't implemented all of SUN's java libraries yet, so some Java code won't run with it. For a good development environment for Java, check out Eclipse.	Win, Linux, Mac
		Eclipse	Eclipse is an IDE and toolkit for 12 different languages, including C/C++, Fortran, PHP, Perl, Python, and Ruby, but it most used for Java programming. The Eclipse SDK uses a different widget toolkit than standard SUN Java and has a number of GUI tools to simplify the construction of applications.	Win, Linux, Mac
Compression	WinZIP WinRAR PK-ZIP WinAce	7-Zip	7-Zip can decompress 15 different compression formats, so it can open just about any compressed file. It has a unique compression format which is 10% more compact than RAR and 75% more compact than the standard ZIP compression used by most programs. It's only drawbacks are its odd interface and the fact that it can't decompress multi-volume ZIP files.	Win, (Command Line: Linux, Mac)

Software Category	*Proprietary Program(s)*	*Free Software Alternative*	*Comparison*	*Platforms*
Anti-virus	Norton AntiVirus McAfee AntiVirus	ClamWin Free Antivirus	ClamWin is based on the ClamAV scanning engine which has a relatively high rate of virus detection. ClamWin does not an on-access real-time scanner like some of the proprietary anti-virus programs, but it does have a scheduler for regular anti-virus scanning and a plugin to scan email in MS Outlook for viruses.	Win
Network Security Scanner	Tenable Network Security Nessus (version 3)	nmap	nmap scans networks for security problems. In Linux, nmap can be used with the GUI front end nmapFE, but in Windows it can only be used from the command line.	Win, Linux, Mac
		Nessus (version 2) / OpenVAS	Nessus is an excellent network security scanner which used to be free software, but Tenable Network Security decided to turn it into proprietary software with version 3. Open source advocates are developing a free version called OpenVAS based upon the old version 2 code, but it is not yet available for download.	Win, Linux
Scanner and OCR	ScanSoft OmniPage ABBYY FineReader NewSoft Presto!	GOCR	There is no free software in Windows for controlling scanners. For OCR, GOCR is a very rudimentary command-line tool for converting image files into text files. Nobody has created a graphical interface for it and people who aren't used to the command-line will find it difficult to use. If you want the help files, you have to download the source files as well.	Win
Command Line	MS-DOS	Cygwin	DOS is extremely limited as a command line interface and should be avoided when possible. Cygwin is a UNIX emulator which gives you all the command line capabilities of UNIX inside Windows, but you can't run BAT files or Windows programs while inside Cygwin.	Win
		FreeDOS	FreeDOS is a free software implementation MS-DOS. It works fine if you just want a DOS boot disk, but I'm not sure how it would function inside Windows XP.	

For a more comprehensive list of every program available in Windows, see the OSSwin Project. For Spanish speakers, see the comprehensive list at CDLibre.org.

If you would like to download all these programs at once, The Trinidad and Tobago Computer Society has compiled a WinOSS CD with the latest versions of most of these programs. If you just want a basic introduction to free software, try The Open CD. For Spanish versions of these programs, CDLibre.org offers a DVD and several CDs with most of these programs. See these notes for the Spanish installation.

Of the programs listed, all seem to be developing rapidly to rival their proprietary competition--only the development of FreeDOS and Nvu (a web page editor) seems to be currently stalled.[200]

Unfortunately, there are number of areas, such as personal finance, scanning and OCR, photo management, movie editing, and CD/DVD burning, where there do not seem to be any perspective free software projects in the offing. Many excellent free software programs that would fill these lacunae like KSquirrel, KDE Developer, Scribus, and K3B (and all the other KDE programs) will probably never be ported to MS Windows since they rely on the QT library which TrollTech won't release under a free software license in MS Windows since it is their main source of revenue. Likewise, some of the programs like gThumb that rely on GNOME won't be ported, unless GNOME as a whole is ported over to Windows. The developers of other GNU/Linux programs like GNU Cash that don't rely on QT or GNOME seem to have little desire to waste their time with a proprietary operating system like Windows.

Ultimately, the best solution is to switch to GNU/Linux if you want to use free software, but using free software in Windows is a good stop-gap solution for the non-technical user. Learning to use free software in Windows will ease the transition into GNU/Linux in the long-run, since most of the good free software programs that run in Windows are cross-platform. GNU/Linux is rapidly becoming so easy to use, that in a few short years, there will be no reason for even the most technically-inept person to not switch.

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Notes:

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suspect that the Japanese keep using their old computers as a secondary computers as is common in the US. Eric Williams, "Energy intensity of computer manufacturing: hybrid analysis combining process and economic input-output methods", *Environmental Science & Technology,* Oct 2004, 38(22): 6166-6174. Abstract: http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/2004/38/i22/abs/es035152j.html

50 Based upon US national average of 1.514 lbs carbon dioxide per kWh. "US EPA E-Grid", 2002, EIA Electric Power Annual 2001, 2003, http://www.epa.gov/cpd/pdf/brochure.pdf. CO2 equivalencies based on data from the U.S. Climate Technology Cooperation Gateway, http://www.usctcgateway.net/tool/index.cfm

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80 Starting with his blow-up with Lucid over emacs, Stallman has had an antagonistic relationship with a number of FLOSS software companies. Stallman insists that he is not against corporations *per se* or making a profit on software. In fact, he claims that his organization, the Free Software Foundation, pioneered making money with free software. Stallman insists, however, that freedom must be the primary goal, and all other benefits, such as revenues from the software are secondary. As Stallman has increased his association with Latin American anti-globalization movements in recent years, I suspect he has only grown more critical of corporations.

