

Selected Pages for Property Managers And Building Owners

Property managers and building owners often ask me, “What can I do to lower my utility bill?” Here are the most relevant pages from my book, *Addicted to Energy* addressing this question. I have re-sequenced the pages, putting the suggestions that save the most money first. *Addicted to Energy* is written as policy manual for a fictional governor and President, so these selected pages are missing many transitions.

Almost every building in America can reduce its energy bill by 50% to 70%. Why not be a leader in your industry or town?

The full book is available at Amazon.com or on my website. You may copy *these* pages for your team members or post it on your website.

For more information, as well as downloads of the author’s PowerPoint presentations, please visit www.EltonSherwin.com

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What are Your Company's Top Energy Wasters?

What are the top energy wasters in your company? I talk to experts and visit businesses around the country. The amount of wasted energy is staggering.

Here are the most environmentally damaging things I see:

- Old, large-diameter fluorescent tubes and their fixtures
- Poorly calibrated HVAC equipment which needs re-commissioning
- Over-sized, over-aggressive air conditioners
- Lighting control systems either not installed at all, or installed without occupancy sensors, light-level sensors, and automatic dimmers
- PCs left on nights and weekends with power management systems disabled
- Inefficient manufacturing and transportation of products
- Incandescent and halogen bulbs—especially in restaurants and retail
- Water heated by burning oil or gas instead of using solar or waste heat
- Thermostats without occupancy sensors or twist timers³⁴⁷
- Fixed-speed pumps, fans, and motors with no back-pressure sensors
- Office equipment not ENERGY STAR rated
- Poorly maintained cooling towers
- Windows with R-values below 8
- Sunny windows that are not spectrally selective
- HVAC systems with fixed-speed fans
- Rooms without individual thermostats and occupancy sensors
- Under-insulated walls, ceilings, and floors
- Vending machines
- Air compressors in factories, auto-shops, and gas stations
- Refrigeration equipment and refrigerated display cases
- Agricultural pumps and wells
- Restaurant kitchen exhaust hoods and factory exhaust fans
- No thermal storage on air conditioners
- Windows or doors left open while the heating or cooling system is running
- Smoke and soot from fires and diesel trucks
- Refrigerants leaking or released into the air³⁴⁸

The Low-Hanging Fruit

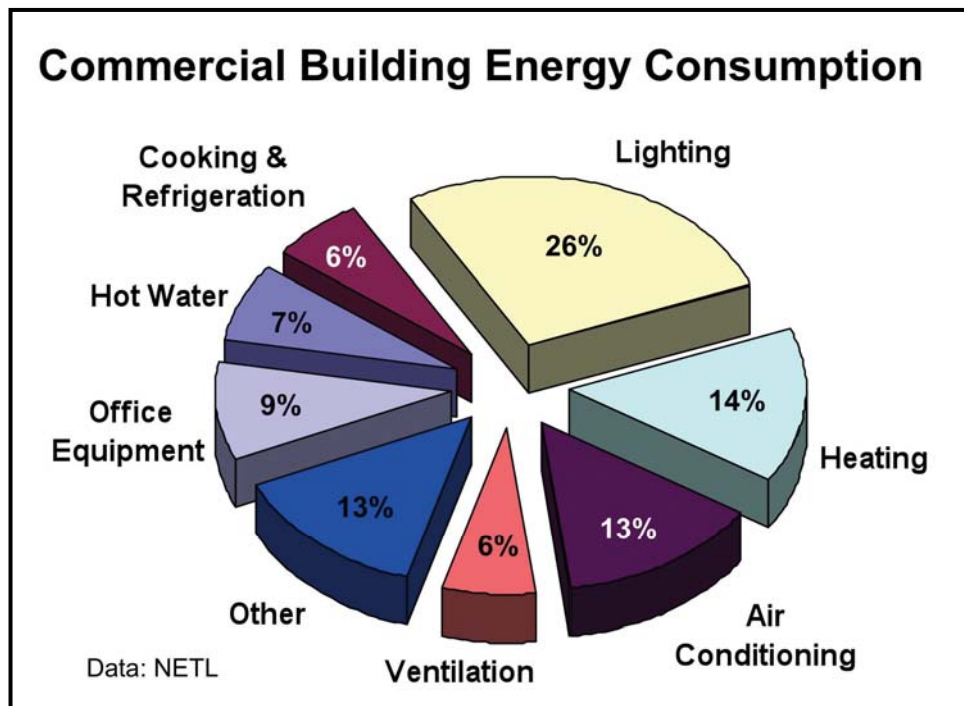


This section on low-hanging fruit has an *Alice in Wonderland* feeling to it. Each time I read it, I think, “This cannot be true, this must be from some other time and place. This is unbelievable.”

Surely these products cannot be this wasteful. But alas, they are.

Surely if these products were this easy to replace, they would already be gone. But they are not; they sit in our homes, offices, and factories, wasting our money and destroying the environment.

Now is the time to replace them.



5. Upgrade the Lights in All Commercial Buildings

The best commercial lighting systems reduce energy consumption by 70%.

Old fluorescent tubes and their fixtures are surprisingly inefficient. The best fixtures today use small diameter fluorescent tubes and consume half as much electricity. Energy consumption drops even further when you add occupancy sensors, automatic dimmers, and daylight sensors.

The best commercial lighting systems available today:

- Use LEDs or **small diameter** tubes (T8 or T5)
- Automatically **dim** when a room is **empty**
- Automatically **dim** when **sunlight** is present
- Create a more **pleasant** work environment with less glare
- Have **no flicker** and no hum
- Provide a **web user interface** for each room
- Control each individual fixture so that light can be **turned off above a screen** and in front of sunny windows.

Smart lighting systems on the market today enable workers in cubicles to control their work environment while dramatically reducing energy consumption.³⁵

A Simple Suggestion

You could create a complex law which specifies smart lighting systems and details all the network protocols they should use. But just requiring three things will give you most of the benefit:

1. LEDs or small diameter fluorescent tubes (T5 or T8)
2. Dimmable ceiling fixtures
3. Occupancy and daylight sensors

New commercial lighting fixtures pay for themselves in less than two years. They will reduce your state's carbon footprint for decades.

**Over the next 10 years,
replace every commercial light fixture in your state.**

7. Replace a Million Motors or More

Electric motors consume half the electricity in America.

U.S. Department of Energy³⁹

It is not just pool pumps that are grossly inefficient. Electric motors consume half of the electricity in America, and much of this is wasted.

How can motors be so wasteful? Imagine a world where car stereos had no volume controls. If the radio were too loud, you would just put a pillow in front of the speakers. This sounds absurd, yet most motors in America are installed this way, stuck on high speed and wasting about half the electricity they consume.⁴⁰

This implies that one-quarter of all the electricity in America is wasted because motors are installed without speed controls. As unbelievable as this seems, this is likely the case.

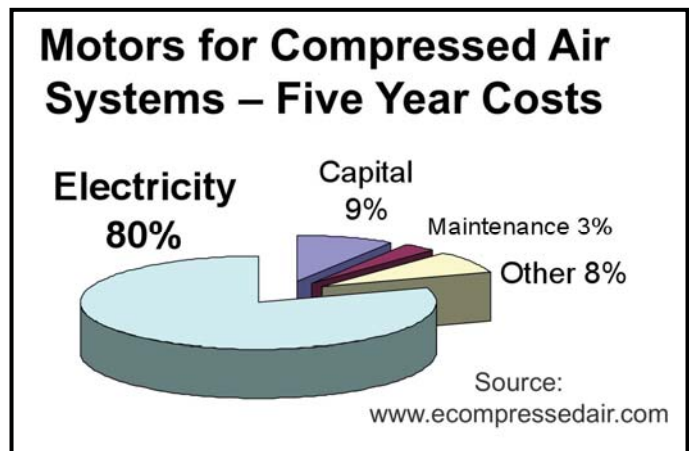
Grundfos, one of the world's largest pump manufacturers, estimates there are 120 million small, single-speed recirculation pump motors in Europe. If these motors were replaced, it would save a staggering 44 terawatt hours of electricity and 17.6 million tons of CO₂ per year.⁴¹

There are millions of identical fixed-speed recirculation pumps installed in American homes. Millions more somewhat larger, fixed-speed pump motors are installed in American businesses. **Recirculation pumps often use four times more electricity than needed.** Air compressors, irrigation systems, building fans, and industrial motors all have similar opportunities for dramatic savings. And collectively they use 50% of the electricity in America, much of which is wasted.⁴²

In some states you could reduce power consumption by 25% just by replacing inefficient motors. It is time to hunt down and replace these energy hogs.

