COLD COMFORT

AFTER SUFFERING THROUGH ANOTHER SUMMER OF RECORD-BREAKING HEAT, IT'S TIME TO RETHINK OUR CENTURY-OLD LOVE AFFAIR WITH AIR-CONDITIONING *BY MICHAEL BEHAR*

ILLUSTRATIONS BY GUYCO

BEFORE MODERN COOLING MACHINES ENVELOPED CIVILIZATION IN FRIGID AIR, humans living in hot climes used all sorts of techniques to stay reasonably comfy. Egyptians fashioned homes with mud and stone. Domed mosques and temples in the Middle East and India funneled hot air upward. Dwelling in subterranean chambers kept denizens of Cappadocia in Turkey and Petra in Jordan from breaking a sweat. Some cultures draped water-soaked fabric over open windows; others topped their roofs with thatch or earth to diffuse heat. Roman emperors had their plebeians haul snow from distant mountaintops and pile it along palace walls. More recently, residents of America's Deep South kept their homes airy with vaulted ceilings, spacious front rooms, wraparound porches, and picture windows.

Then, in the early twentieth century, a tenacious young engineer named Willis Carrier introduced us to the miracle of indoor climate control. Today, the company that Carrier founded earns $11.4 billion in annual sales, but its products, having revolutionized the way Americans live, remain the least efficient appliances in a typical household. They devour 16 percent of an average household's annual energy tab, producing the equivalent of 2,290 pounds of carbon dioxide emissions. "We've always taken air-conditioning for granted," Gordon Holness, president of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), told me recently. "We've got into these lazy patterns because energy has been readily available and cheap. Now we're realizing there isn't an endless supply."

The dilemma isn't all that much different from that faced by the automobile. On its evolutionary time line, the air conditioner today is about where the automobile was in the 1970s. It is a pathetically inefficient machine to which we have become both psychologically addicted and economically dependent, blind to its environmental footprint. Since Carrier introduced his "chillers" more than a century ago, the basic mechanics of how we cool air haven't changed. It's fair to say that the most state-of-the-art air conditioner today is akin to a gas-guzzling muscle car from 40 years ago. To carry the analogy forward, the automotive industry finally responded, albeit at a snail's pace, with improved fuel economy, smaller cars, and, more recently, hybrids, hydrogen cells, plug-in electrics, and various types of alternatively powered vehicles. Unfortunately, air conditioners don't have an equivalent of the Prius, at least not yet.

Carrier was born in 1876 near Angola, New York. Those who knew him say that as a child he had "tremendous power of concentration." He excelled academically, winning a state scholarship to Cornell University.

Soon after graduating, Carrier was hired by the Buffalo Forge Company, which manufactured components for ventilation systems. His bosses, William and Henry Wendt, recognized his exceptional analytical skills and assigned him to R&D. In 1902, while waiting for a train in Pittsburgh, Carrier had his "aha" moment. It was a foggy evening, which got him thinking about the interaction between condensation and cooling. This led to an interest in what he termed "dew-point control," the ability to infuse air with very precise amounts of moisture, thus affecting its humidity and temperature.

That same year, the Sackett-Wilhelms Lithographing Company in Brooklyn, New York, enlisted Carrier to solve an ongoing problem with its multicolor printing press. Fluctuating humidity inside the plant caused the paper to stretch, shrink, and curl between passes, and because the overlaid colors wouldn't align properly, text and images were blurred. Carrier invented a network of fans and coils that circulated cold water to lower the air temperature in the press and had some success in maintaining the relative humidity at exactly 55 percent no matter what the weather was like outside.

Carrier still wasn't satisfied. He continued experimenting with humidity control, eventually developing an entirely self-contained unit that used misters to saturate the outside air with water, which cooled it. Next, to remove excess water, a fan pushed the saturated air through a set of vertically aligned metal plates called baffles. Water vapor clung to the plates and then drained into a collection tank. Finally, a heater warmed the chilled, dry air until it reached the desired temperature and humidity.

Carrier's clout as a big thinker was enough to persuade the Wendt brothers to launch, in 1907, a new subsidiary to focus exclusively on heating, ventilation, and humidification. They named it the Carrier Air Conditioning Company of America and installed the 31-year-old only child from rural New York as vice president.

The machines that Carrier invented became a national obsession. He sold humidity control systems to dozens of customers in the film, tobacco, pharmaceutical, textile, and other industries. For the first time, they didn't have to worry about humidity destroying their goods during production.

