It's the Architecture, Stupid!

Who really holds the key to the global thermostat? The answer might surprise you.

by Edward Mazria

One of the keys to slowing global warming on our beautiful little blue planet may be educating architects and other building professionals about designing and building more efficient buildings.
Photo courtesy of NASA

How do we dramatically cut down on greenhouse gas emissions, lessen our dependence on fossil fuels and become more energy-efficient without arguably wrecking the U.S. economy?

So far, no one's come up with a viable answer, largely because we keep looking at global warming from the same angle. The result is tunnel vision—we keep missing the forest for the trees with remedies like cleaner cars, fewer smokestacks, more renewable energy sources. Each is necessary, but solves only part of the problem.

Gordon H. Schenck, Jr.

The Mount Airy library, in Mount Airy, North Carolina, a U.S. Department of Energy demonstration project built in 1981, is a completely daylit, passively heated and cooled facility that uses 75 percent less energy than a typical library in the region.

What we need is a paradigm shift in the way we view energy consumption in this country. It's architecture—residential, commercial and industrial buildings and their construction materials—that account for nearly half of all the energy used in this country each year. And it's the architects who hold the key to turning down the global thermostat.

The government doesn't recognize this. The scientific community and public do not recognize this. The architects themselves do not recognize this. Why not?

The answer is simple. Most people don't understand what architects really do and most architects don't have a deep understanding of the relationship between architecture and the natural environment.

Missing the Obvious

The biggest problem with the current thinking on global warming is that solutions have been focused on areas where nominal reductions in energy consumption and emissions can be achieved. For example, environmental watchdogs and the media have made sport utility vehicles (SUVs) the chief villain of the green movement. But if you took every SUV off the road tomorrow and replaced them with hybrids, the impact on global warming would be minimal.

That's because the entire fleet of SUVs, mini-vans and light-duty trucks in this country account for only 6 1/2 percent of the total U.S. energy consumed each year. That doesn't mean we should abandon efforts to produce more efficient, environmentally-friendly SUVs and automobiles (reducing emissions in all sectors as well as our dependence on foreign oil is critical), but it does illustrate a huge blind spot in America's energy consciousness. Those who develop and promote the framework for environmental initiatives have boxed us into a narrow view of the problem, thereby limiting the scope of potential solutions.

They've overlooked the biggest source of emissions and energy consumption in this country.

It's architecture.

The Big Picture

Addressing global warming is like solving a Rubik's Cube puzzle. It takes the right combination of elements to complete a picture of a plausible emissions reversal program that won't overburden the U.S. economy.

In the process of divining a solution, data has traditionally been divided into four sectors—industry, with the highest energy consumption and greenhouse gas emissions, followed by the transportation, residential and commercial sectors (Figure 1).

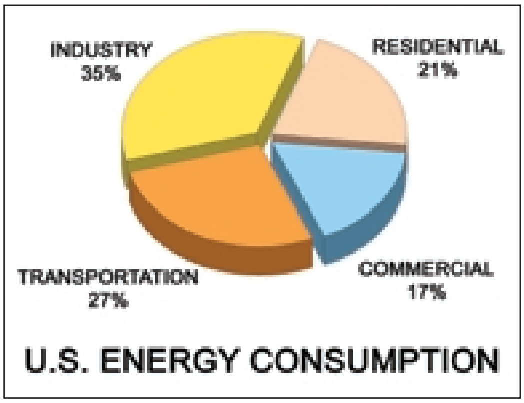

Figure 1

The loudest voices call for major reforms in the transportation sector beginning with greater fuel efficiency and pushing the auto industry to develop new fuel sources and vehicles, such as fuel-cell cars and light trucks.

The industrial agenda focuses on more efficient technologies for production, coupled with the use of less-polluting natural gas (to replace coal) and non-polluting renewable resources (wind, biomass, geothermal and solar) for electric power generation.

In the residential and commercial sectors, the emphasis has been on enacting standards and providing incentives to increase the energy efficiency of building shells, appliances, lighting fixtures and mechanical and electrical systems.