Every state has a slightly different mix of motors, but universally they are inefficient and fixed-speed, like stereos with no volume controls. Efficient, variable-speed motors with smart controllers pay for themselves and will reduce your state's demand for electricity.⁴³

Motors waste 25% of the electricity in some states.



It is time to hunt down and replace these energy hogs.

Some electric motors are so inefficient they are like cars that consume \$1 million of gasoline.

There are several startups working on innovative motors. A friend of mine, Emily Liggett, heads up NovaTorque, a Silicon Valley startup with an ultra-efficient, lightweight, variable-speed motor.

Another motor start-up is QM Power. Each year the National Renewable Energy Laboratory, NREL, hosts a conference showcasing some of America's most remarkable start-ups. At the 2008 conference, QM Power presented their high-efficiency motor. In August of 2009, I called to see how their testing was going. During the course of the conversation, they mentioned that for some industrial motors, 98% of their lifetime cost is the electric power they consume. The motor itself is a relatively inconsequential 2% of total lifetime costs.⁴⁴

This would be like a \$20,000 car consuming a million dollars in gasoline. In comparison, a typical car might consume \$10,000 to \$20,000 of gasoline over its useful life.⁴⁵

If cars consumed a million dollars in gasoline, vehicle efficiency would be everyone's number one criterion when buying a car. You might, therefore, expect owners of electricity-guzzling motors to be concerned about their efficiency. But alas, it is not so. Most electric motors in America are inefficient, and most owners of electric motors are oblivious to the opportunities for improvement. You must change this.

Over the life of a motor, electricity sometimes costs 20 to 50 times more than the motor itself.⁴⁶

All new electric motors should be:

- Variable speed.
- 90% efficient across a broad range of speeds.⁴⁷
- Installed with adaptive speed controls that use temperature or pressure to optimize speed.

Most in need of replacement are:⁴⁸

- Motors using more than 250 watts of power: pump motors, compressors, air conditioners, blowers, large fans, refrigerators, display cases, and industrial motors.
- Motors using 50 to 250 watts that are on more than 12 hours a day, mostly small pumps and fans.

Have your staff develop a program to replace most of your state's electric motors. Set a 10-year timetable: **Get all these energy hogs off your state's grid.**⁴⁹



NovaTorque high-efficiency motor

8. Put Window Film on 10 Million Windows

Spectrally selective window coatings can block 70% of the sun's heat and reduce A/C bills by 40%.

Summary of U.S. Department of Energy research⁵⁰

Windows Too Hot to Touch

In October of 2008, I attended the country's largest solar energy trade show in San Diego. I stayed at the waterfront Marriott adjacent to the convention center. Thursday morning the sun rose to a beautiful, cloud-free, blue sky so bright I had to close the drapes to use my laptop.

Opening the drapes to take one last look at the San Diego harbor before going to the airport, I leaned forward, put my hand on the glass, and burned my fingertips. Startled, I jumped back.

Then I did what any young boy would do: I put my other hand on the window. More cautious this time, I used my palm, which is less sensitive to pain. The window was so hot, heated by the morning sun, that it burned the palm of my hand. The interior surface of the double pane window was so hot I could not touch it.

Four large windows, too hot to touch, radiated heat into my hotel room. Behind me, the air conditioning blasted cold air, but failed in a race with the sun, as the room's temperature rose quickly.

Looking out at San Diego's waterfront, dozens of similar glass towers stood tall, each absorbing the sun's radiation.

I tried to estimate how many windows in San Diego were radiating heat inward, providing gainful employment for their air conditioners. Fearing I would miss my flight back to San Jose, I gave up counting. But there were thousands of windows baking in the sun that morning. Perhaps tens of thousands, each with an air conditioner struggling on the other side.

Outside, It Was Only 75 Degrees

It was *not* hot that October day in America. Yet in Los Angeles, Phoenix, Dallas, Houston, Miami, Las Vegas, and Sacramento, air conditioners were using electricity to remove heat trapped in buildings by their windows.

How many 650-megawatt coal-fired power plants were consumed, I wondered, producing electricity to remove the sun's energy from these buildings? What a wasteful and environmentally destructive use of our nation's wealth.

Heretofore, this topic had depressed me, but I was now energized by the problem. Previously, I had assumed that once an architect had built a glass tower with

windows exposed to the sun, the glass tower would need massive amounts of air conditioning forever, remedied only by a wrecking ball.

Incorrectly, I assumed it was the sun's visible light that was causing the problem. It certainly was not hot air, because I had seen this situation many times in Palo Alto on cool, even cold, days.

A chance meeting enabled me to understand how to affordably fix this widespread "sun on glass" problem endemic to the modern skyscraper.

Earlier in 2008, I had been wandering through the *Going Green* exposition in San Jose, an exhibit hall full of products for green builders, when a surprising sight caught my eye. A heat lamp, one of those 250-watt reddish bulbs once popular in bathroom ceilings, was heating a piece of glass from 6 inches away.

A thin, almost invisible film on the glass completely blocked the heat.

Three times I returned to the booth to test this newfound "miracle film" and peppered the exhibitor with more questions.

I had built one house, remodeled the windows in another, read widely on the topic, attended lectures on green building practices, and never heard of "spectrally selective window coatings."

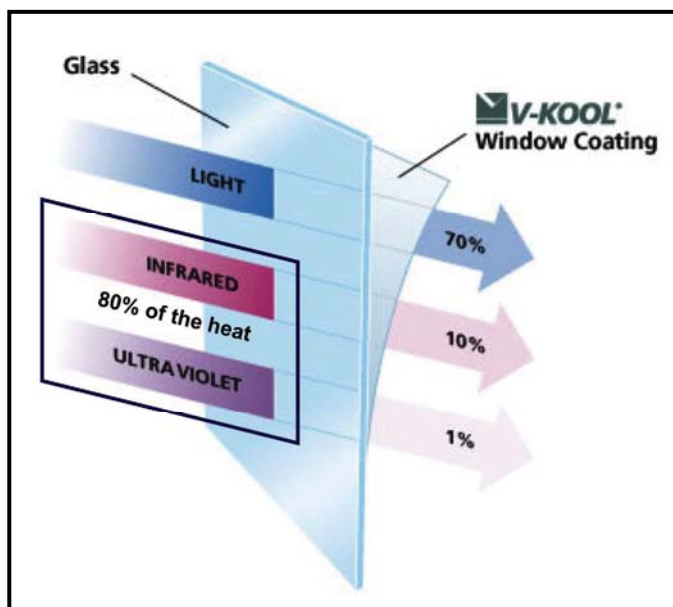
Spectrally selective window coatings can fix the "sun on glass" problem that destroys the efficiency of so many tall buildings.

What Is a Spectrally Selective Coating?

Only 20% of the sun's energy is carried in the visible light. Eighty percent of the sun's energy is invisible, carried in the infrared and ultraviolet spectrums.

Spectrally selective coatings let the light in while blocking everything else. These coatings have layers of nanoparticles blocking the heat but letting in the light.

The best coatings are spectrally **reflective**, stopping 90% of the sun's invisible energy, reflecting much of it away from the building, while blocking less than a third of the visible light.



Spectrally selective windows and films can be clear; actually, they have a slight gray tint only noticeable when held next to a completely clear piece of glass, but appearing clear to most observers.