In 1922 Carrier patented his "centrifugal chiller." Unlike his humidity systems, which targeted industrial applications, the chillers were marketed mainly for personal comfort. Two years later, he installed a unit in the basement of Detroit's J. L. Hudson Company department store. Hudson's ran daily newspaper ads during the summer months proclaiming that "Pure Fresh Cool Air Makes Shopping in the Basement a Pleasure" and "On Warm Days It's 8 to 12 Degrees Cooler in the Basement Store than Street Temperature." Shoppers went gaga, and department stores across the country clambered to purchase their own Carrier chillers.

Next came movie theaters. One of Carrier's first clients was the Rivoli theater in New York, which touted "Always 69 Degrees" on its marquee. By 1938, of the 16,251 theaters operating in the United States, 15,000 had installed air conditioners, many of them Carrier-made. The pervasiveness of AC in theaters changed the way Hollywood made films. When theaters were too hot during the summer to attract moviegoers, they closed down. With air-conditioning, people had a compelling new reason to go to the pictures: to escape the heat. Summer ticket sales soared, and studios responded, premiering their lavish blockbusters during June, July, and August.

Advertising campaigns portrayed Carrier as a "wielder of supernatural powers," wrote Marsha Ackerman in her book *Cool Comfort: America's Romance With Air-Conditioning*. A master marketer, Carrier quickly understood the potential of

ILLUSTRATION: BRUCE MORSER

NRDC SETTING THE STANDARD

KATHERINE KENNEDY
NRDC's chief counsel on energy and an expert on energy efficiency and renewable energy policy and law

Energy efficiency standards for appliances have always been a priority for NRDC. Why are they so important?
Energy efficiency standards require manufacturers to make sure that their products meet energy-efficient performance levels. Stronger standards are a win-win proposition from so many perspectives. They reduce energy consumption, help to avoid the need to build new power plants, reduce global warming and other air pollution emissions, and save consumers money on their energy bills—all while providing them with the same level of comfort and services from the appliances in their homes.

What progress has NRDC made in improving energy efficiency standards for air conditioners and other appliances?
We have a long and successful history of pushing for more efficient performance for all sorts of commercial and residential products. One of the highlights was at the very end of the Clinton administration, when we successfully advocated for a 30 percent increase in energy efficiency standards for central air conditioners. Under the Bush administration, the U.S. Department of Energy tried to weaken these, but we challenged this in court and won a decision reinstating the tougher standards.

Are stronger standards for air conditioners still possible?
Absolutely. Last year we negotiated an agreement with efficiency groups, states, and manufacturers that will lead to even stronger standards for both central air conditioners and furnaces. Under the agreement, the South and Southwest will have to meet more stringent requirements for air conditioners because those regions make such heavy use of them. Similarly northern states will have tougher requirements for furnaces. We are working with our coalition partners now to have this agreement adopted as law, either through legislation or regulation. By 2030, if adopted into law, the agreement would save consumers $13 billion through lower energy costs and save enough energy to power 18 million homes.

What other tools do we use to promote more efficient appliances?
Standards set the "floor" for efficiency. But we also work to raise the "ceiling" by encouraging voluntary incentives for more efficient appliances, including supporting tax incentives for "super-efficient" products and participation in the federal EnergyStar program. When you're shopping for a new air conditioner, always look for the EnergyStar label.

his chillers to capture the American psyche. An advertisement in the *Saturday Evening Post* said of Carrier, "He creates the climate of Maine in Arizona. He even creates climates that do not prevail anywhere in nature. It is not a dream. It is a dream come true."

By the end of World War II, Americans had become accustomed to air-conditioning—and in fact expected it—in theaters, department stores, high-rises, and bowling alleys. Most government offices were artificially cooled. With the growth of the suburb, Carrier and other AC manufacturers sought to cash in on the exploding residential market, targeting housewives in particular with the compact, affordable Weathermaker, one of the world's first units to use Freon. With the Weathermaker's sophisticated engineering and Freon's potent chilling ability, manufacturers were able to produce much smaller stand-alone room units or window boxes. It also was safer: earlier refrigerants had often been made with toxic and flammable gases. (Freon later proved to have drawbacks of its own, as one of a class of chemicals, called chlorofluorocarbons, that punctured the earth's ozone layer.)

If you've ever dusted off your computer keyboard with compressed air and noticed that the aerosol can turned cold, then you've experienced the fundamental thermodynamic process behind the Weathermaker and almost every AC unit made since.

