Efficiency Pays

Small Changes Equal Big Savings

Bernd Geisler

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Even if you live in an ordinary suburban home like my family does, you can still take advantage of many opportunities to save energy and money. Over the last four years, I have monitored my family's energy consumption and the effectiveness of several measures we took to make our home more energy efficient. The energy efficiency measures complement our renewable energy (RE) systems—wind, photovoltaics, and solar hot water. (See *HP100*.)

Find Your Starting Point

Even though our house is only ten years old, it needed some efficiency improvements. I started with an inventory of small, energy-wise changes I could make that would reap the most benefits. No matter the age or condition of your house, starting with a list gives you a place to begin. From there, it's just a matter of fitting it into your budget. For about US$30, you can buy a kilowatt-hour meter to help you analyze your appliances' energy use. For larger electric loads, you can refer to the EnergyGuide labels that come with most large appliances.

Good Setbacks. Although you shouldn't have to sweat or freeze in your own home, you probably have a comfort zone. Keeping indoor temperatures near the borders of that zone can save lots of energy. The U.S. Department of Energy (DOE) estimates that setting your thermostat back 10°F to 15°F (5.5–8.3°C) for 8 hours can provide an annual savings of 5 to 15 percent on your heating bill. Each degree Fahrenheit (0.5°C) of setback over 8 hours can shave about 1 percent off your utility bill. A similar relationship holds for cooling loads.

A programmable thermostat (US$50 and up) allows you to adjust indoor temperatures to the lowest comfortable

Programmable thermostats offer hassle-free comfort.

Using a removable whole-house fan eliminated one month of air conditioning use in this Texas home.

level in winter and the highest comfortable level in summer without constantly fussing with the dial. Common models let you set several different programs to activate during different times of the day. This turns the furnace or air conditioner off automatically when the house is unoccupied, or dials the heat down or air conditioner up when you need it least, such as while you're sleeping.

Bundle Up. Sealing the leaks in your house is one of the cheapest and quickest energy upgrades. Professionals use blower door tests to diagnose a leaky house. These specially equipped units fit into a home's doorway. Powerful fans pressurize or depressurize the house slightly, and measure the airflow and the fan-induced pressure. The more airflow that is required to induce a pressure difference, the leakier your home is.

You can make a less accurate but quick assessment of leakage by lighting a candle and then watching the flame flicker as you move it next to door and window frames, or by burning incense and observing how the smoke moves. These methods work best in the wintertime when leaks expand as building materials contract. If you can see the flame flicker near the leak or feel a cold air stream, take action.

Caulking and weather-stripping the gaps in your home probably offer the best use of your bucks in terms of home energy improvements. It will also make your home feel warmer and eliminate or at least reduce drafts. Before you batten down the hatches, assess the air quality in your house and make sure your home's ventilation is adequate. Sealing up a house too tightly can trap indoor air pollutants, such as carbon dioxide, mold, and dust. A house should replace its air volume two or three times every hour.

Also consider adding insulation to your home's attic, walls, and floors, which will keep your home cooler in the summer and warmer in the winter, and reduce the run time of your cooling and heating equipment. The DOE recommends in most regions that, at a minimum, attics be insulated to R-49, walls to R-18, and floors to R-25.

Get a Cheaper Cool. Using fans can be exceptionally helpful in keeping your house cool during transitional seasons, since running a fan draws just a tiny fraction of the power required to run an air conditioner.

I found an ideal position for a fan in my house in the ceiling of the second floor, right under a circular attic air vent. Since the fan is positioned close to the highest point of the living space, it exhausts the hottest air straight through the attic, and draws cooler air from the rooms below. Before I installed the fan, on warm days that upper room was uncomfortable and pretty much useless because all the hot air in the house would accumulate there.

I bought an industrial-grade fan for US$40 (available at most home improvement stores) and fitted it with a little flap I made from Styrofoam insulation board. The flap opens by air pressure when the fan is switched on and closes when it is switched off. The whole setup cost less than US$50 and can be installed in about five minutes.

One of the two inefficient electric attic fans that were removed and replaced with ridge and soffit vents.

