RMI Solutions

Rocky Mountain Institute ◦ Volume xxii ◦ #3 ◦ Fall 2006

Inside

RMI Adopts the "2030 Challenge"

Carbon-Neutral Buildings in 24 Years the Ultimate Goal

By Cameron M. Burns

Your home. Your office. The local supermarket. The kids' school.

They seem benign enough, and we tend not to think of our built world the same way we think of our cars and trucks and factories—as great, pollution-spewing beasts. But buildings consume roughly 40 percent of *all* the energy consumed in the United States *and* they're responsible for about 40 percent of greenhouse gases emissions. The tailpipes are just farther away.

Rocky Mountain Institute has been working on building-energy consumption long before our passive-solar Headquarters in Snowmass, Colo. was completed in 1984. Our staff has helped green up hundreds of big developments and individual buildings—from the White House to city skyscrapers. We even helped establish the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) green building standard, back in the early 1990s when "green building" was a relatively unknown term.

But in July, Rocky Mountain Institute took a big step and embraced an initiative called the 2030 Challenge, formally adopting it for all future green building work.

The 2030 Challenge is the brainchild of architect Edward Mazria, AIA, senior principal at Mazria Inc. Odems Dzurec in Santa Fe. Mr. Mazria launched the Challenge in early January, as a combination web-based rallying cry and online resource for designers.

Specifically, the Challenge addresses greenhouse gas emissions from the burning of fossil-fuel-based energy. It calls for all new buildings and renovations to be designed carbon-neutral—meaning their operations will release zero carbon dioxide into the atmosphere—by the year 2030. The buildings will either use no fossil-fuel-generated energy or their operators will offset their emissions through the purchase of certified carbon dioxide reductions or sequestrations elsewhere.

Before 2030 and carbon neutrality, however, the Challenge outlines interim emissions reduction targets. It calls for a minimum 50 percent reduction in carbon dioxide emissions* for new construction and renovation projects immediately; for a 60 percent reduction in emissions by 2010;

DAVID PATTERSON

for a 70 percent reduction by 2015; for an 80 percent by 2020; for a 90 percent reduction by 2025—and then, of course, the ultimate goal: carbon-neutral buildings by 2030.

Victor Olgyay, AIA, a Principal with RMI's Built Environment Team said the Challenge is not a result of designers' frustrations with the LEED system, but rather that it adds another dimension and complements the many evaluation systems already in use. He also acknowledged that meeting the 2030 Challenge will turn some green-building clients off.

"We have already seen some pushback from clients," he said. "I think this is healthy, especially as people try to understand what this level of performance entails for them. Most people I have spoken with are excited about trying to achieve the 2030 Challenge and are coming to RMI *because* we can deliver extra-high-performance buildings. However, some don't see why they should change from business as usual—in fact, this is where the real excitement of this proposal lies! These 'status quo' people are the ones who will really make a difference when they discover that it is not painful, and may even be profitable, to make a significant difference—and the bar will be raised." Victor also noted that getting to 50 percent (or 100 percent) carbon reduction is something that is within reach of *all* designers and builders—the only requirement is commitment.

"If you don't have the design, use money," he said. "If you don't have money, use design. If you don't have either, you aren't committed."

He also pointed out that because there are so many carbon reduction methods, there is one to suit every situation.

"Of course not everyone will join the parade, but that is the cost of taking a stand," Victor added. "I believe that we are pointing to a greater good, and eventually—perhaps sooner rather than later—our client load will increase because people will see the added value of accepting the 2030 Challenge."

2030 Challenge Carbon Dioxide Reductions Goals for all new and renovated buildings

- **50 percent now**
- **60 percent in 2010**
- **70 percent in 2015**
- **80 percent in 2020**
- **90 percent in 2025**
- **100 percent in 2030**

***Note: While the 2030 Challenge is aimed at greenhouse gas reduction, some advocates of the Challenge are using fossil fuel use as a proxy for carbon dioxide reductions. RMI's adoption of the challenge will focus directly on carbon dioxide.**

Since its launch, several other organizations have accepted the Challenge and made it an operating dictum. In December, the American Institute of Architects (AIA) endorsed the Challenge, and started encouraging its members to strive for a reduction of energy use in all new and renovated buildings. In June, the 2030 Challenge won backing from the U.S. Conference of Mayors, which approved the 2030 Challenge for their cities' buildings.