THE SOCIAL CRITIC VANCE PACKARD LAMBASTED CONSUMERS FOR "BLURRING THE LINE THAT DISTINGUISHES AMERICANS' LUXURIES FROM AMERICANS' NECESSITIES," PLACING MUCH OF THE BLAME ON THE AIR CONDITIONER

Air conditioners contain a refrigerant, a compound that can shift rapidly between gaseous and liquid states. (Nowadays, instead of Freon, manufacturers use something called R-410A, sold by Carrier as Puron.) When you switch on an air conditioner, liquid refrigerant is forced through an expansion valve and into a set of coils, where it evaporates quickly, making it very cold—just like your aerosol can. A fan blows across the coils to push cool air into the room. The refrigerant, now in a gas form, is then circulated to a compressor and a condenser, where it is converted back into a liquid so the process can repeat itself.

With the smashing success of the Weathermaker, a slew of manufacturers retooled their assembly lines to build copycat products. Prices plummeted: a room cooler that cost $400 in 1938 could be had in 1952 for half that much. Residential AC was no longer an enviable luxury reserved for wealthy homeowners. Like the automobile, air conditioners steadily became something every family wanted in its arsenal of appliances.

Advertisers and the media fueled the cool-air delirium. A 1954 *House Beautiful* ad noted that home construction costs could be dramatically reduced with air-conditioning because there was no longer a need for windows that opened, porches, screens, or pitched roofs. In the same year *House & Home* profiled a couple in Dallas who "soon discovered that air-conditioning was so pleasant that they almost never used their outdoor terrace." Manufacturers touted all sorts of miraculous benefits from air-conditioning: it encouraged productivity, rejuvenated health, and restored "energy and ambition."

In 1957 the Federal Housing Administration added payments toward air conditioners to its low-interest mortgage packages. Shortly afterward, the California Federal Savings and Loan Association of Los Angeles required AC in any new home valued at more than $20,000. With the debut of the air conditioner, migration to once sparsely populated Southern states—Alabama, Mississippi, Louisiana, Texas, Georgia, Florida, and South Carolina—reached biblical proportions. Next came the desert Southwest. Arizona's population more than doubled between 1960 and 1980. During that same period, the number of new residents in Las Vegas almost quadrupled.

A backlash ensued. The New Moralists, a cadre of academics and essayists, challenged the unabashed consumerism engulfing America, singling out air conditioners because they had "divorced us from nature." The social critic Vance Packard's 1960 book, *The Wastemakers*, lambasted consumers for "blurring the line that distinguishes Americans' luxuries from Americans' necessities," placing much of the blame on the air conditioner.

Despite this outcry, Americans wanted to hear only one thing: the dull hum of their air conditioners—until 1973, that is, when Arab members of the Organization of the Petroleum Exporting Countries embargoed oil sales to the United States and Europe. Long lines at the pump shocked Americans (at least fleetingly) into contemplating energy conservation. In 1973 *Consumer Reports*, a longtime air-conditioning cheerleader, reversed course and suggested readers ditch the machines altogether. Two years later, President Gerald Ford drafted the first federal efficiency standards for heating and cooling appliances. President Jimmy Carter took up the cause in 1977, shortly after his inauguration, telling Americans in a televised speech, "Ours is the most wasteful nation on earth." Without conservation, he said, we could expect a "national catastrophe."

But we were having none of it. In 1977 a *New York Times*/CBS poll indicated that more than half of Americans didn't believe there was an energy shortage, suspecting it was a ruse by oil companies and utilities to gouge consumers and hike profits.

"Carter lost the election and didn't have the courage to issue final standards before leaving office," recalls David Goldstein, co-director of the energy program at the Natural Resources Defense Council (NRDC).

California passed its own appliance efficiency standards in 1976. Florida, Kansas, Massachusetts, and New York soon followed. But manufacturers worried that they would be faced with a slew of different state regulations and lobbied for federal legislation. The outcome was the National Appliance Energy Conservation Act, which President Ronald Reagan signed into law in 1987. The U.S. Department of Energy was given the authority to periodically update the regulations, but the changes couldn't keep pace with Americans' overwhelming desire for cooling.

Our dependence on cooling—economically and culturally—continues to deepen. The pharmaceutical and microprocessor industries, among countless others, could not exist without climate-controlled manufacturing facilities. It's hard to imagine the major Asian economic hubs, places like Singapore and Taiwan, or Dubai's financial and real-estate megalopolis, without air-conditioning. Not to mention the Internet: server farms and switching hubs would literally liquefy without robust cooling systems to prevent circuit boards from melting.