Our whole-house fan draws between 67 and 123 watts, depending on the chosen setting. Our 4-ton air conditioner pulls 4,000 watts—for that amount you could run about 33 small fans!

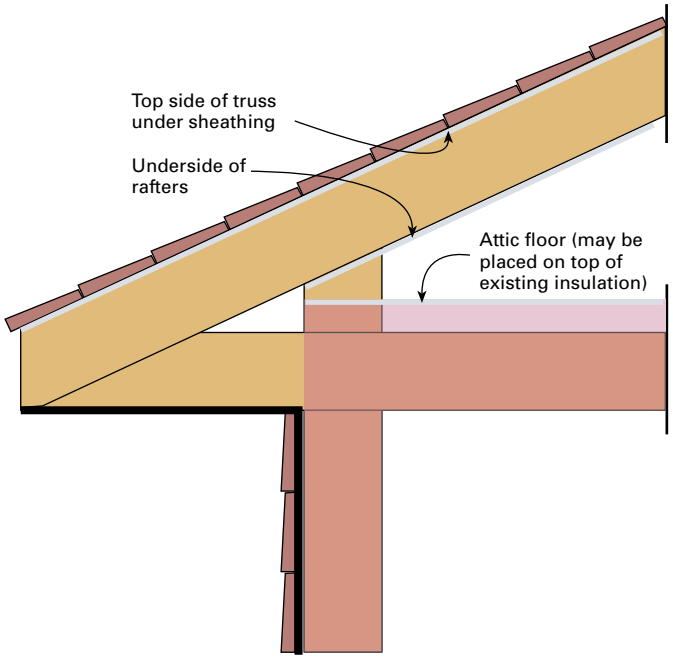
This small upgrade saves us from at least one month of air conditioning in our hot, humid climate, and easily paid for itself within one year. When we finally turn on the air conditioner, we keep the fan off to prevent blowing out the cool indoor air. In the winter, I remove the fan and fit the hole with an insulated piece of drywall.

Ventilation. In warm months, an uninsulated attic transfers heat to the living space below. Our thermostat-controlled electric attic fans consumed about 6 KWH on a typical, hot summer day, without cooling the attic noticeably. A better way to ventilate an attic is with ridge and soffit vents that run along the whole length of the roof. The air circulation works naturally—the hottest air escapes at the ridge, while cooler air is drawn in through the soffit vents.

A 4-foot-long (1.2 m) section of ridge vent costs about US$10, and a 1-foot-long (0.3 m) piece of soffit vent costs less than US$2. Installing ridge and soffit vents for my entire house cost less than US$100. This passive attic ventilation works better than the active one did, and saves us several hundred KWH per year. At our current rate of US$0.135 per KWH, that translates into annual savings between US$40 and US$80.

Block the Heat. Up to one-third of a home's heat gain comes through the attic. Radiant barriers (foil-faced insulation, films, or sheathing) work by blocking radiant heat transfer. In certain climates, they can save between 8 and 12 percent on air conditioning costs.

Attic Radiant Barrier Placement



Installing a radiant barrier under attic rafters can considerably reduce heat gain through the roof.

For retrofits, the recommended way to install radiant barrier in an attic is to staple it to the bottom side of the roof rafters, which leaves an air space between the barrier and the roof sheathing. Install the barrier with the foil side facing downward.

The hot air, within the space enclosed by the rafters and the radiant barrier, rises toward the roof's ridge, and cooler air is drawn in from the bottom. Provided there are enough ventilation openings, the hot air will rise out of the attic naturally. For that reason, the radiant barrier should end 1 foot (0.3 m) above the attic floor and 4 inches (10 cm) below the roof ridge, so that the hot air can escape through the ridge vent and the cooler air can enter at the bottom.

Even a well-insulated and ventilated attic will still get slightly warmer than the outside air temperature. But reducing summer attic temperatures by just 10°F (5.5°C) goes a long way towards reducing your cooling bill. It cut our cooling bills in half.