Spectrally reflective coatings may redeem the modern skyscraper, those glass towers that have become so popular around the world, glass towers that require enormous air conditioners. Spectrally reflective coatings can be mixed with darker colors and mirrored finishes, and block almost all the sun's heat, keeping these glass buildings cool and lowering their power consumption.

The best coatings are spectrally reflective, stopping 90% of the sun's invisible energy.

Window Films Can Rescue Existing Buildings

Many building owners can add spectrally reflective films to their existing windows and dramatically reduce their air-conditioning bills. Stanford University retrofitted Encina Hall, installing a spectrally selective window film on the existing windows. Air-conditioning demand fell by 50%.⁵¹

One vendor claims \$1.50 savings per year per square foot of window. Many large buildings have more than 10,000 square feet of windows exposed to the sun. The \$1.50-savings-per-year-per-square-foot calculation was done in New Orleans.⁵² Many parts of the country pay more for electricity or have more sunny days than New Orleans, so presumably their savings would be greater.

Window films are a hugely important weapon in the war on climate change. They pay for themselves quickly through reduced energy bills and can dramatically reduce the carbon footprint of many cities and states. They are a very cost-efficient method of reducing greenhouse gas emissions. They also reduce peak power demand on hot days, helping stabilize the grid and lowering the need for new power plants.

Most New Windows and Window Films Are Still Not Spectrally Selective

Spectrally efficient windows and window films are unfortunately the exception. Today, most new windows are not the optimal window for the job at hand.

Make sure your state does not waste time and money installing mediocre products. Have one of your universities or state labs develop strict standards. The best films can block over 70% of the sun's invisible energy, while blocking less than 30% of the visible light.⁵³ All new windows should do at least this well.

Develop a program to identify the buildings that need help; your utilities can tell you where they are because they use the most power on sunny days. Once found, ensure their windows are filmed or replaced with first-rate products.

Window films can pay for themselves quickly and can dramatically reduce the carbon footprint of many cities and states.

There are Problems with America's Appliances.

Some HDTVs used over \$150 a year in electricity

104 HDTVs measured in CNET's Lab²⁴⁷

CNET found one TV that used \$174 a year in electricity. If I plugged this HDTV in at my home in Silicon Valley, where I pay over 40¢ a kilowatt for electricity, this plasma TV would cost me over \$500 a year. This is \$5,000 in 10 years, more than the cost of the TV.

None of these TVs is manufactured in America. Some will quietly cost their owners more to power them than they cost to buy. It is unconscionable that we allow them to be imported into America.

If the recommendations on the following pages seem harsh, think of the low-income worker who, after saving up to buy an HDTV, brings it home to discover it costs him hundreds of dollars a year to power.

Power Consumption Compared	Watts
Average Plasma TV	338
Average LCD TV	176
PlayStation 3	197
Xbox 360	185
Average PC	118
Nintendo Wii	19

Source: CNET²⁴⁸

America needs to *mandate* efficiency standards. Here are some of the facts that convinced me:

- “The average HD set top box with a built-in DVR consumes over 350 kWh per year.”²⁴⁹
- “. . . A typical microwave oven consumes more electricity powering its digital clock than it does heating food.” *The Economist*²⁵⁰
- In 2005, less than 40% of the refrigerators sold in America were ENERGY STAR compliant. Nexus Market Research for the State of Massachusetts²⁵¹
- *Half the electricity in a PC is wasted.* Summary of Google Analysis by ZDNet²⁵²
- Fifteen compact refrigerators tested by Consumer Reports “guzzle almost as much electricity as a full-sized model yet hold only 10 to 25 percent as much.” *Consumer Reports*²⁵³

According to the U.S. Environmental Protection Agency and U.S. Department of Energy, “The typical household spends more than \$2,000 a year on energy bills. With ENERGY STAR, you can save over one-third or about \$700.”²⁵⁴

Yet few homes have all ENERGY STAR appliances. It is time beef up the program.

How Do I Find the Energy Hogs in My House?

“The most energy-intensive segment of the food chain is the kitchen.

Much more energy is used to refrigerate and prepare food in the home than is used to produce it in the first place.

The big energy user in the food system is the kitchen refrigerator, not the farm tractor.”

Lester R. Brown,
Earth Policy Institute³⁴²

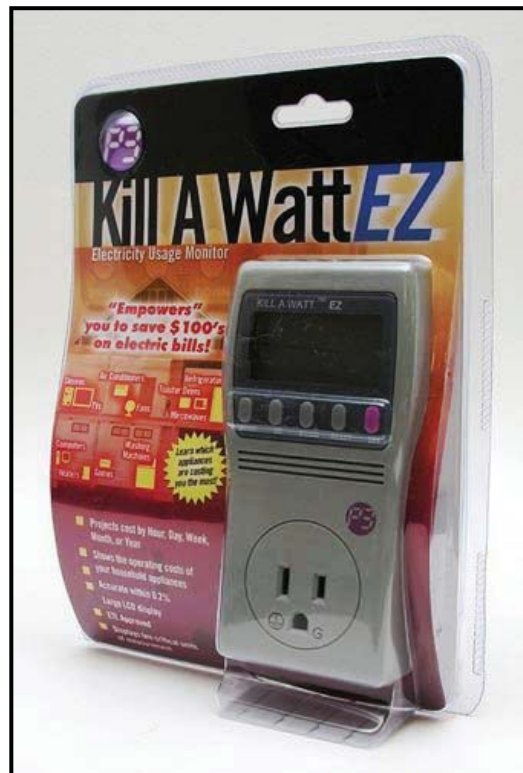
How much electricity does your TV use? Your second refrigerator?

I used several products to find my energy hogs—two proved most useful:

- The Black and Decker Power Monitor pictured on page 67 and described in *footnote 78*.
- The Kill A Watt EZ meter pictured here. I bought it online and used it to discover how much electricity my PCs and TVs were using, anything with an accessible plug.³⁴³

Ace Hardware has a product similar to the Kill A Watt called an Am/Watt Appliance Load Tester. It looks like a blue egg with an electric cord. Manufactured by Reliance, it has also received good reviews.

The results of the Sherwin family energy audit are posted at www.EltonSherwin.com in a PowerPoint presentation.



9. Find and Replace Your State's Villains of Inefficiency

Every state's situation is a bit different. Every state has a different mix on energy hogs and most are on this list. The first three steal energy in every state.

What are the *most wasteful* appliances and products in your state?

- Incandescent and halogen bulbs
- Old, large-diameter fluorescent tubes and their fixtures
- Lighting control systems missing or installed without motion detectors, light-level sensors, and automatic dimmers
- Office building windows that are not spectrally selective
- Poorly insulated windows with low R-values
- Poorly insulated walls, ceilings and floors
- Old refrigerators
- Domestic water heaters
- Pool and spa pumps
- Thermostats without motion detectors or twist timers⁵⁴
- Residential HVAC systems with only one thermostat per floor
- Fixed-speed residential furnaces
- Fixed-speed air conditioners
- Idle PCs and servers
- Cable and satellite set-top boxes
- Refrigerated display cases in stores
- Vending machines
- Restaurant kitchen exhaust hoods
- Air compressors in gas stations, auto dealerships, and factories
- Agricultural and well pumps

Identify your state's most wasteful products. Then replace them all. Not 1%, not 10%, not 50%; replace over 90% of your worst performers.

**Replace them. They steal your state's wealth and its jobs,
and they damage the climate.**

10. Insulate Everything

**The colder your winters,
the hotter your summers,
the more you need to insulate
your state's older buildings.**

In your state, the buildings most in need of insulation are usually the buildings with the highest utility bills per square foot. You can have your fire departments drive around with their infrared cameras, or just ask your local utilities for a list of the most energy-intense buildings, the ones with the largest heating and cooling bills per square foot.

Simple as it sounds, few states have found a way to effectively add insulation to these buildings. While insulation is cheap, motivating people to install it has proven very hard.