Taken together, these strategies are all worthwhile and necessary, but only address a portion of the U.S. contribution to global warming. For example, it would take increasing gas mileage of every passenger and light-duty vehicle on the road to an average of 40 mph over the next ten years just to stabilize the projected increase in their gas consumption at today's levels.

The environmental lobby, the electric utility industry and the current administration are miles apart when it comes to the use of renewable energy technologies for generating electricity. The environmental community would like to see about 8.6 percent of the total U.S. demand for electricity in 2020 generated by renewables (wind, solar, biomass and geothermal), while industry and the Energy Information Administration (EIA) project only 2.3 percent. However, 8.6 percent of electricity produced by renewables in 2020 would only supply about 30 percent of the EIA projected increase in electric demand. Meanwhile, in the residential and commercial sectors, stringent prescriptive building codes have already been adopted by many states, so substantial code-driven energy and emissions reductions in these sectors are unlikely.

None of these strategies reverses our emissions, though they mitigate the impact of emissions as our future need for energy spirals upward. Think of it as deficit spending. As our national debt mushrooms, we're making payments on the interest without touching the principal.

We need to turn down the global thermostat, but it's locked. Who holds the key?

It's the architects.

The Case for Architecture

By graphically rearranging the traditional way of reporting energy use and gas emissions, the key to visualizing the issues and the actions necessary to address the situation becomes clear. Creating a new sector termed "Architecture," which combines the residential and commercial sectors and that part of the industrial sector containing industrial buildings and building materials, a new and very different picture emerges. This picture clearly illustrates the problem and the sectors that must be carefully investigated in order to effect a change (Figure 2).

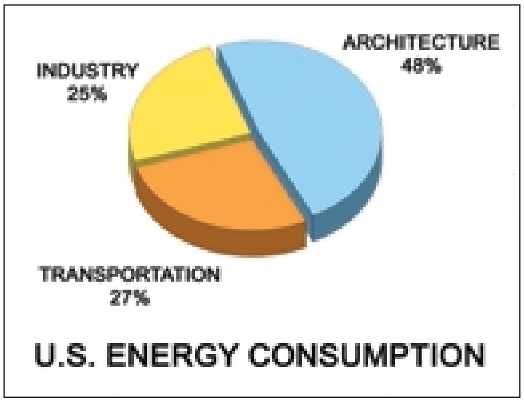

Figure 2

In this new picture, Architecture consumes approximately 48 percent of all the U.S. energy produced and is responsible for 46 percent of all U.S. CO_2 emissions annually, almost double any other sector. It's also the fastest growing energy-consuming and emissions sector (Figure 3).

Buildings are among the most long-lived physical artifacts society produces. They are typically used for 50-100 years, so their inertia has a major impact on future energy use and emissions patterns. Today's architecture will be with us for a long time.

Architects design most buildings and specify all the materials used in their construction. The design of a building—its form, fenestration, construction materials and finishes—largely determines the building's lifetime energy consumption and gas emission patterns.

The mechanical and electrical systems incorporated into a building design will convert today's fossil fuel energy to make that design habitable—to heat, cool, light and ventilate spaces as well as power equipment. Buildings can be designed to use large or small amounts of imported energy and in some cases no imported energy at all.

Today, architecture has become estranged and totally divorced from nature. Most structures are designed to be isolated from their surrounding environment. They require an uninterrupted supply of fossil fuel energy in order to operate. Otherwise, if their energy supply is discontinued, they become uninhabitable—too hot, too cold, no light, etc. They insulate themselves against the environment for as long as possible in an effort to preserve their internal conditions. The construction standards and building codes in force today fully support this design strategy.

Currently, most building energy codes require ample insulation values for walls, roofs, foundations and glass areas in support of this design strategy. These codes are at the point where more stringent requirements yield very small returns. In many cases the energy it takes to produce the additional material is greater than any potential savings. In fact, U.S. energy consumption per square foot of building has been increasing slightly since 1990, a testament to the fact that building codes have not been effective in stimulating further reductions in the Architecture sector.