A Bright Idea. Compact fluorescent lightbulbs (CFLs), which use 75 percent less energy than typical incandescent bulbs, offer an easy energy saving opportunity. Just unscrew your old incandescent bulbs and screw in

Renewable Efficiency

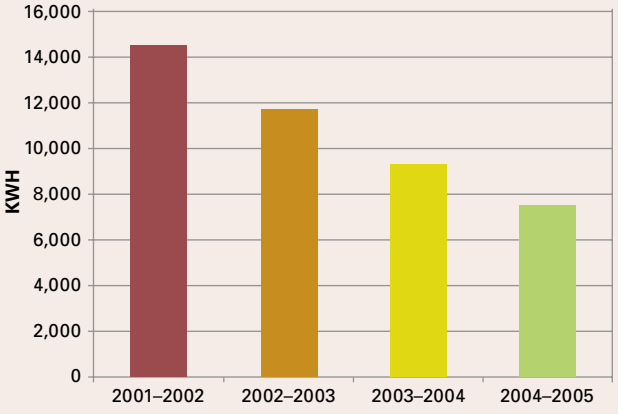
We have cut our yearly energy consumption by almost half—from 14,619 KWH per year to 7,341 KWH. Without accounting for subsidies or changes in energy prices (which are bound to keep increasing), the worst-case scenario payback time of all our efforts should be about twenty years.

My first improvement was to install a whole-house attic fan and add insulation to the attic in June 2002. These changes cut our energy use by about 46 percent. The energy-saving benefits of improved insulation, caulking, and weather-stripping that following winter decreased our December 2002 energy use by more than 30 percent.

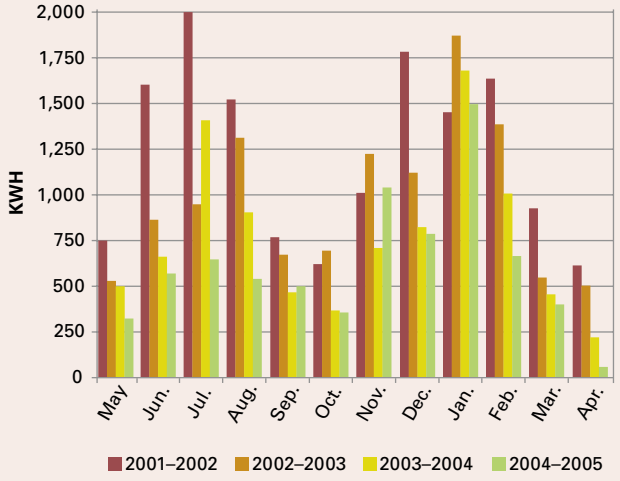
The other changes are more difficult to pinpoint on the graph at right. For example, if the solar water heater saves 1,500 KWH annually, that represents a 150 KWH change over 10 months of operation—an amount too small to show dramatic results on the graph. That's where examining the complete picture, by comparing overall annual reductions in consumption, comes into play.

Our average energy use per month is 611 KWH. Our African Wind Power 3.6 wind turbine, which generates 104 KWH per month on average, and our 880-watt solar-electric system, which produces an average of 92 KWH per month, meet about one-third of our energy needs. The solar hot water system and the backup electric tankless water heater are an efficient combination, and the 40-gallon, solar-heated water capacity is more than sufficient for our family of four. Replacing our ten-year-old heat pump with a state-of-the-art unit could shave between 25 percent and 50 percent off the remaining heating and cooling bills. This would be an excellent improvement.

Annual Household Energy Consumption



Household Energy Consumption



A 10-day vacation in July 2002, compared to July 2003, accounted for the lower energy consumption.

Hotter than normal fall weather accounted for the small increase in energy consumption from September 2003 compared to September 2004, and from October 2002 compared to October 2003.

In November 2004, guests increased the household from four to six people, increasing the household's energy use.

A weeklong vacation in January 2002 reduced energy consumption compared to January 2003.

new CFLs. Many CFLs offer a light spectrum similar to their incandescent counterparts, and come in shapes, styles, and sizes to fit a range of fixtures and lighting needs. Most come with a seven-year manufacturer's warranty, start quickly without flicker, and cast a warm light.

With a design life of 10,000 operating hours, one CFL will outlast at least ten incandescent lightbulbs. Although their upfront cost is more than the cost of incandescent bulbs, the lower energy use multiplied with their longevity results in impressive lifetime cost savings. Another benefit is that CF floodlights and bulbs generate much less heat in recessed ceiling fixtures.