Insulation is the low-hanging fruit no one can reach.

Because bags of insulation are inexpensive, everyone assumes it is “low-hanging fruit.” However, effective programs have proven illusive. As Professor Jim Sweeney, adviser to Governor Schwarzenegger and director of Stanford's Precourt Institute for Energy Efficiency, says, “They are the 20-dollar bills glued to the floor.”

Your advisers may have a better idea, but I think it will take a combination of aggressive actions to get the majority of your older buildings insulated, including:

- Putting report cards and rankings in utility bills.
- Mandating building audits.
- Disclosing utility bills when buildings are sold or leased.
- Posting the “energy grades” of commercial buildings.

All of these are described in the upcoming sections on *Utility Fundamentals* and *The Power of Information*. Using Jim Sweeney's language, these sections describe how to pry those 20-dollar bills off the ground.

So while several of the upcoming recommendations sound tough, gentler approaches have failed to achieve high levels of participation.

**While insulation is cheap, motivating people to
install it has proven very hard.**

II. “Green Up” Your State’s Hotels, Restaurants, and Hospitals

Become the state with the greenest hotels.

Green Hotels

Recently, I walked into a hotel room so cold from air conditioning that water was condensing on the window. The thermostat was the same type installed in my parents’ house circa 1960. I then went down to the hotel’s business center and it was an oven.

In the last decade, I have stayed in countless hotels around the country. Less than half use compact fluorescent light bulbs. Only a few have sophisticated thermostats with motion detectors.

Hotels are among the easiest commercial buildings to inexpensively upgrade and save electricity. They are the low-hanging fruit because:

- Every room already has a separate thermostat, which can easily be upgraded.
- They use many lamps with lampshades, which work well with CFLs.
- Most rooms are very similar, which simplifies planning and testing.
- They use lots of hot water, which can be preheated with solar panels or waste heat.

Audit every hotel in your state. Call this your *Green Hotels Initiative*. Give awards to the best performers, and post them on your web site. You can rank them based on their energy consumption per thousand square feet and their CO₂ emissions per occupied room night.

Upgrade your state’s hotels and they will become more profitable. Your state will lower its CO₂ footprint and waste less money on coal and natural gas.

Green Restaurants

Restaurants are among the most energy-intense buildings in America. Per square foot, they have large utility bills and large carbon footprints.⁵⁵

Restaurant chains using the same building design across your state are an opportunity to carefully find upgrades for one structure and then replicate promising results across many identical energy-intense buildings.

**Give awards to
the best
performing
hotels and
restaurants.**

Upgrade your restaurant chains. Most fast-food restaurants should:

- Install spectrally reflective windows with an R-value of 10 or above.
- Install thermal storage on their air conditioners, probably an Ice Bear unit from Ice Energy (more about this on page 78).
- In the Southwest and West, install a Coolerado unit (www.coolerado.com).
- Install a variable-speed blower on the HVAC system.
- Add dimmable lights with daylight sensors.
- Upgrade the kitchen ventilation.
- Add a heat exchanger to the air handler in cold climates.
- Paint the roof white or silver.

With a bit of research and encouragement, your state's restaurants can be more profitable, more comfortable, and less damaging to the environment.

Green Hospitals

American hospitals are also among the most energy-intense buildings on the planet. Pick two or three hospitals in your state and fund a small team to audit and upgrade them. Then take the lessons learned and roll them out to all the hospitals in your state.

I predict that your state's hospitals can cut their electricity consumption by one-third just by making three changes:

- Replacing the old, large-diameter fluorescent tubes with newer, efficient, small-diameter fluorescent tubes.
- Installing state-of-the-art lighting control systems.
- Upgrading and optimizing their HVAC control systems.

Your audit team will probably find other opportunities to lower hospital utility bills. Lowering the energy intensity of hospitals not only saves money and helps the environment, but also increases the robustness of your emergency response during a major disaster.

**American hospitals
are some of the
most energy-intense
buildings on the
planet.**

**Hospitals that sip power
are much easier to keep open during a disaster.**

14. Give Everyone a Utility Bill

“Residents, when paying for their own electricity via submetering, use between 15 and 30 percent less electricity.”

Habitat Magazine, using data from the
New York State Energy Research and Development Authority⁷³

Many apartments and office buildings do not have individual water, gas, and electric meters. Landlords and condo associations apportion utility bills to tenants or include them in full-service leases.

Not surprisingly, a small percentage of renters use a disproportional amount of water and power. Not accountable for their usage, they leave their lights on while at work and their heaters on while on vacation. When submeters are installed, their behavior quickly changes.

Install Submeters and Consumption Will Go Down

When a building installs submeters and everyone gets a bill, overall consumption of both water and power drops by 15% to 30%.⁷⁴

A similar situation exists in large corporations, government agencies, and universities. Most receive one large, consolidated utility bill, paying it centrally and hiding consumption from department heads. If individual departments paid for their actual utility usage, consumption would drop.

Every renter, condo owner, and office manager in your state should get a utility bill. Start with electric bills, and then add water and natural gas bills. Eventually you should require submetering of heating and cooling.

Submeters can be added to any building and quickly pay for themselves. Devices are available to retrofit older buildings, measuring water, electricity, and natural gas usage and enabling separate bills for each apartment, office, and condo.⁷⁵

**Renters,
condo owners,
and office
managers should
get their own
utility bills.**

Eliminate Full Service Leases

Ban full-service leases. Require that all businesses, renters, and condominium owners pay their *actual* utility bills. Put submeters in every apartment and in every office. You will see a significant drop in your state’s energy consumption.

When the actual user of electricity, water, or natural gas pays his or her own bill, consumption drops. Conversely, when someone else pays the utility bill, consumption is higher.

16. Put Utility Monitors *Inside* Every Home and Business

**“Savings are typically of the order of 10%
for relatively simple displays.”**

Sarah Darby, Environmental Change Institute,
University of Oxford⁷⁷

In December of 2006, I got my first-ever electric bill over \$500.

Shortly thereafter, I read a story about the Blue Line PowerCost™ Monitor.⁷⁸ It promised to reduce my electric bill. I ordered one.

The monitor came with two components: a transmitter to clamp onto my electric meter, reading the spinning wheel as it rotated, transmitting our family’s usage to a monitor, its second component, which I placed on the kitchen counter. Its elegant screen continuously displayed how much electricity my family was using, the image of a small wheel rotating more rapidly as usage increased.

I installed the unit on a Wednesday afternoon in about an hour, twice the 30 minutes advertised.

The Power of Instant Feedback

Thursday morning at 10:10 a.m.—the time being significant, forever burned in my memory—my wife called, her voice half an octave higher than normal: “It says we are spending over \$1,000.” Confused, I thought we might have gotten an extraordinary cell phone bill. She continued, “The vacuum cleaner is off, all the lights are off, nothing is on.”

The new electricity monitor was working and, to my surprise, my wife had looked at it.

What could be using so much electricity at 10 in the morning? Within 24 hours of installing the Blue Line PowerCost™ Monitor, my wife had discovered that our *new* pool pump, timed to start each morning at 10 a.m., was using over \$100 a month of electricity. Luckily, it was not on 24 hours a day or I would have gotten a \$1,000 electric bill.



Monitors Help Find Energy Hogs

After some Internet research, we installed a variable-speed pool pump that uses 70% less electricity.

My family is not unique; these real-time displays have had a significant impact on electricity consumption. Studies of large populations show that real-time displays inside homes reduce electric consumption by 5% to 15%.⁷⁹ People use less when they see how much power they are using. In addition, sometimes they find a hidden energy hog, like my pool pump.



Tendril Monitor

If your state is installing smart meters without real-time, in-home displays, STOP.

The monitor and display together now cost \$99 retail. In quantities of one million, you should be able to buy similar units for under \$75.

The most effective systems provide a small, cute display for the kitchen. It is a real motivator, as my wife and I experienced, enabling homeowners and businesses to see their usage in real time and find their energy hogs.