In developing countries, air conditioners have kindled prosperity across a swath of economic activities. Air-conditioned call centers in India and electronics assembly and manufacturing plants in China have created a plethora of new jobs. The trickle-down has ushered tens of millions from poverty into a nascent middle class, and AC has become the coveted symbol of their success. Twenty years ago in China, less than one urban family in 100 had air-conditioning. By 2007, for every 100 households 95 air conditioners had been purchased. In India, sales of air conditioners have grown by 25 percent in the past two years, and revenue from domestically produced units has doubled.

It's a global pandemic: market researchers at Global Industry Analysts predict annual sales of 78 million air conditioners worldwide by 2015. This kind of unbridled growth in countries like China, India, and Brazil isn't viable for the long haul because of something called peak demand. During the hottest part of the day, typically mid-afternoon, we like to crank up the AC. This triggers an abrupt thirst for electricity that spikes between 2:00 p.m. and early evening. To meet the demand, electric utilities have to ramp up production significantly. Coal-fired plants (which generate about 50 percent of the nation's electricity) and nuclear reactors (which meet one-fifth of our power needs) run around the clock. But they aren't very good at providing big bursts of electricity on demand. Think of driving your car up a steep mountain pass, pedal to the floorboard, engine flat-out, and then having to overtake an 18-wheeler in mid-climb. The extra oomph simply doesn't exist.

Renewables aren't much help, either. The wind is fickle and doesn't always blow when you need it. The juice arrives too early with solar. The sun is at its zenith around 1:00 p.m., and its efficacy drops right about the time everything else is heating up. And there isn't yet an affordable, scalable way to store surplus electricity from renewables that can be tapped when there's a surge in demand.

This leaves few alternatives. The energy source that utilities turn to most is methane, or natural gas, but this is expensive. A secondary problem occurs when methane generation can't meet peak loads. When this happens, utilities have to snap up surplus power from other providers located, for example, where it might be cooler and air conditioners aren't running. Supply and demand rules apply here: utilities desperate for electricity must purchase it from suppliers who know they can charge exorbitant rates. It's this one-two punch that makes peak power so pricey.

MARKET RESEARCHERS AT GLOBAL INDUSTRY ANALYSTS PREDICT ANNUAL SALES OF 78 MILLION AIR CONDITIONERS WORLDWIDE BY 2015. THIS KIND OF UNBRIDLED GROWTH ISN'T VIABLE FOR THE LONG HAUL.

"On critical peak days, when the whole grid is stretched to the limit, the cost to generate that power is 100 to 1,000 times more," says ASHRAE's Gordon Holness. Because state regulatory commissions dictate what utilities can charge for electricity, only a tiny fraction, if any, of peak costs are passed on to consumers. If seasonal peak demand in a particular region escalates unchecked, methane generation becomes too expensive, as does buying power elsewhere. What's left for the utility is to build an entirely new power plant and run it all summer, even though the electricity it produces is needed for only three or four hours on dog-day afternoons.

In the warmest regions of the country, peak loads are growing at nearly 10 percent annually. Climate change is also a factor. The 10 hottest years in history have all occurred since 1995, and the National Oceanic and Atmospheric Administration has announced that the first half of 2010 was the steamiest six-month period on record. At the same time, air conditioners are getting progressively cheaper (you can get a Chinese-made unit from Amazon for $160, shipping included).

Thankfully, a handful of companies, academic institutions, and government scientists are beginning to investigate new ways of cooling to make air conditioners dramatically more efficient, which would significantly diminish peak demand and greenhouse gas emissions. To get a glimpse of what this might entail, I visited Ice Energy, a seven-year-old company headquartered 45 miles north of Denver in Windsor, Colorado. It was a bluebird day in early June when I arrived at its 30,000-square-foot research and development laboratory. Outside, the temperature hovered in the mid-90s. But lofty ceilings, masonry walls, a reflective roof, and natural airflow kept the interior of the facility a pleasant 72 degrees without artificial cooling. While the company does have an air conditioner in the event of a freakish heat wave, its chief technology officer, Brian Parsonnet, told me it's rarely switched on.

Parsonnet showed me a Jacuzzi-size plastic vat, custom-molded for Ice Energy by a hot-tub manufacturer. He raised a lid to reveal 140 hollow copper coils aligned in 14 rows and submerged in 480 gallons of ordinary tap water. The unit, called an Ice Bear, is coupled to a conventional commercial air conditioner, the kind you might see perched on the roof of a big-box retailer. At night, when electricity is cheaper to produce, a compressor pumps refrigerant through the coils, freezing the surrounding water. During peak periods, when demand for electricity drives up generation costs, the ice chills the refrigerant. Instead of an energy-hungry compressor struggling to keep the refrigerant cold on blazing afternoons, the ice formed at night does the heavy lifting.