81 For a sense of the passionate divisions in the hacker community, check the posting on FLOSS web sites such as slashdot.com The choice of the words "GNU/Linux" versus "Linux" is often a signifier of political and philosophical belief within the free software and open source world. By the early 90s, Stallman and other hackers had managed to create or cobble from other projects almost all the elements of a complete UNIX system, except for the kernel—the lowest level of software which directly interacts with the hardware. In 1991, Linus Torvalds, a young Finnish programmer, began work on a kernel which others dubbed Linux and merged with GNU to make a complete operating system. Although Torvalds chose to release his kernel under the GNU's software license, the GPL, he never fully subscribed to the tenets of free software. In Stallman's words, Torvalds saw free software as a "development methodology" which should be used because it was technologically superior rather than ethically superior. Torvalds encouraged developers of the Linux kernel to use BitKeeper, a proprietary program to manage their code. Alarmed that the principals of the GNU project were being lost and no one was talking about the importance of freedom, Stallman asked people to refer to the operating system as GNU/Linux and only call the kernel Linux. Since only 8% of Red Hat 7.1 (only 1.7% of Debian 3.1) is the Linux kernel, whereas more than 1/4 is GNU*, this was not an unreasonable request, but most "open source" adherents rejected this request. Even among Linux users who acknowledge that it would be more appropriate to call their system "GNU/Linux", many still refer to it as "Linux" out of habit. The only major distribution which calls itself "GNU/Linux" instead of "Linux" is Debian, but within the community Debian is widely regarded as the "universal operating system" and the guide post against which all other distributions are measured. Most of the popular new distributions, such as Knoppix, Ubuntu, and Mepis, have chosen to start with the codebase from Debian. Debian and its derivatives are bypassing Red Hat and its derivatives to become the most popular form of Linux.
* When I added together the biggest GNU packages from Red Hat 7.1, I got 25%, but it is probably a larger percentage if all packages were included. David A Wheeler, "More Than a Gigabuck: Estimating GNU/Linux's Size", last updated July 29, 2002, http://www.dwheeler.com/sloc/redhat71-v1/redhat71sloc.html; Juan-José Amor-Iglesia et al. "Measuring *Libre* Software Using Debian 3.1 (Sarge) as A Case Study: Preliminary Results", *Upgrade*, Vol. VI, No. 3, June 2005, http://www.upgrade-cepis.org/issues/2005/3/up6-3Amor.pdf

82 "November 2005 Web Server Survey," Netcraft, http://news.netcraft.com/archives/2005/11/07/november_2005_web_server_survey.html. David A. Wheeler provides a good overview of all numerical surveys and presents all the major arguments for using GNU/Linux. "Why Open Source Software/Free Software (OSS/FS, FLOSS, or FOSS)? Look at the Numbers!," revised Nov 14, 2005, http://www.dwheeler.com/oss_fs_why.html

83 40% is a very rough estimate based upon June 2001 data from Netcraft: 29.6% GNU/Linux + 6.1% BSD + 7.1% Solaris = 42.8%. Since 2001, GNU/Linux use has probably grown and Solaris use has probably shrunk. At the time of the survey, Solaris was proprietary, but I include it as free software because it is currently switching over despite the fact that many computers are still running proprietary flavors of Solaris. Unfortunately, Netcraft doesn't divide up BSD between its free software varieties (freeBSD, netBSD, openBSD) and it proprietary varieties (BSDI BSD/OS), but very

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few people use proprietary BSD, so most of the 6.1% is free software. "Netcraft Web Server Survey", Sept 2001, http://survey.netcraft.com/index-200109.html#computers

84 Mark Shuttleworth, the South African millionaire, is hardly your typical South African and his company's employees are as likely to be European as African. In many ways, de Icaza and Mena are transnational citizens as much as Mexican as shown by the ease which they enlisted the support of Red Hat in launching GNOME and attracted the cooperation of hackers all over the world. Mena eventually took a job in North Carolina at Red Hat. De Icaza created the startup company Helix Code in the US in 1999, which was renamed Ximian and eventually bought up by Novell in 2003. The fact that de Icaza lives in the US and is married to a Brazilian reveals the transcultural complexity of many free software practitioners. "Miguel de Icaza", accessed Feb 2, 2006, http://en.wikipedia.org/wiki/Miguel_de_Icaza

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> If de Icaza seems to have left behind open sources rebel personality, maybe its because he had a different revolution in mind all along. Having himself grown up in a country where most people cant afford computers, de Icaza has long championed the open-source movement as a means of bringing affordable computing to poor communities. Ive got a global goal, he says. I want to make Linux successful on the desktop for countries where people cant afford computers with proprietary software.

David H. Freedman, "Sellout or Savior? He's been accused of betraying the open-source dream, but Ximian cofounder Miguel de Icaza believes corporate partnerships are the best way to realize it." *Technology Review*, Sept 2004, http://www.technologyreview.com/InfoTech/wtr_13730,300,p1.html

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> 5. Lead in glass of cathode ray tubes, electronic components and fluorescent tubes.
> 6. Lead as an alloying element in steel containing up to 0,35 % lead by weight, aluminium containing up to 0,4 % lead by weight and as a copper alloy containing up to 4 % lead by weight.
> 7. - Lead in high melting temperature type solders (i.e. tin-lead solder alloys containing more than 85 % lead),
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All these scores should be taken with a grain of salt. Since DMIPS doesn't measure floating point operations which are vital in graphics and its results are so open to manipulation, many regard it as a meaningless measure. ARM wrote a paper showing that the DMIPS score on their processors could be tripled with compiler optimizations which ran most of code from cache. Nonetheless, DMIPS is the oldest and most widely used measure and it does give a rough idea of the evolution of processing power since the 1970s.

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200 After releasing version 1.0, Nvu has not released any new versions. Hopefully, Linspire will turn Nvu over to a broader community of developers since it hasn't done much to develop the program lately.