Your state's smart meters should come with in-home displays. Unfortunately, most smart meters in America are installed WITHOUT any in-home display. This does not work. Providing web feedback alone is less effective.⁸⁰

Smart Meters Need In-home Displays

If your state is installing smart meters without real-time, in-home displays, STOP. All smart meters should have displays that give feedback to a building's occupants. Long term, your state needs one inexpensive display that provides feedback on water, natural gas, and electricity. These next-generation displays will communicate with smart meters and monitor the power usage of large appliances.

In-home displays combined with web-based tools, like those being developed by Google and Microsoft, can significantly reduce your state's electricity consumption. These units are simple to install. Many homeowners can install them; it took me about an hour. Alternatively, you can have your state's utilities install them. A professional installer can install one in under 10 minutes, often without turning off a home's power and without needing to enter the house.

Install real-time monitors and displays in your state. Start with the least efficient homes and businesses.⁸¹

You need both in-home displays and web tools.

Require Variable-Speed HVAC Systems

“A 20% reduction in fan speed can reduce energy consumption by nearly 50%.”

U.S. Department of Energy²⁷⁹

Most residential heating and air-conditioning systems have two states, *High* and *Off*. Compounding this problem, most homes have one thermostat controlling the heat and air conditioning for an entire floor.

This is like having a TV with no volume control. More accurately, it is like having all the TVs in your house turn on and off together, at high volume.

Every TV and radio in America has a volume control; every heater and air conditioner should have one as well.

Heating or cooling just one room in most American homes requires homeowners to heat or cool every room. This is staggeringly wasteful.

Today’s A/C systems are like TVs with no volume controls.

Impact on the Elderly

Forcing retirees and others on fixed incomes to heat and air-condition their whole house or apartment is just wrong. It sometimes leads to tragic endings as the elderly, trying to stretch their incomes, turn off their heat or air conditioning.

Consuming almost half of the average utility bill, heating and cooling are the single largest users of energy in American homes. Improving efficiency here saves money, saves natural gas, and lowers greenhouse gas emissions.

Variable speed systems reduce energy consumption as much as 72%.²⁸⁰

Variable speed HVAC systems can reduce energy consumption by as much as 72%.²⁸¹

Mr. President, it is time to ban all one- and two-speed heating and air-conditioning systems. Require all residential and commercial HVAC systems—heaters, fans, and compressors—sold in America to be capable of running efficiently at one-quarter speed.

This will dramatically reduce building energy consumption and CO₂ emissions.²⁸²

Require all HVAC systems to be capable of running efficiently at one-fourth speed.

42. Replace every Furnace in Your State and Install a Thermostat in Every Room

On average, 45% of the energy used in an American home is used for heating and cooling.¹⁵⁵ Much of this energy is wasted. One story illustrates the problem:

Sevin Rosen's New Office

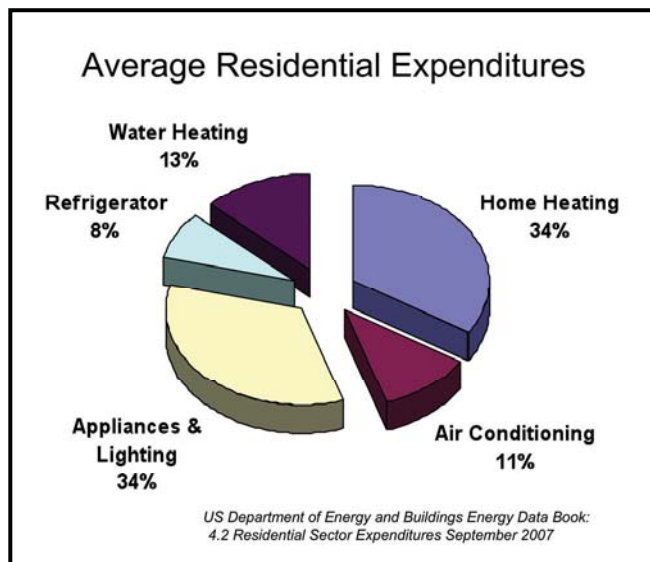
My firm has invested in two companies with Sevin Rosen, another well-known venture capital firm. Sevin Rosen recently downsized its offices and moved into a cute remodeled house in downtown Palo Alto across the street from Zibibbo's restaurant. It is a beautiful remodel. Venture capital firms, like high-end law firms, spare no expense when remodeling.

A strategic planning session for one of our joint investments was held in the new conference room. It was not a particularly warm day, but the large picture window in the former living room, now a conference room, caught the afternoon sun, warming the room. As it got warmer, I had trouble staying awake. The office manager brought in a dozen of the small Fiji water bottles, which I eyed longingly. Not a fan of bottled water, but needing a cold drink and hoping no one would notice, I eventually drank two.

Finally, the newly installed air conditioner kicked on. It sounded like a jet engine. The room got so cold, one of my colleagues got up and went to find a jacket. As the meeting progressed, the room alternated between too hot and too cold. I do not remember exactly what decisions we reached, but I do remember the little Fiji water bottles and the air conditioner on steroids.

Many restaurants struggle with this problem. Even on hot days, I always take a jacket with me, never knowing when I will encounter an aggressive restaurant air conditioner. Chili's in Menlo Park, before it closed, had such a strong air conditioner, customers got up during their meals and tried to close the vents or point them at other tables.

We have all experienced air conditioners that overshoot their targets and heating systems that overheat one room and freeze the adjacent room. This is expensive and wasteful. **On summer afternoons, air conditioners can consume half the electric power in some states and can make your state vulnerable to blackouts or brownouts.**



Another Thought Experiment: A World without Volume Controls

What if home stereo systems were installed like home heating systems?

Every room in the governor's mansion would have a speaker. Each floor would have only one on/off switch. There would be no volume controls. When the stereo was on, it would be on in every room, *full blast*.

There would be no way to listen to music in only one room.

There would be no way to listen to music softly.

Off or full blast would be the only choices. This is actually how the heating and cooling systems are installed in most homes, and many businesses. If you want to heat the master bathroom on a cool morning, you heat your whole house. If you want to cool one office on a sunny afternoon, you must air-condition every room, even the ones that are already cold.

An advanced industrial society in the 21st century can do better than this.

Every room in your state needs its own thermostat.

If the governor's mansion has four or five empty guest bedrooms, they do not need to be air-conditioned. If you don't use your formal dining room for breakfast, don't heat it in the morning.

A thermostat in every room saves a lot of energy, reducing some air-conditioning bills by over 50%.¹⁵⁷

Room-level controls require more expensive furnaces and air conditioners, ones that are variable speed. Analogous to volume controls on a stereo, variable-speed blowers and fans can put just the right volume of hot or cold air into a room. This also requires smart ductwork to route the heat or air conditioning to the correct rooms.

One company that specializes in such systems is Home Comfort Zones, www.homecomfortzones.com. I met them at the 2008 Cleantech conference in San Francisco. They have a product called MyTemp™ for “room-by-room temperature control of your home.”

This combination of many thermostats and speed controls on heaters and air conditioners saves money and also creates a more pleasant environment. No longer are some rooms too hot, while others are too cold. Gone also are the wild temperature swings.

Room-by-room temperature controls with variable-speed HVAC systems save enormous amounts of energy. They should be the rule for all new residential and commercial construction.

All new furnaces should be variable output and variable speed.

Variable-speed systems can save 40% to 70% of heating and cooling costs.¹⁵⁶

32. Find the *Smartest* Thermostat for Your State

Programmable thermostats “achieved no significant savings over nonprogrammable thermostats.”

U.S. EPA¹²¹

The most wasteful “computer” in a typical home or business is the thermostat. Heating and cooling consume 45% of the energy used in homes. Much of this energy is wasted by primitive or poorly programmed thermostats.