Designed to pair with virtually any type of commercial air conditioner, the Ice Bear can slash total energy consumption up to 40 percent, and more than 250 units have already been deployed across the United States and Canada. "We have installations at data centers, restaurants, convenience stores, libraries, fire stations, an airport, and even a movie studio," Therese Wells, Ice Energy's director of marketing, told me. In January, the company struck a deal with the Southern California Public Power Authority (SCPPA) to install 6,600 Ice Bears at 1,600 sites throughout the region. The project will offset some 64 gigawatt-hours of peak electricity every year, enough to power 10,000 homes. With the Ice Bear, utilities spend less because they don't need to generate as much costly peak power or acquire the electricity at a premium from other producers. The savings are so substantial that SCPPA and power companies in six other states actually pay for their commercial customers to install the machines.

The Ice Bear is only one of many efforts to reinvent the way we cool ourselves. An initiative called Building Energy Efficiency Through Innovative Thermodevices (BEETIT) at the Department of Energy's Advanced Research Projects Agency–Energy (ARPA-E) is challenging scientists to give air conditioners a desperately needed makeover. Formed in 2009 with $400 million in initial funding, ARPA-E awards grants to what its director, Arun Majumdar, describes as "transformational energy research." New cooling technologies are one of seven priorities in the agency's search for innovative solutions to our energy crisis—the kind of paradigm-shifting stuff that is too risky financially for commercial entities to pursue. In a depressed economy, government spending on bleeding-edge research is a hard sell for taxpayers. But Majumdar believes that recent events should make it easier for ARPA-E to rally public support. "The oil spill in the Gulf was a wake-up call for all of us," he told me. "It's the Sputnik moment for our generation."

In July ARPA-E announced that it had awarded $30.1 million in BEETIT funding for 17 projects, each lasting two to three years. Scientists at the Battelle Memorial Institute in Columbus, Ohio, received $400,000 to develop a reverse osmosis AC system that runs on salt and water. A research team at the University of Notre Dame is spending its $2.8 million in BEETIT funds on a prototype that uses carbon dioxide as a refrigerant (but without CO_2 emissions), while a company called Material Methods, in Irvine, California, got $400,000 to build a "phononic heat pump" that cools air by blasting it with sound waves. Some of the ARPA-E money will go to researchers developing solid-state air conditioners. While conventional refrigerants must be repeatedly compressed from a gas to a liquid—an energy-intensive process—solid-state devices use special compounds that absorb heat when charged with electricity. They are remarkably efficient and release no greenhouse gases. Because humidity forces air conditioners to work harder, several BEETIT projects are examining ways to remove excess water from ambient air before chilling it. The Advanced Materials Group in Hudson, Ohio—awarded $3.2 million, the largest of the BEETIT grants—aims to dehumidify air with a sandwich made from thin sheets of foil-like metal and ceramic.

A thermodynamic principle known as the Carnot cycle makes Majumdar especially optimistic that many of these projects can significantly improve air-conditioning technology. Named for the French physicist Nicolas Léonard Sadi Carnot, it sets an absolute limit on the efficiency you can squeeze from a mechanism that relies on heat energy to operate. Majumdar says that existing air-conditioner technology is "a factor of 10 away from the Carnot limit, so we have a lot of room for improvement." Even doubling the efficiency of air conditioners would put an almost immediate halt to the rapid buildup of new power plants in developing countries and shave off a sizable chunk of America's peak energy consumption.

Meanwhile, a new school of "building scientists" is embracing AC holistically, asking how to integrate it into sustainable design and green construction. Architects must join forces with heating, ventilating, and air-conditioning (HVAC) engineers, suggests Gordon Holness, to rethink the way artificial cooling interacts with structures, with air-conditioning supplementing natural methods. "We're starting to see buildings as totally integrated—not just an architectural element, an electrical element, and an HVAC element, but something designed together as a complete system," Holness says. Majumdar agrees that, "We have to shift the role [of cooling] beyond the air conditioner to all the components of a building, because the most efficient air conditioner is the one that is turned off."