We identified 24 fixtures that we use most often and over extended periods, and then replaced those incandescent bulbs with CFLs, at a total cost of about US$100.

Appliance Upgrades. Horizontal-axis clothes washers consume at least one-third less hot water than traditional top loaders, easily saving 500 KWH per year, depending

A front-loading (horizontal-axis) washing machine reduced hot water consumption from 40 to 24 gallons per load.

on the number of loads and wash-water temperature. Three years ago, we traded in our old top loader for a front-loading washer. This upgrade played a big role in saving energy.

Besides clothes washers, other wise appliance investments include refrigerators, water heaters, room air conditioners, and dishwashers. Our 21.6-cubic-foot Kenmore refrigerator is still a guzzler, using 767 KWH per year. We will save another 300 KWH per year once we replace it with a modern Energy Star model.

According to the American Council for an Energy-Efficient Economy, replacing a 20-year-old refrigerator with a new, energy-efficient model will save about 800 KWH per year, and, if you're reliant on the utility for your energy, it will reduce your home's greenhouse gas emissions by about one ton per year.

Bigger Changes. After our other efficiency upgrades, we decided that we were ready to invest in a solar hot water system. Using the sun to heat water is one of the most cost-effective applications of solar energy. Generally, you can recoup your investment in three to five years.

For us, the most important criteria for our solar hot water system were simplicity and low maintenance effort. I decided on a passive, open-loop system with an electric tankless water heater for backup. The ProgressivTube 40 (US$1,650) batch water heater fit the bill. (For more on solar hot water systems, see "Solar Hot Water—Simplified," in *HP107* and "Simple Hot Water," in *HP108*.)

A batch water heater mounted on the garage roof (alongside the solar-electric array) meets a large portion of the Geisler family's hot water needs. The 880-watt, utility-intertied array offsets electrical use by about 15 percent.

Author Bernd Geisler maintains his African Wind Power 3.6 turbine—another component in achieving his family's goal of energy independence.

I chose a Seisco RA-28 (US$490), electric, on-demand backup water heater. Because the unit uses polymer heating chambers, it is impervious to scale. The heater monitors the temperature of the incoming water and, using five temperature sensors, adds just the right amount of heat, raising the outgoing water to the desired temperature. The sensors' resistances all have to be within 10 percent of each other, or the device will not work and will give an error message identifying the sensors that are out of spec. Replacing a temperature sensor turned out to be necessary more often than I liked. Although the procedure is quite simple and well documented, there's probably some room for improvement.

That said, our system is very reliable; if one heater fails, we can still use the other one most of the time. The ProgressivTube's design is robust; apart from possible freeze damage, virtually no other components are vulnerable to breakage. For precaution, I drain the solar heater and bypass it in January and February, when there is a chance of hard freezes. For the remaining ten months, we get our hot water almost for free!

An energy saving, on-demand, tankless water heater serves as a good backup to a solar domestic hot water system.

The Bottom Line

Many small changes like these can add up to make a big difference in your household's energy efficiency, and help you on your way to lower utility bills and greater energy independence. While you're enjoying the benefits at home, saving energy and using RE resources wisely also can benefit local, regional, and national economies by employing local solar installers and supporting the solar industry, as well as others striving to make useful, energy-smart products. Besides demanding that our political leaders support renewable energy, we can all do our share. So instead of propping up the United States' dependence on oil and coal, start a renewable energy revolution at home, beginning with your own.

Access

Dr. Bernd Geisler, 776 Lakewood Rd., Denison, TX 75020 • 903-327-4262 • texregeninfo@aol.com

Microtherm Inc., 223 W. Airtex Blvd., Houston, TX 77090 • 888-296-9293 or 281-876-3300 • Fax: 281-876-3338 • deseitz@attglobal.net • www.seisco.com • Seisco tankless water heater

Thermal Conversion Technology, 101 Copeland St., Jacksonville, FL • 904-358-3720 • Fax: 904-358-3728 • info@tctsolar.com • www.tctsolar.com • ProgressivTube solar hot water system

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