We know that buildings can be designed today to operate with less than half the energy of the average U.S. building at no additional cost. The design information needed to accomplish this is freely available. It was developed in the 1970s and 1980s along with demonstration projects that were built and monitored at that time. The Mt. Airy, North Carolina, library is an example of one of these demonstration projects (see photo, page 49). Since then, many buildings of all types have been designed and constructed with annual energy consumption and CO_2 emissions of 50 percent to 75 percent below the U.S. average, further illustrating that this magnitude of reductions is readily attainable.

Blueprint for a Revolution

Achieving these reductions in the Architecture sector will require nothing short of a revolution in the architectural design community. The challenge is that the architecture inherited from our predecessors is no longer valid today. The global problems we now face provide the basis for a new architecture and a dialogue with nature that will give this new architecture its uniqueness.

This revolution, if it is to succeed, begins with design education and the understanding that each work of architecture has global implications. There are currently 124 accredited schools of architecture in the U.S. with an enrollment of more than 30,000 students. Fewer than half the schools have faculty with a deep understanding of the design principles necessary to transform architecture from its mindless and passive reliance on fossil fuels to an architecture intimately linked to the natural world in which we live. And, of the schools that do have faculty with experience designing low-energy buildings, many have only one faculty member with the necessary expertise.

There is precious little time to educate thousands of faculty in the design principles necessary to effect a dramatic change in the Architecture sector's emissions output and operational and embodied energy consumption patterns. However, because of the nature of architectural programs and their system of design studios, the education of students and faculty can take place almost overnight.

What is needed in each and every "studio," included as a requirement in the problems issued to students, is that architecture be designed to engage the environment in a way that significantly reduces or eliminates the need for fossil fuels. Due to the investigative nature of the design studio, students educate themselves through the research necessary to address the design problem, and—through studio critiques—they will educate their instructors as well.

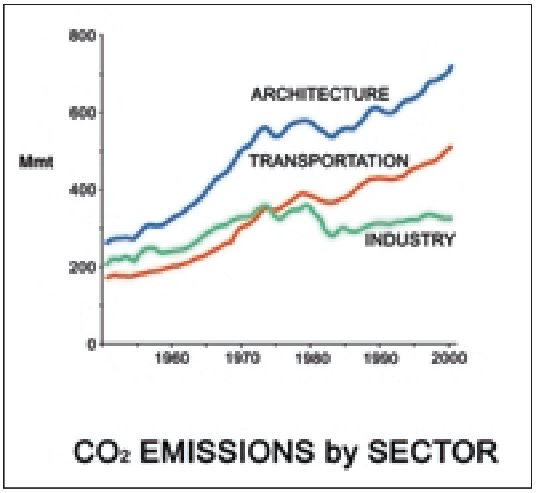

Figure 3

Schools must also offer computer simulation and living systems courses to augment the design studio and provide students with a deep understanding of the principles involved in natural processes. The schools, then, have the potential to institute changes in the profession so profound that we can begin to speak about a new direction in architecture. It thrusts architecture into a pivotal role in solving a critical global dilemma, and in doing so it serves the highest creative purpose.