RMI announced adoption of the Challenge at the American Solar Energy Society's "Solar 2006" annual conference in July.

For more information about the 2030 Challenge and the building sector, visit: ***www.architecture2030.org*** *and* ***www.advancedbuildings.net/index.htm.***

The 2030 Challenge in Practice

1. Good design. We start with all the normal green-design practices: building orientation, energy analysis, shading, daylighting, high-performance glazing, insulation, efficient mechanical systems, etc. This is often "free" as part of good, responsible design, and can get to 50 percent (carbon reduction). If, for some reason, this is not enough...

2. Add technology: Photovoltaics, solar hot water, fuel cells, micro-hydro, wind, geo-exchange, etc. Any of the suite of low-carbon on-site renewable energy-generation technologies can be employed. These offset utility-produced electricity, and have all the added benefits of distributed generation. If, for some reason, this is not enough...

3. Buy it: Utility-generated wind power, "green E" power, tradable energy certificates, carbon offsets, etc. This is an emerging market that is very exciting and available to all.

—Victor Olgyay

RMI/ENSAR Built Environment Team Guides CU Memorial Center to LEED Existing Building Certification

The University of Colorado at Boulder's Memorial Center (UMC) has become more than just a place where students relax, dine, and socialize—it is now one of the greenest buildings on campus. On June 19, the CU Memorial Center's new addition was awarded LEED Silver certification under the U.S. Green Building Council's Leadership in Energy and Environmental Design certification system for Existing Buildings (LEED-EB). The Memorial Center is the second building in Colorado, and the twenty-eighth in the nation to receive this prestigious honor under the LEED-EB system.

Open to students since 2002, the Memorial Center addition included roughly 50,000 square feet of new space and the renovation of another 136,000 square feet of existing space. Sustainability was one of the priorities for the UMC project team, and the goal was "to create a more livable, enjoyable, and sustainable space for students, workers, visitors, and the environment." Through an analysis of system processes and the use of environmentally friendly materials, the UMC project team was able to streamline maintenance procedures while creating a space that was inviting and energy efficient. Rocky Mountain Institute's RMI/ENSAR Built Environment Team assisted with the initial design of the addition and then recently provided assistance to the UMC project team throughout the LEED certification process. Being the first LEED-EB project at CU, the UMC will serve as a model for future campus building renovations as well as an example for other universities seeking to promote sustainability in the remodeling process.

The Memorial Center's key sustainability achievements include:

- An Energy Star score of 91 out of 100, denoting the highest standard of energy efficiency compared to similar buildings;
- Powered by 100 percent renewable wind energy;
- Use of recycled and sustainable materials in the building process, including bamboo flooring and workstations made of 98 percent recycled content;
- Daylighting through strategic window placement and daylight-sensor lighting controls in the atrium;
- Access to eighteen bus lines connecting students and employees to the greater Boulder/Denver metro area; and
- Native flora used in the surrounding landscape.

Rocky Mountain Institute's Built Environment Team is one of the world's leading proponents of green development, a fast-growing field in which the pursuit of environmental excellence produces fundamentally better buildings and communities—more comfortable, more efficient, more appealing, and ultimately more profitable. For more on our work, please visit our website at **www.rmi.org** (our Media Materials section is at **www.rmi.org/sitepages/pid65.php**).

An Expedient Path Through an Inconvenient Truth

An Introduction to Greenhouse Gas Markets

By Lena Hansen and Kitty Wang, PE

The broad scientific consensus is that the earth's climate is experiencing unprecedented changes caused by greenhouse gas (GHG) emissions due to human activities. In reaction, much of the world has come together to address and reduce this climate impact. The United States is one of only two developed countries that has not joined this effort, and continues to resist mandatory controls on GHG emissions.

Despite this fact (and perhaps because of it), individual states, local governments, and companies in the United States are proactively and aggressively reducing their GHG emissions. And, at least in the short term, almost all of them are relying on one market-based solution to achieve GHG-reduction goals flexibly and cost-effectively: emissions trading.