Unfortunately, programmable thermostats in homes have delivered mixed results, sometimes *decreasing* energy consumption, but sometimes *increasing* it. After analyzing five field studies, the EPA concluded, “Programmable thermostat installation achieved no significant savings over nonprogrammable thermostats.”¹²²

Occupancy Sensors and Twist Timers Are Effective

However, churches that put twist timers¹²³ on thermostats report a dramatic decline in heating and cooling bills.

Hotels that put occupancy sensors on thermostats report a 25% to 40% decline in HVAC usage.¹²⁴

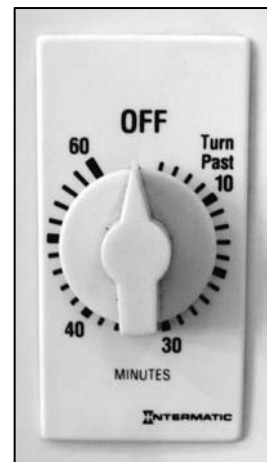
The problem with programmable thermostats is that they require programming. They are also dumb; they will heat or cool an empty house forever.

I recently bought three programmable thermostats; two are still in the original carton. I was so exhausted after installing the first one, I have never gotten around to installing the other two. They are a lot of work to program, and you never get it quite right. I do not want a thermostat that requires programming. I want a smart thermostat that can figure out what to do *without* programming.

I used to be a programmer and I hate to program these things.

The opportunities for savings are too large to ignore this thermostat quagmire. Have one of your universities run a contest and see if anyone can develop a thermostat that actually saves homeowners money in your state.

If you need more TV exposure, you can model your search on *American Idol* and you can be a judge. But however you do it, find the very best thermostats. You are looking for “superstars” in several categories: 1) thermostats for existing homes, 2) thermostats for new homes, and 3) thermostats for commercial buildings. The winner in this search for stardom is the thermostat that delivers the lowest utility bill.



Superstar Thermostats

My company, Ridgewood Capital, was a pre-IPO investor in Comverge (NASDAQ: COMV), and one piece of their business is advanced thermostats. Since Comverge went public, I have met with several other companies building advanced thermostats. Every couple of years, I buy the most advanced thermostat I can find and try it out on my family.

I will make 12 controversial predictions. They are controversial for professionals in the HVAC business. You, like me, may think they are obvious, but in professional circles, I get pushback on these.

A smart thermostat should not require any programming.

The most *efficient* thermostats will have:

1. **No programming** requirements. They will just have an ↑ up arrow and a ↓ down arrow to change temperature. Smart thermostats will *learn* what you like.
2. **Half degree** increment adjustability.
3. **An occupancy sensor** to detect when a room is empty.
4. **An infrared sensor** to detect the temperature of the whole room.
5. **A light sensor** to detect when a room is dark.
6. **A humidity sensor** and perhaps even a CO₂ sensor.
7. **A radio receiver** for a remote thermometer to detect temperature and motion in another room.¹²⁵
8. **Internet connection** to get the weather forecast and various other pieces of useful data from the electric utility.
9. **PC connectivity** to send detailed usage data to building owners.
10. **A remote emergency off switch** to enable electric utilities to turn off air conditioners in a crisis.
11. **Twenty-four months of memory.** Long-term memory in thermostats is helpful for finding problems in home heating and air-conditioning systems.
12. **Superior comfort.** They will learn the rhythms of a house and have fewer temperature swings.

Smart thermostats should cut heating and cooling cost by more than 20%, with a similar reduction in CO₂ emissions. Homeowners will prefer these superstar thermostats because they will save money and deliver superior comfort.

Over time, these superstar thermostats should become quite clever, with the ability to discriminate between pets and people and, ultimately, between an empty room and an individual asleep on the sofa.

45% of residential energy is used to heat and cool homes.

U.S. Department of Energy and Buildings Energy Data Book¹²⁶

Require Commercial Air Conditioners to Run at Night

Credit Suisse moved its air-conditioning load from the day shift to the night shift on one building in New York.

This reduced CO₂ emissions by 3.6 million pounds per year.²⁴⁰

Every commercial air conditioner should have thermal storage units and be capable of running at night. Over 2,000 “nighttime air conditioners” have been installed in America and the evidence is very clear. They:

- **Emit less CO₂.**²⁴²
- **Avoid the need for new coal plants.**
- **Save money for building owners.**²⁴³
- **Use intermittent wind power.**²⁴⁴

Dozens of studies verify that these systems pay for themselves. Yet less than 1% of America’s six million commercial buildings have installed these thermal storage units that enable air conditioners to run at night.



Buildings with “Nighttime” Air Conditioners

General Electric Co.	Cincinnati
U.S. Court House	S. Boston
BP Plaza	Houston
Qualcomm	San Diego
Doubletree Hotel	San Diego
Army National Guard	Manassas
Heritage Museum Center	Cincinnati
Indiana State University	Terre Haute
Inter-Island Terminal	Honolulu
Children’s Hospital	Birmingham
Bellevue Place	Bellevue
The Trane Company	LaCrosse
First Interstate Bank	Milwaukee
Carolina Medical Center	Charlotte
Kaiser Hospital	San Diego
C.U.N.Y.	Brooklyn
American River College	Sacramento
Pasadena City College	Pasadena

Northern cities are in bold

Source: Calmac Manufacturing Corp²⁴¹

The world’s tallest building, **Taipei 101**, has an ice storage system installed from the **Baltimore Air Coil Company.**²⁴⁵

It is time to upgrade all six million *commercial* buildings in America.

Give building owners 10 years to convert, and then pull the plug on any air conditioners that do not have thermal storage.

It will save the building owners money, create jobs in America, and enable America to exploit its vast wind resources.

Ban All Incandescent Bulbs in Commercial Buildings

Lighting is the largest or second largest user of electricity in most commercial buildings

Summary of U.S. Department of Energy Data²⁹¹

In the summer of 2007, I walked into Draeger's, the local upscale supermarket, and discovered it had replaced hundreds of halogen spots with CFL spots. Impressed, I talked with the store manager and eventually with one of the owners, Richard Draeger.

Draeger's replaced over 1,000 incandescent spotlights. Expecting a three-month payback, Mr. Draeger told me it was closer to six weeks because their air-conditioning bill dropped. One thousand halogen bulbs throw off a lot of heat.

North Face has also replaced all the incandescent and halogen bulbs in its Palo Alto store, piloting a new lighting system for its chain of retail clothing stores.

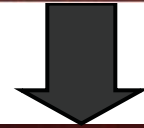
Unfortunately, Draeger's and North Face are still the exception.

I recently went shopping at the local mall. The ceiling of one large department store was covered with halogen spotlights. I started to count them and eventually gave up. Thousands of these hot, inefficient bulbs covered the ceiling in every direction. This well-known national chain has over 150 large stores.

Many of these halogen bulbs were identical to the bulbs Draeger's had replaced in 2007. As you recall, the replacement bulbs at Draeger's paid for themselves in less than three months.

For each dollar that Draeger's invested in CFL spotlights, its electricity bill had declined by \$4 a year. **This is equivalent to a bank paying 400% interest, guaranteed forever.**

Replacing the Halogen Spot



**One ceiling fixture
can use
\$2,000 to \$5,000
of electricity
over its useful life.**

Fifty-Year Electricity Costs for One Recessed Ceiling Light ²⁹⁵				
Hours per day				Cost of Electricity
12	8	6	4	
\$5,749	\$3,833	\$2,874	\$1,916	35¢
\$2,464	\$1,643	\$1,232	\$821	15¢
\$1,807	\$1,205	\$903	\$602	11¢
\$1,314	\$876	\$657	\$438	8¢

California has banned the installation of ceiling fixtures for halogen and incandescent bulbs. This ban applies to new fixtures and *only in kitchens and bathrooms*. Below you see three of the now *banned cans* in my kitchen, which was completed several years before the current law.

Last year I visited a new house, just on the market. The architect had followed the letter of the law, but still managed to install 122 recessed incandescent ceiling lights, mostly 75-watt halogens. Built in PG&E territory, this one home could easily spend \$250,000 to power these ceiling cans over the next 50 years. This assumes PG&E has no rate increases. These recessed ceiling cans are most commonly installed with incandescent and halogen spotlights that are about 5% efficient.

