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## TO REDUCE GREENHOUSE GASES, START BY SHRINKING BUILDINGS

By Katherine Salant  
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New Mexico architect Edward Mazria has a proposal to reduce the greenhouse gas emissions that contribute to global warming. His target: buildings.

Most people do not connect the two, but in the United States, buildings are the largest source of greenhouse gases. And half of these buildings are houses.

About 25 percent of building-related greenhouse gas is produced on-site by fossil-fuel-burning furnaces and water heaters. The rest is produced off-site by the local utility that generates electricity. About half of U.S. electricity is generated at coal-fired plants, which are hugely polluting.

Mazria's proposal would eliminate fossil-fuel-based energy use in all U.S. buildings by 2030.

Mazria's proposal, which he calls the 2030 Challenge, is well known in green building circles. It calls for an immediate 50 percent reduction in fossil-fuel-based energy in all new construction and major renovations of existing buildings, and further reductions of 10 percent every five years, starting in 2010. By 2030, all fossil-fueled equipment would be phased out, and all energy used in new and renovated buildings would come from renewable energy sources such as the sun, wind or earth.

This may seem impossible, but Mazria says that the majority of his initial 50 percent reduction in houses could be met simply by building smarter so that less energy is required.

With housing, the first step is a smaller house. Mazria sees a trend in this direction because you don't have to heat or cool what you don't build.

Many people assume that a smaller house means a diminished lifestyle, but architects have shown over and over again that it's possible to wring utility out of every square foot and live well in a small house.

How small is small? The national average for a new single-family house is now about 2,400 square feet, palatial by global standards and roomy enough for four bedrooms (including a capacious master suite) and a first floor that includes a home office, separate living and dining rooms and an eat-in kitchen/family room. Lop off 400 square feet and you would lose the fourth bedroom, some of that master suite excess, and the living and dining rooms that are never used anyway. In areas where basements are common, you would still have that space for overflow.

The next consideration is the shape of the building envelope. Mazria said the places to seek solutions are houses that were built before central heating and air conditioning. When you look beyond their stylistic embellishments to concentrate on the basic building shapes underneath, you find they're a practical response to the local climate that helped keep owners dry and warm in winter and cool in the summer – although not to a 21st century comfort standard, he acknowledged.

Mazria's third recommendation for "a better box" draws on an ancient building tradition that has gained currency in the United States over the past 30 years: passive solar heating and cooling. Orient the main living areas to the south, and you can tap the free heat of the sun for warmth in winter. You

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will need sizeable windows and a finish material such as exposed brick or concrete that can absorb heat during the day and radiate it back in your living space at night, after the sun has gone down.

Properly sized overhangs will shade these areas in summer, keeping heat out. Heat will still pass through the walls, but the brick or concrete will absorb it, keeping the spaces cooler during the day. At night, when the heat is released back into the space, you can open the windows.

With about 300 days of sun a year in New Mexico, Mazria meets 70 percent of his heating needs this way in his own house. (The rest is provided by a natural-gas-fired furnace). He doesn't use air conditioning.

For areas with extensive winter cloud cover, passive solar heating can provide about 20 to 40 percent of winter heating needs, but as much as 40 to 50 percent of summer cooling needs, Mazria said. In fall and spring, you might not need any back-up heating.

To reduce energy use even more, enhance your better box with better windows, more insulation and ducts sealed with mastic to reduce leakage, Mazria said.

For most homeowners, the hardest part of Mazria's 2030 Challenge will be switching out their conventional heating, cooling and hot water equipment to those fueled by renewable energy sources. These are still quite costly.

For most households, this equipment will be affordable only when it's offered by a home builder or developer that installs many at once for a lower unit cost or installs a large system that serves the entire community.

If you're building a custom house in a state that doesn't provide subsidies for renewable energy equipment, your most affordable option is a roof-mounted, solar collector that provides hot water. Mazria meets 70 percent of his own hot water needs with this; the rest is supplied with a natural-gas-fired water heater. With a bigger solar collector, you can design a system that provides both heat and hot water, but Mazria said this could be costly if you also need air conditioning because you would still have to install a forced-air system with ducts.

Roof-mounted photovoltaic systems that convert solar energy into electricity have received enormous media coverage, but they are in wide use only in states where subsidies for homeowners are available, such as California.

Elsewhere the cost can be prohibitive. In Colorado, a 5 kilowatt system – big enough to supply the electricity needs of a 2,400-square-foot house with a very efficient building envelope – would cost about \$40,000, said Bolko von Roedern, a research scientist at the National Renewable Energy Laboratory in Golden, Colo., who has worked on photovoltaics for the last 25 years. In areas such as Seattle, which has far less sun, you would need a bigger array, he said.

The prices for photovoltaics are gradually falling, however. By 2015 the cost of a 5 kilowatt system could be as low as \$20,000, von Roedern said, but this is still a big expense for most households. The most affordable way to use electricity from renewable sources, he said, is to purchase "green electricity" from your local utility when it is offered.

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