Emissions trading is not a new concept. Emissions trading programs are based on the commodity trading markets that have been a staple of the U.S. economy throughout history—the Chicago Board of Trade (CBOT) and the New York Mercantile Exchange, for example, provide platforms for trading everything from corn to crude oil.

The U.S. Environmental Protection Agency implemented emissions trading pilot programs as early as 1980. These efforts were relatively successful, and the United States now has active regional markets for trading reductions of nitrogen oxide, sulfur dioxide, particulate matter, and more.

This experience with pollution trading is now being carried over into carbon dioxide and other GHGs. But can GHGs be traded in the same way as other commodities? Unfortunately, the answer is no. While CBOT traders can be relatively certain that one bushel of corn has the same value as the next bushel of corn, the same is not true for one ton of GHG because not all tons are created equal. In this article we'll explain why, and explore the implications for emerging carbon markets.

> Nitrous oxide has three hundred and ten times the global-warming potential as one ton of carbon dioxide, while sulfur hexafluoride has a whopping twenty-four thousand times the potential.

The Currency of Greenhouse Gases

Just as crude oil is measured in barrels, GHG is measured in tons. But tons of what? While carbon dioxide is the most common GHG, there are twenty-three other GHGs that contribute to climate change. These include common gases like methane (a major component of natural gas) and nitrogen dioxide, as well as more exotic gases such as halocarbons, perfluorocarbons, and sulfur hexafluoride.

Each of these other GHGs has a more severe climate impact than carbon dioxide. For example, the global-warming potential of one ton of methane is the same as that of twenty-one tons of carbon dioxide. Nitrous oxide has three hundred and ten times the global-warming potential as one ton of carbon dioxide, while sulfur hexafluoride has a whopping *twenty-four thousand* times the potential.

In order to create a common "currency," emissions of all gases are typically normalized to an equivalent number of tons of carbon dioxide. This unit is typically expressed as "tons of carbon dioxide equivalent."

Designing the Market

While the United States does not currently have national-level GHG regulation, nine northeastern states are in the process of establishing a regional cap-and-trade market for electricity generators. California and other West Coast states are also considering establishing statewide cap-and-trade systems that address large emitters. The primary benefit of the cap-and-trade schemes is that they allow the participants to shop around for the best deals, allowing them to achieve their emissions reduction targets at the lowest possible cost.

Existing GHG markets are either closed or open. Closed markets include a number of entities that are regulated (e.g., utilities, manufacturers, etc.), set a "cap" on their emissions, allocate a

fixed number of emissions "allowances" to the parties within the market, and then allow for the trading of allowances between those entities. Thus, entities that cut their energy use and reduce their emissions beyond their requirements can then sell the ability to emit GHGs to entities that cannot meet the emissions limits.

However, because the impact of GHGs is global, the location of an emissions reduction is not important. Open markets allow regulated entities to not only trade allowances within the market, but to purchase emissions *offsets* from entities outside the market. In this way, offsets (presumably less expensive) from other regions can provide additional compliance flexibility. Whether a market allows for the purchase of offsets as well as allowance trading can fundamentally change the game.

In addition to buying and selling allowances and offsets to meet a cap, under some market designs, entities can also bank (i.e., save for use at a future time) and borrow allowances and offsets. These mechanisms also add flexibility and should contribute to lower costs. However, unduly generous banking rules can blunt the near-term impact of GHG regulations.

The Basics of Offsets

Offsets represent emissions reductions from entities not regulated by a cap. However, all offsets are not created equal. By definition, an offset is a difference: the difference between the baseline emissions (what would have happened absent the project) and emissions after a reduction project. The baseline is what is replaced by the project—it doesn't actually exist! Thus, measurement is inherently uncertain. Some projects involve activities that are easily quantified and measurable, while others are more uncertain. For example, with forestry projects the growth-rate of the trees, the type of trees, and the long-term preservation of the woodland all create uncertainty in quantifying the offsets. The "degree of certainty," then, defines offset quality and exposes the buyer and/or seller to risk.

The quality of an offset can be further defined by the following criteria that, together with cost, determine the offset's overall value (in a perfectly efficient market, the quality of the offset would be incorporated in the offset cost). These include the "**RSVPE**" criteria—that is, they must be: **R**eal, **S**urplus, **V**erifiable, **P**ermanent, and **E**nforceable.