One home had 122 built-in ceiling cans designed for incandescent bulbs.



Ban the installation of fixtures designed for inefficient bulbs.

Ban the sale of wall-mounted and ceiling-mounted lighting fixtures that support inefficient bulbs. This would ban the installation of fixtures for:

- **Incandescent bulbs²⁹⁶**
- **Halogen bulbs**
- **MR16s and GU10s**
- **T12s**

Mr. President, ban them. There is no reason to install new fixtures with an insatiable thirst for electricity.

Demand Excellence from PCs and Servers

A Canadian study of one building found 306 PC monitors left on. “Their users were away from their desks or had left the building.”³⁰³

One Canadian government study of 307 *unused* PCs reported:

- 147 PCs were on, “blazing away.”
- 140 PCs were on and running screen savers, which use as much electricity—sometimes more—as PCs without screen savers.
- Six were running in vacant offices “whose occupants had left weeks before.”

Less than 1% of the Canadian PCs Were Installed Correctly

Of the 307 PCs in the building, *only one* had its power management software set correctly to power down its monitor.³⁰⁴ The report continues, “Only a few of the computers were older models that were not capable of software power-down. In all but one of the others the ENERGY STAR software had either been disabled or had never been installed.”³⁰⁵

The report’s conclusion: “It appears preferable to take the energy-saving function off the software desktop and plug in a hardware gadget on the physical desktop where it saves energy without requiring constant efforts to keep it operational.”

This is not a Canadian problem. This could have been any office building in North America.

Although more than 90% of the desktop computers sold in the United States are ENERGY STAR compliant, the U.S. Department of Energy reports, “ENERGY STAR depends on users enabling the sleep mode to generate energy savings. Yet recent research by Lawrence Berkeley National Laboratory, Ecos Consulting, and others consistently finds that the sleep mode is disabled on most networked office computers.”³⁰⁷

Reduce Idle Power By 90%

This is an embarrassment to the technology industry. It must be a national priority to reduce electricity squandered by PCs. The objective should be to reduce the electricity consumed by PCs *in idle* by at least 90%, reducing idle power consumption from over 100 watts to less than 10 watts and still *return to action* in less than two seconds.

One blogger reported, “I hooked up my Watt meter to my PC’s power cord and put the computer in sleep mode. Eighty-four watts was still being used. . . .”³⁰⁸ When I

Sleep mode is disabled on most office computers.

U.S. DOE³⁰⁶

first read this blog, I assumed the PC was not really in “sleep mode.” But, it turns out, there are multiple sleep modes, and it is easy to have a PC that uses quite a lot of power, even when “sleeping.”

Why Are PCs So Wasteful?

Multiple overlapping problems build on each other. Most PCs in America do not automatically go into sleep mode. Some PCs cannot wake up. Others, once awake, are unable to reconnect to their networks. The results: Frustrated PC users and IT professionals who turn off power-saving modes.

The root problem, the problem that will probably be the most difficult to fix, is that PCs waiting for work use almost as much power as PCs working hard. This must be fixed.

Raise the Bar for PCs and Servers

Mr. President, you should:

- Adopt a national objective to reduce idle power by 90%.
- Require all PCs and servers to track and report their *actual* power consumption to their owners (discussed earlier on page 171).
- The statistics on PC and server power consumption should be made public, identifying the manufacturer, model, and operating system, along with each model’s lifetime power costs.
- Independently test and label all PCs.
- Build monitors and keyboards with proximity sensors or motion detectors forcing PCs into a low-power mode when a room is empty.
- Ship desktop PCs with a smart power strip that automatically powers down speakers, scanners, and printers when the PC is idling, in standby, or off.

“The average server wastes 30 to 40 percent of its power.”

Dileep Bhandarkar,
Microsoft Distinguished Engineer³¹⁰

The brains of these computers and the software that runs them were designed in America. This is an embarrassment to our nation.

It is time to demand a new level of excellence from our PCs and servers.

The ENERGY STAR web site lists more than a dozen software products to help individuals and system administrators manage PC power.³¹¹

Google ‘PC energy management software energy star.’

Putting a PC in Standby Mode is “Black Magic”

“Setting up a PC to properly enter and return from low power states like standby . . . can be quite troublesome. . . . It’s often considered black magic, even by experienced PC technicians.”

Slick Solutions web site³¹²

Things that disable PC sleep modes

- Anti-virus software
- Network adapters
- Screen savers
- Program bugs
- User error
- Company policies
- Operating system errors
- Computer manufacturers

PC Power Modes

PC ACTIVITY	Sleep State		Windows XP/Vista state	Typical power consumed
100 percent CPU/graphics load	G0	Power on	Running	305W
3D screen saver	G0	Power on	Running	225W
Simple screen saver	G0	Power on	Running	195W
Idle; Windows desktop	G0	Power on	Running	195W
Monitor and hard drives powered down	G0	Power on	Blank screen	160W
Monitor and hard drives powered down, CPU halted, fans and other devices running	G1/S1	Power on suspend	Standby/Sleep	135W
Context saved in RAM, everything except RAM is off	G1/S3	Suspend to RAM	Standby/Sleep	10W
Context saved to disk system powered off	G1/S4	Suspend to disk	Hibernate	9W
System powered off	G1/S5	Soft-off	Shut Down	9W
System unplugged	G3	Mechanical off	Shut Down	0W

Table derived from *PC World* article “Reduce Your PC’s Power and Operating Costs” by Scott Mueller³¹³

Demand Excellence from Pumps and Motors

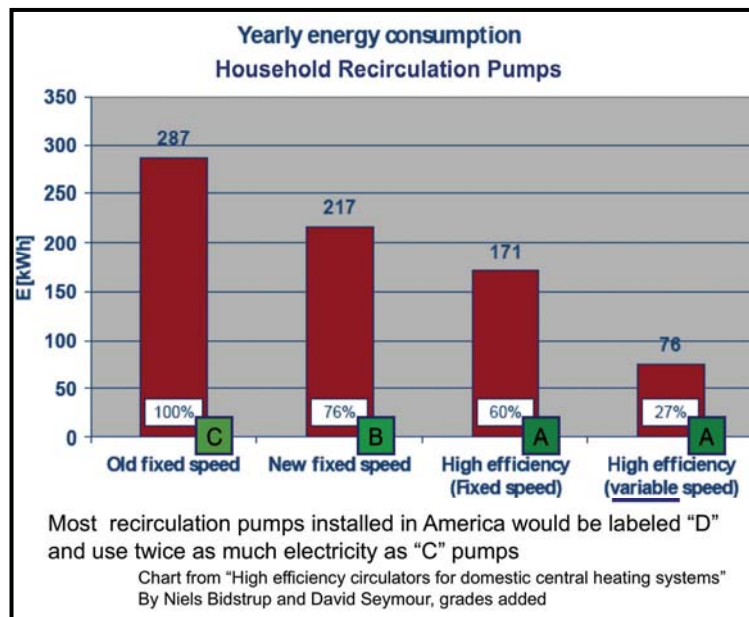
Many foreign pumps sold in America use three to eight times as much electricity as the best versions of the same pump, sold only in Europe.³¹⁴

Motors Are America's Largest Energy Waster

Motors—and the pumps they drive—consume about half of the electricity in America.³¹⁵ Most pumps and motors waste most of the electricity they consume. Inefficient, fixed-speed electric pumps and motors are probably the single largest wasters of electric power in America.

They consume many times their original purchase price in electricity.

In Europe, pumps are graded from A to F, with a few getting even lower grades. In my basement, I have a pump sold in Europe with a D rating, which seems to be the norm in America. My pump uses eight times more electricity than the A version, available in Europe, but not in America.



America can reduce total electricity consumption by an astonishing 20% if all motors and pumps were variable-speed, European "grade A" with smart controls.³¹⁶

All pumps and motors sold in America should be variable speed and installed with feedback sensors and smart controls.