Satish Kumar is an architect with the Energy Conservation and Commercialization project, a joint green-building effort of the United States Agency for International Development and the government of India. He remembers when "a lot of palaces, temples, and guesthouses, because of high ceilings, a large thermal mass, and networks of water flowing through the buildings, could be air-conditioned through natural means." In modern India, he complains, these traditional practices have been lost to the lure of the quick fix. "Today you can get away with whatever crappy design you want and then just slap an AC system onto it," Kumar says. "AC is a brute-force technology." It will work anywhere, he explains, even if the structure it is intended to cool—like a slapdash cinderblock home—absorbs heat like freshly poured asphalt.

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>
> —Arun Majumdar

Kumar is working with India's Bureau of Energy Efficiency and the Ministry of Power to develop courses on building science at 20 architectural and engineering colleges around the country. Students will learn how to use sophisticated computer-simulation software to create virtual heating and cooling scenarios for buildings during design or renovation. Kumar also consults with government agencies trying to establish green building codes. While the standards are voluntary, they are desperately needed, considering that in the next 20 years India will see a 200 percent increase in commercial building space.

There are plenty of traditional building methods to choose from, like those that cool the Ice Energy R&D lab during the hot Colorado summers. Another increasingly common practice: planting sod or other vegetation on rooftops to help insulate buildings from heat and cold. Today, a booming "green roof" industry has resurrected this ancient technique to cool everything from gas stations to skyscrapers. A team of MIT engineers is taking the idea a step further with Thermeleon, a roofing tile containing a polymer gel that changes color with temperature. When it's cold the tiles go dark, absorbing heat and warming the building. When the temperature rises, the tiles turn white, reflecting solar radiation to keep things cool inside.

But a green future for air-conditioning can't happen without a smart grid. I live in Boulder, Colorado, one of the few cities in the United States that provide smart meters to utility customers. Eventually, my Internet-connected smart meter will ping Xcel Energy, my power company, whenever my AC is running. If demand for electricity rises abruptly, Xcel can switch off my unit, and those of thousands of others, for roughly 10 minutes, to avoid having to scavenge for power from dirty sources during peak periods on hot days. Load shedding, as it's dubbed, has been tested in California and Michigan with remote appliance controllers, devices that attach to air conditioners and bridge a communications gap between smart meters and utility companies.

Stage two of smart-grid integration—real-time electricity pricing—is essential because it hits us where we're most vulnerable: in our wallets, forcing us to pay more to consume energy during peak periods. Detractors say such a system punishes low-income families, whose only choice will be to swelter.

Even so, real-time pricing is already curtailing my bad habits. In May, Xcel sent me a letter to announce it would charge more per kilowatt-hour if I exceeded 500 in a month. This is the first step toward a pricing model that ties my power consumption to a floating rate based on overall demand—a rate that would almost certainly surge higher during peak periods.

Admittedly I live in an environmentalist enclave where we embrace all kinds of green schemes without balking. To be equitable, real-time pricing rates might be pegged to annual earnings, carbon footprint, or the size of residence. Deployed on a large scale, pairing smart meters with real-time pricing could virtually eliminate peak loads from the midday air-conditioning crush. But so far, the technology has been confined to small trials in suburban communities. We're at least a decade away from a nationwide rollout. First, we'll need legislation to define how and when mandatory price controls would be enforced. And then there's our antiquated grid, which will require a coast-to-coast upgrade before smart meters can work effectively.

No matter where you live, the near-term solution is to combine high-tech with low-tech, starting with efficiency overhauls to aging structures. Gordon Holness told me, "If we spent $170 billion a year retrofitting existing buildings, we could reduce their energy use by 23 percent over a 10-year period." Additionally, all new construction should incorporate design elements that bolster rather than burden HVAC systems. One such method is so-called demand control ventilation, which uses CO_2 sensors to detect the location and number of people within a building and only cool occupied areas, shaving energy consumption up to 60 percent. But simple improvements are equally essential—higher ceilings, robust insulation, reflective rooftops, and more windows to let in both fresh air and sunshine (lightbulbs emit heat that further encumbers AC). Now include innovations from Ice Energy, BEETIT, and other likeminded R&D efforts, and suddenly our enduring romance with air-conditioning begins to look sustainable.

In the meantime, I'm trying to break my cooling addiction, spurred, admittedly, by Xcel's 500-kilowatt-hour monthly ration of cheap power. As I write this in my centrally cooled home-office on a scorching summer afternoon that's pushing 100 degrees, I switch off my AC, open a window, and pour myself a tall glass of iced tea.

Michael Behar's last article for OnEarth *was our Spring 2010 cover story, "Renewable Energy Catches On in Red America."*