To represent real (or measurable) emission reductions, a project must be "additional" or surplus to what would happen otherwise. The baseline must be proven to be a credible projection of emissions without the project, and the reductions from that baseline must be measured and verified independently. The project must also demonstrate that the reductions are permanent and not simply deferred.

In practice, it is the project developer who must provide satisfactory evidence to the seller that all these conditions are met. Once this is done, the seller is likely to insist that there be some (frequently financial) mechanism for enforcing against violations of these principles.

Finally, in addition to the RSVPE criteria, some markets will consider other attributes, such as additional environmental benefits (e.g., nitrous oxides or sulfur oxides reductions or soil erosion impacts) and social impacts (including the impact of the project on the local economy, for example).

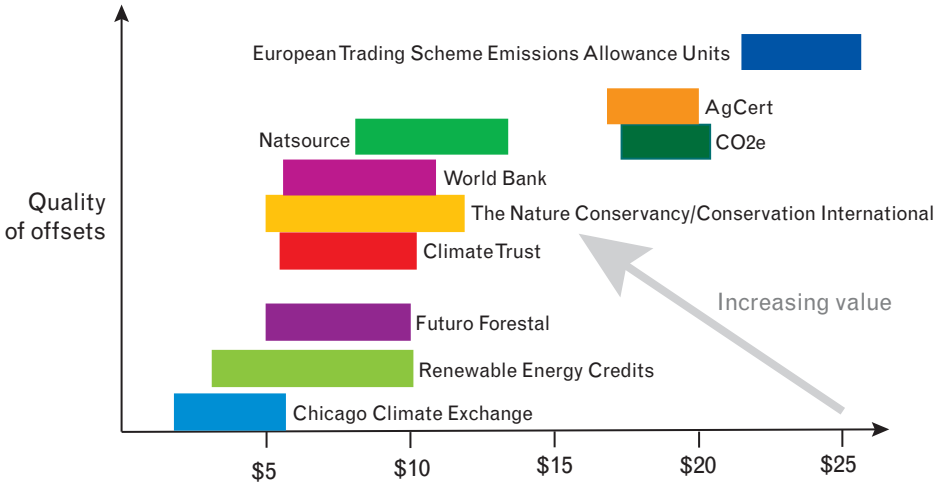
The graph shows the wide range of quality of offsets currently available in various offset markets around the world and their costs. The most valuable offsets are those that are low cost and high quality.

Early carbon restrictions appear to favor the cap-and-trade approach as the best way to achieve GHG reduction goals at the lowest cost. As these carbon markets mature, it will be increasingly important to understand how they work.

Although it can be argued that we are late in getting started, cap-and-trade offers a proven mechanism for moving the nation towards a climate-neutral economy. Eventually, we anticipate that the various markets under consideration will be harmonized so that offsets will be tradable across all of them. Understanding how these markets work will become a new specialty in the field of commodity trading.

Lena Hansen and Kitty Wang are members of RMI's Energy & Resources Team.

Figure 1. Cost and Quality Determine the Total Value of GHG Emissions Offsets



Energy-Efficiency Managers and Economic-Development Directors

—An Under-Explored Political Alliance

By Jonathan Kevles and Michael Kinsley

On one side of town, energy-efficiency (EE) managers at the electric utility are charged with reducing demand. On the other, economic-development (ED) professionals are judged on their ability to increase the number of jobs. Though they could help each other achieve their respective goals, such an alliance is rare. The result? Lost opportunities for both and, worse, for the communities in which they work.

In the United States, electricity generation produces more greenhouse gases than all mobile sources combined (e.g., cars and trucks). Energy-efficiency investments would significantly reduce electricity-generation emissions and save utility ratepayers billions (see box).

Yet most utilities are not investing in EE to the extent necessary to realize these achievable results. The reasons are numerous and include perverse utility regulations, bureaucratic intransigence, and an orientation toward keeping utility *rates* low instead of keeping monthly utility *bills* low.[1]

Like oil tankers, electric utilities are notoriously slow to change direction. Many engines need to be going full throttle to make a turn successfully—rate payer demands, regulatory demands, financial demands, political demands. Lack of political will is one major reason for under-investment in EE. Yet, an effective alliance of EE and ED advocates can help turn the corner.