America should never again install a single-speed motor. Single-speed cars are not legal. Single-speed motors, like the one-speed car, never make sense, ever.

All pumps and motors sold in America should be variable speed.

What Ails America's Buildings?

I predict your blue ribbon panel will discover the homes and buildings in your state with the **highest utility bills**, and the largest CO₂ footprints, share the following characteristics.

Fifteen Practices that Steal America's Wealth and American Jobs

1. **Insulation** is insufficient and poorly installed.
2. **Heating and air conditioning** system is too large.
3. **Ductwork** for the HVAC system is too narrow, leaks, or was poorly installed.
4. **Thermostats** or HVAC controls are the wrong model, poorly programmed, or one thermostat controls more than one room.
5. **The wrong windows** are installed.
6. **Exterior window shades** are missing on sunny windows.
7. **Fans, pumps, and compressors** are fixed speed.
8. **Outside fresh air** is poorly managed; heat exchangers are missing.
9. **Ovens, refrigerators** and refrigerated display cases are inefficient or vent hot air inside buildings when the air conditioning is running.
10. **Halogen and incandescent bulbs** are still used.
11. **No occupancy/daylight sensors** are installed *on lighting systems*.
12. **No occupancy sensors** are installed *on heating and air conditioning systems*.
13. **No real-time, energy-consumption feedback** given to building occupants.
14. **No knob for users** to turn *down* overactive heating and cooling systems.
15. **No switch for users** to turn *off* heating and cooling systems in individual rooms.

How Many of These Problems Do You Have?

These practices are almost universal in America. They export money and jobs out of your state. They are both environmentally destructive and wealth destroying.

A Simple Green Building Code for Commercial Property

You can slightly modify the residential building code on the prior page and get a commercial building code that dramatically reduces greenhouse gas emissions and utility bills.

The Top 10 Items Currently Absent From Commercial Building Codes

- 1) **Thermostat.** A separate thermostat with an occupancy sensor in every room and office controlling the room's heating and cooling.
- 2) **Furnace.** Variable-output, variable-speed, modulating furnaces and boilers with heat exchangers for outside air; variable-speed fans and pumps commissioned at installation.
- 3) **Air Conditioner.** Variable-speed, multistage, right-sized air conditioners with a minimum of 40% thermal storage, commissioned at installation.
- 4) **Water Heater.** Solar heat or waste heat from a furnace used to preheat hot water.
- 5) **Windows.** R-10 spectrally selective windows.
- 6) **Smart Lighting Systems.** Dimmable fluorescents and LEDs with occupancy and daylight sensors.
- 7) **Insulation.** Two R-values of insulation above California Title 24, with the building shell blow-tested and thermally imaged for leaks.
- 8) **Energy Monitoring.** Real-time reporting of all electricity, HVAC and water usage by room.
- 9) **Utility Bill Disclosure.** All buildings claiming to be "green" must disclose their energy consumption.
- 10) **Roof.** Reflective roofs, sometimes called cool roofs.³⁵¹

These are better buildings. They have lower utility bills, lower CO₂ footprints, and will be more comfortable. These ultra-efficient buildings will also protect your state and its businesses from future energy price increases.

All green buildings must disclose their utility bills.

Designing Extraordinary Buildings—A Checklist

I originally developed this checklist as an alternative to the LEED point system. It has 50 points. Great buildings should have *at least* 25 of these features. Sadly, some “green” buildings today have less than five.

The ultimate test of a building’s “greenness” is how much energy it uses, but this checklist can help you get there.

CO₂ footprint during construction

- All wood products are certified as sustainable.
- The CO₂ footprint of all building materials is calculated and reported.
- Uses low-carbon Sheetrock.
- Uses low-carbon cement.
- Less than 10% of building exterior is wood.³⁵²

Building comfort

- HVAC system monitors CO₂ levels at multiple locations on each floor and dynamically adjusts fresh air.
- HVAC system optimizes its performance based on humidity.
- There is a thermostat in every room.
- Building is designed to be habitable during a 24-hour power outage without AC compressors running. One point for each season of the year.
- Occupants can temporarily request more heat or AC in a room.
- Occupants can temporarily adjust blower speed in a room.
- Occupants can change direction of some airflow in offices (similar to an airplane seat).
- Occupants can control a window shade or equivalent in all rooms.
- Occupants can open a window or request more fresh air.
- Building has an open wireless network to receive feedback from tenants and visitors on building comfort, temperature, and problems. Feedback is collected and reported. Optimally, allows users to set some HVAC parameters (temperature, fan speed, and extended away times).

Tenant Feedback

- Building owner provides tenants with Web dashboard of the tenant’s energy consumption updated every fifteen minutes or more frequently.
- Building manager bills individual tenants for their actual electricity consumption and enables large tenants to bill at a department level.
- Building owner provides tenants with breakdown of electricity consumption by room.
- Building owner bills individual tenants for actual hot water consumption.
- Building owner bills individual tenants for actual HVAC consumption.
- Real-time building energy consumption is displayed in building lobby.
- Real-time tenant energy consumption is displayed on each floor (for example, an LCD display in elevator lobbies of each floor).

Monitor and report energy consumption by room.

HVAC

- Major HVAC system components monitor energy consumption (electricity, gas, and oil), report problems, and alert facility managers to unexpected levels of energy consumption.
- HVAC system monitors and reports energy usage by floor.
- HVAC system monitors and reports energy usage by room.
- Occupancy sensors reduce HVAC usage in empty rooms.
- Weather forecasts help HVAC system anticipate load.
- Building system reports percent of air-conditioning load sent to rooms remaining empty for the following hour and the percent of heating sent to rooms remaining empty for the following two hours.

Lighting

- Lighting system tracks and reports its energy consumption by room.
- Addressable, smart lighting system automatically reduces consumption when natural light is present or when people are absent.
- Building monitors and records light levels and daylight availability in all rooms.
- Building system reports percent of power used by lighting, percent of lighting used in empty rooms, power saved by motion detectors on lighting systems, power saved by lighting level (brightness) sensors, and percent of lighting provided by daylight.

Plug Load and Occupancy Reporting

- Building monitors and reports electricity usage of subpanels.
- Building tracks and monitors electricity usage of individual circuit breakers.
- Building tracks and reports electricity usage of individual plugs.
- Building can sense, track, and report total power and HVAC load consumed by each room and calculate percent of total building energy allocated to unoccupied rooms.

Demand Response

- Eighty percent of daytime HVAC system is controlled by a utility-demand response system.
- Seventy percent of lighting is controlled by a utility demand-response system.

Water

- Weather radio or sensor data adjusts 80% of landscaping irrigation and sprinklers.
- Water usage is monitored and tracked for landscaping and HVAC systems.
- Water usage is monitored and tracked for each room (restrooms, kitchen, etc.).
- Water usage is monitored and tracked at a fixture level (every shower, toilet, etc.).
- Hot water usage and energy consumption is monitored and tracked.
- Urinals average less than two cups of water per flush, toilets less than one gallon.
- Building owner bills individual tenants for their actual water usage.
- Building has a gray water system.
- Water usage data is available to tenants online.

"I couldn't put it down. It's smart, practical, and proves the point that what is good for the environment is good for the economy."

David Miller
Mayor of Toronto

"Simple solutions for governments, corporations, and individuals"

William F. Miller
Former Provost of Stanford University

"Sherwin lays out an action plan tackling the most economically and environmentally attractive options we have. You don't need to agree with everything he says to find enough good ideas to fill the agenda for any state, county, city, or family."

James Sweeney
Director, Precourt Energy Efficiency Center, Stanford University

*"A practical cookbook for consumers, industrialists and policy makers.
...Bravo!"*

Bill Keating
Executive Chairman, Skyline Solar

"A magnificent roadmap for creating jobs, wealth and real progress"

Nicholas Parker
Executive Chairman, Cleantech Group