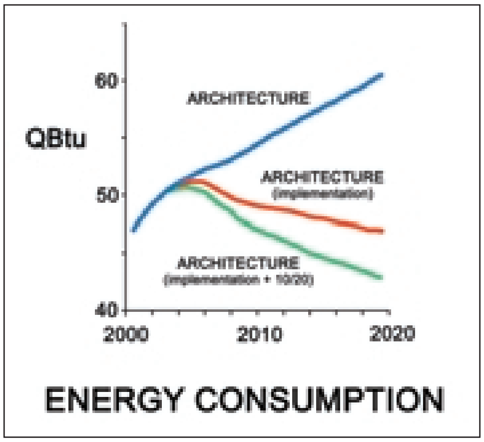

Figure 4

Figure 4
(Architecture sector in quadrillion Btus)
The Architecture (+program) scenario assumes the programs outlined in this article are fully implemented as follows: (1) energy consumption reductions for government owned buildings are implemented in 2004, (2) energy consumption reductions for all buildings are implemented in 2007 and (3) the 15 percent embodied energy reduction for all buildings is implemented over a 5 year period, beginning in 2005. The Architecture (+program, +10/20) scenario assumes the programs outlined in this paper are fully implemented, as well as the States implementing a renewable energy portfolio standard (10 percent of electricity supplied by renewables by 2015 and 20 percent by 2025, as outlined in the Union of Concerned Scientists Clean Energy Blueprint, October 2001).

To ensure that all this takes place quickly, the National Architectural Accrediting Board should make the accreditation of architecture programs contingent upon fulfilling the above requirements, and State Licensing Boards must include in their professional architecture licensing exam a segment requiring an understanding of these principles.

There are other beneficial impacts to implementing this educational strategy. Roughly 15 percent of architecture students come from abroad and many of these international students are in graduate programs. The U.S. will be training these students, many of whom will return to their native countries, in the design principles necessary to affect significant worldwide reductions in greenhouse gas emissions. This is especially important in developing nations as they strive to increase their standard of living with major investments in infrastructure and building projects.

And schools with studio-based industrial design and interior design curriculums can incorporate the same strategies to effect a major change in their programs as well.

Meeting the Challenge

Coupled with this transition in design education, there must be a process in place to support a similar movement in the professional architecture community. To set the wheels in motion, federal and state governments should require that all government renovation and new building projects be designed to meet an energy consumption performance standard of one half the U.S. regional average for that building type. Once this standard is established, most city and county governments, school boards, housing authorities and educational institutions will follow suit with similar standards.

The adoption of these performance standards should be linked to an intensive federal program to refine and transform complex and cumbersome building performance simulation programs so they are user-friendly, graphic in format and seamlessly integrated with the Computer Aided Design and Drafting (CADD) programs currently used by architecture firms. This will ensure that architecture firms will have the appropriate tools necessary to comply with the new standards.

When these simulation programs are in widespread use, building codes for all housing developments and commercial, institutional and multi-family buildings can be changed from their current prescriptive requirements to the newer performance standards that will be in place for all government buildings.

The American Institute of Architects (AIA) has produced a wealth of information regarding the embodied energy in building materials. To further reduce energy consumption and emissions in the Architecture sector, this material should be incorporated into a federally sponsored, nationwide, AIA continuing education program with the specific goal of reducing the embodied energy of building designs by a modest 15 percent by the year 2008.

With about 1.75 billion square feet of building demolition, 5 billion square feet of new construction and 5 billion square feet of renovation taking place in the U.S. each year, the potential for annual energy consumption and CO_2 emissions reductions are enormous. If the above programs were fully implemented, energy consumption and emissions in the entire Architecture sector would stabilize and begin to decline (Figure 4). This would put the U.S. well on its way toward meeting its international obligations.

Because 76 percent of all the electricity produced in the U.S. is used just to operate buildings, these programs would also replace the need to construct most of 1300 new power plants over the next 20 years projected by the Administration's National Energy Policy. It would reduce the need to mine, transport and burn 750 million tons of coal and build thousands of miles of new gas pipelines and power lines during that same period.

Robert Reck

The Natatorium of the 170,000 square foot Genoveva Chavez Community Center in Santa Fe, New Mexico, is a current example of a building that incorporates south-facing clerestories for daylighting and heating, as well as to take advantage of the special quality and intensity of light in Santa Fe.

The Key

The American architectural community has the unique opportunity to lead the way in reversing the destructive trend of human-induced climate change. They hold the key to the lock on the global thermostat. If they open the lock, and if the automobile industry likewise accepts its responsibility to increase the gas mileage of its fleet—and if more States require that a percentage of their energy come from non-polluting renewable resources—then the U.S. will have a viable strategy in place to combat global warming and restore its international good will and credibility. ✪

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