How can EE managers and ED directors help create the political will? Energy-efficiency investment creates jobs (see "RMI Refines Community Energy Opportunity Finder," **www.rmi.org/sitepages/pid1218.php**). People are employed to design, install, and sell the gadgets required for efficiency, their spending creates jobs, and lower utility bills free up money to be spent locally—most of which would have been spent outside the community to pay for electricity.

If we think of a local economy as a water bucket that is full when prosperous, we would notice that most ED efforts focus on finding more hoses to fill the bucket, which is often well worth doing. But less obvious, and getting virtually no attention, is the fact that the bucket is full of holes—also known as economic leakage. In the case of electricity use, energy *inefficiency* is the culprit that allows this leakage. Plugging the leaks is a powerful ED tool.

Jobs created directly by EE investments range from blue-collar jobs to more technical positions—from installers putting in high-performance windows and insulation to engineers designing and installing more efficient equipment and processes in a factory.

Indirect jobs result from an increased "economic multiplier." When electric bills decline, many of the dollars that would have left the community to pay for electricity instead recirculate in the community and create jobs, which in turn increases local spending.

Several studies have demonstrated the utility bill savings and direct and indirect job-creation benefits that EE investments can yield. A 2002 study by the RAND Corporation for the State of Minnesota con-

Electricity Generation & Emissions

On national scale, U.S. electricity generation produced 2.290 billion metric tons of carbon dioxide equivalent* in 2004. By comparison, U.S. cars, trucks, and planes generated 1.86 billion metric tons of carbon dioxide equivalent during the same time period. Energy efficiency and renewable energy programs can dramatically reduce those emissions because they encourage individuals and communities to upgrade inefficient lighting, motors, roofing, windows, and insulation—to name a few energy efficiency opportunities. Indeed, a 1998 study commissioned by the World Wildlife Fund estimated that adoption of WWF's Climate Protection Scenario policies would result in an 8.5 percent decline in U.S. carbon emissions between 2000 and 2010 (instead of a 20 percent increase without any policy changes), and a 28 percent decline between 2000 and 2020 (rather than a 36 percent increase). The impacts would also benefit electric utility customers' wallets—to the tune of $600 billion inaccumulated savings by 2020. Source: EPA

* Carbon dioxide equivalent: "A measure used to compare the emissions from various greenhouse gases based upon their global warming potential. For example, the global warming potential for methane over 100 years is 21. This means that emissions of one million metric tons of methane are equivalent to emissions of 21 million metric tons of carbon dioxide."
Source: http://stats.oecd.org/glossary/detail.asp?ID=285

cluded that EE measures created statewide per capita energy expenditure savings of $242 from 1982 to 1992. This equates to a 33 percent decline in energy expenditures (the result of efficiency measures and energy price reductions). This created a statewide savings to residents of $1.1 billion (in 1998 dollars). Another 2002 study, by the Southwest Energy Efficiency Project, estimated that EE investments in Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming would generate a net savings to consumers of $28 billion between 2003 and 2020, create 58,400 net new jobs in the region, and increase income in the region by $1.34 billion per year by 2020.[2]

Energy efficiency should be especially attractive to towns and cities that are struggling economically because these measures create jobs and savings where opportunities seem nonexistent. Energy-efficiency benefits do not depend on an upturn in the economy. Lower utility bills make a community more attractive to business, a fact obvious to those interested in starting, expanding, or locating a company. And because EE investments rely less on decisions made by distant governments or companies, they give struggling communities an opportunity to regain some autonomy over their economic destinies.

These benefits will resonate particularly strongly with publicly and cooperatively owned utilities (POUs and COUs, respectively, owned and managed by the rate payers themselves, either indirectly through a city government, or directly in the case of electricity utility cooperatives).[3] The EE–ED link can be particularly powerful in POUs and COUs because the decision-makers and the beneficiaries are both local, they are beholden to local stakeholder groups, and they include community goals in their organizational missions.

In contrast, the mission of investor-owned utilities (IOUs) is to maximize shareholder value, and those shareholders may or may not live in the communities served by their utilities. Yet community leaders, armed with job-creation arguments brought to them by an alliance of EE managers and ED directors can influence the local utility, the PUC, state legislators, and other elected state officials who oversee their PUC.

If EE managers and ED practitioners remain unconnected, ill-informed political leaders can allow job-creation opportunities to sit on the vine, local economies will continue to "leak" unnecessarily, and greenhouse gas emissions will not be reduced. In sharp contrast, an alliance of EE managers and ED practitioners can create the political will necessary to increase EE investments and turn the tanker.

Michael Kinsley is a Principal and Jonathan Kevles is an Intern with RMI's Integrative Design Team. Thanks to Skip Laitner for his continuing analysis of jobs and energy.

[1] Utility investment in energy-efficiency programs can cause the per-kilowatt-hour price of electricity (the "rate") to go up as utility cost recovery of investments are spread over fewer kilowatt-hours. But efficiency reduces electricity use, causing customers' utility bills to *go down*. As long as bills go down by more than the rates go up, the customer saves money.

[2] These studies also look at the job creation benefits of investments in renewable energy (RE). This article does not delve into the RE side of the issue because RE investments, while extremely important from an environmental perspective, must be examined on a case-by-case basis to determine their local job-creation potential. For instance, a wind farm might provide clean power to a community, but it may be located hundreds of miles away, meaning lease payments to distant landowners and windmill installation jobs to residents near that distant wind farm; thus, in this example, no direct jobs are created for the community making the RE investments. Alternatively, local labor would be required to install photovoltaic systems or passive solar water heaters, thus creating many good-paying local jobs through RE investments.

[3] According to the American Public Power Association (www.appanet.org), in 2004 there were 2,011 POUs and 884 COUs, which served a combined 16.6 percent of all electric utility customers in the country.

RMIQ: "Strange Bedfellows" A Major Success

On 13 July, the most powerful presentation in the Institute's RMIQ (Quest for Solutions) lecture series to date took place. RMI CEO Amory Lovins, Paul Westbrook of Texas Instruments, Chris DiPetto from the Pentagon, Andy Ruben from Wal-mart, and RMI's Managing Director Joel Swisher, PE, teamed up for a panel discussion. Each panelist gave a short presentation about their energy-efficiency initiatives and how RMI played a role before sitting down to field questions from the audience.

The event, which took place at Paepcke Auditorium in Aspen, Colo., brought in roughly 200 audience members, all of whom were treated to a fascinating evening. Paul presented the new chip "fab" (fabrication plant) that he and RMI were instrumental in developing. The facility saved more than $280 million in capital costs and will save millions in operating costs, all while keeping numerous jobs in Richardson, Tex. Chris described his efforts to improve the energy efficiency of the military's war-fighting platforms, and Andy described Wal-Mart's efforts to improve the efficiency of their trucks and stores. Last but not least, Joel presented two case studies of work that RMI has done with energy utilities to help them save costs while producing energy more efficiently.

The Magic of Windows, Part 1

By Gregory Franta, FAIA

In terms of a building's energy performance, windows can be either heroes or villains. When buildings are "designed by climate," windows can be the major contributor to human needs for heating, cooling, lighting, ventilating, and a connection to the outdoors (through views).

Windows are the main components of fenestration, which also includes skylights, clerestories, and dormers. Glazing refers to the fenestration's light-transmitting materials, and it is typically glass, fiberglass, or plastic. Glass was first used for windows by the Romans, probably in Pompeii and prior to the birth of Christ. In Venice in the thirteenth century, flat glass technology was developed and windows became popular throughout Europe. Not surprisingly, the Industrial Revolution made windows more economical through mass production.

Even higher-performing windows with double and triple glazing are not new. Thomas Stetson first patented multi-paned windows in the United States in 1865. However, it wasn't until more than one hundred years later that they became popular. Today, with our modern window technology and design tools, windows can be designed so they optimize building energy performance, as well as just about everything else in a modern home. Yet, this optimization is far from mainstream in the building industry.

The most fundamental climate-responsive design consideration in terms of windows is orientation. In the continental United States, east- and west-facing windows have low sun angles, meaning big solar gains and glare that's difficult to control. Controlling solar gain and glare through overhangs or lightshelves on south- and north-facing windows is much easier. South-facing windows can provide winter solar heat gain if desirable, and north-facing windows can be great in hot climates.

When the sun's rays strike glazing, they are reflected, absorbed, or transmitted through the glazing. The portion that is transmitted may be ultraviolet, visible, or infrared light energy. All types will produce heat when they are transmitted through windows, but only about half of the energy is visible. This distinction makes for interesting possibilities, and modern technology allows us to filter out invisible heat or visible light, depending upon our objectives. For example, a glazing that reduces solar heat gains in response to cooling loads may have a low solar heat gain coefficient (SHGC), typically less than 0.26. A glazing with the same SHGC could have a relatively low (less than 20 percent) or high daylight transmittance (greater than 50 percent) to help light the building. This can make a big difference in the amount of glass used on a project and the overall building performance, not to mention blocking 99.5 percent of potentially harmful ultraviolet light. Glass color and spectrally selective low-emmissivity ("low-e") coatings make

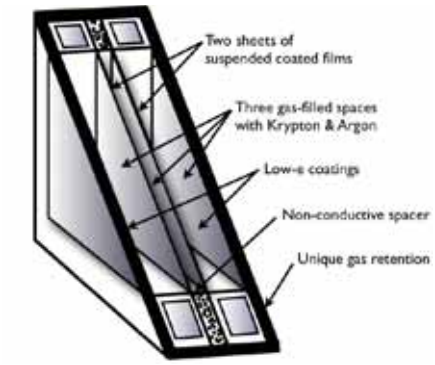
Factor 10 Engineering for Sustainable Cities

by Melissa Semcer

In July, Rocky Mountain Institute, Arup (an international engineering firm based in London), and other sustainability and design experts from around the world gathered in Cambridge, England to explore "Factor 10 Engineering for Sustainable Cities." Factor 10 is a novel approach to sustainable development in which performance outputs (things like the amount of park space that can be kept green with a gallon of water and the amount of office space kept comfortable with a ton of cooling) are improved by a magnitude of ten at no additional—perhaps even reduced—capital cost.

According to the United Nations, the majority of people now live in cities and, as Peter Head of Arup noted, "the future success of humankind is linked to how successful urban living will be as part of the planet's ecosystem." Current urban development techniques and designs lead to environmental degradation and resource depletion, and it is likely that, on a world scale, the building industry (including building operations and embodied energy) is the largest single consumer of energy—certainly it is in the United States. A whole-system integrated design process could result in a new generation of architecture with optimized energy and water efficiency, appropriate natural materials, and superior indoor environments. Energy efficiency and the use of renewable energy in the built environment could create win-win solutions as lower operating costs correspond to reduced atmospheric pollution.

The two-day colloquium focused on promoting and implementing whole-system urban development strategies—turning the way engineers and designers approach urban development on its head. Participants explored topics ranging from environmental footprints and



High-performance windows (U-0.07) used in the Simpson-Franta Residence in Boulder, Colo.

this possible.

Another modern opportunity is to drastically reduce heat transfer via a reduction in heat conduction through the window. With interior glass surface temperatures being closer to the interior air temperatures rather than outdoor temperatures, as with conventional glazing, thermal comfort is increased and heating and cooling loads are reduced.

Single glazing (still common in mild climates) has a rate of heat transfer of about U-1.1,[1] double glazing is about U-0.5, and triple glazing is about U-0.32, all depending upon the air space size, glass thickness, and other characteristics.

Double glass with a low-e coating on one surface achieves less than U-0.30. Suspended coated (low-e) film (SCF) between panes can drop a window's rating to below U-0.20. Combining low-e coatings on the inner surfaces of glass, using two SCFs and filling the gas-filled spaces with optimized mixes of krypton and argon gas results in less than U-0.10. Of course, these values are impacted by the spacer and frame performance, so they need to be high-performance as well. An example of a very high-performance window is on my own residence in Boulder, Colo., where I used clear Alpenglass with fiberglass windows (made by Alpen, Inc., of Boulder) that achieves seven times the performance of thermal pane glazing (U-0.07).

Yes, high-performance windows can seem pricey up front. But to fully assess a window's worth, one needs to understand how it impacts the entire system's performance, the construction cost, and the life-cycle cost. Superwindows may reduce or eliminate the need for costly traditional heating and cooling systems and have other important impacts. Integrated design is the key to revealing "the magic of windows."

Team Leader of the RMI/ENSAR Built Environment Team, Greg Franta, FAIA, practices his magic out of our Boulder office.

[1] "The rate of heat loss, in British thermal units per hour, through a square foot of a surface (wall, roof, door, windows, or other building surface) when the difference between the air temperature on either side is 1° Fahrenheit. The U-value is the reciprocal of the R-Value." Source: www.eere.energy.gov/financing/glossary.html.

energy-use analyses of several major cities to design strategies for engineers and case studies of communities that employed Factor 10 solutions. RMI was represented by Greg Franta, FAIA, who made a presentation on Factor 10 applied to sustainable architecture and initiated a collaboration with Arup to partner on planning for future cities.

In terms of community development, Factor 10 means recognizing the links between economic growth, human health, and sustainability—thereby addressing multiple interests with fewer resources. One notable example is Curitiba, Brazil, which shunned mega-projects in favor of multi-purpose, financially responsible, community-supported projects. The key was the exclusion of typical engineering practices in favor of integrative design processes that treat transportation, land-use, hydrology, poverty, waste flows, health, education, jobs, income, culture, and politics as equal components.

The Factor 10 colloquium in England builds on a project RMI launched several years ago—Factor 10 Engineering (a.k.a. "10xE"; see *RMI Solutions*, spring 2004)—the ultimate product of which will be a casebook that includes a thorough analysis of engineering practice, comparing the differences between standard practice and whole-system integrative design. The casebook—and related presentation opportunities—will allow RMI to bring a sound and compelling pedagogic basis for the "nonviolent overthrow of bad engineering" to firms and classrooms worldwide. The book will also introduce engineers to the value of distributed generation resources, such as solar and fuel cells, despite their additional associated up-front cost.

"Although our Factor 10 Engineering for Sustainable Cities effort is still in its infancy," Greg noted, "we are very excited about the potential opportunities with Arup and others for significant enhancements in resource efficiency, waste reduction, and pollution prevention compared to traditional practice. The future looks bright for cities worldwide as RMI, Arup, and others lead the way toward urban development that meets the economic and social needs of its citizens while simultaneously supporting life-sustaining eco-systems."

Melissa Semcer is an Intern with the Institute's RMI/ENSAR Built Environment Team.

Dances With Batteries

By Cam Burns, Editor

Walk into the office of John Waters, leader of RMI's Integrative Design Team, and if he's not busy plowing through his Rolodex and contacting industry leaders in the automotive sector, he might hand you two batteries: a traditional lead-acid battery that's the size and weight of a brick, and an advanced lithium battery that's the size and weight of a slice of bread.

For John, the difference between batteries is more than physical. They represent the Dark Ages and the Enlightenment in transportation strategies.

"For all these advanced efficiency powertrain systems—in cars, trucks, and other vehicles—that are being developed to be able to achieve their potential, there's a huge need to improve the energy storage systems they use: that is, the battery," he said. "America might even be in the process of trading its foreign oil dependency for another kind of foreign energy dependency—on those countries (China, Korea, etc.) producing the batteries that will be an integral part of the future's highly efficient vehicles."

Lithium, the universe's lightest metal, is used in batteries because it can typically store twice as much energy as today's nickel-based batteries (used in hybrid-electric vehicles today). But until recently, lithium batteries were more promise than reality.

Work on lithium batteries began in the early 20th century, but their inherent instability made functional design elusive. Research moved toward the lithium ion, which, though able to hold less energy than lithium metal, made the batteries safer, rechargeable and more useable. It took until 1991 for lithium-ion batteries to be commercialized.

Lithium-ion batteries have had their critics over the years, but with every passing month, this new technology seems to show increased promise. For example, last year, Altair NanoTechnology (www.altairnano.com) of Reno, Nevada, announced it had made a huge advance in lithium-ion batteries. Their battery can be charged 6,000 times (instead of the typical ~750 times), can be charged in 6 minutes (instead of 2 hours), and can carry 3 times as much power.

Today the lithium-ion battery industry is a mere fifteen years old, and these batteries have generally been used in small consumer goods.

The challenge, John says, is to adapt the technology to larger-format, higher-voltage applications.

But John's work at RMI isn't just about promoting and exploring the best technologies. His job is organizing creative people to find solutions. Earlier this year John met with executives at a leading consumer products firm to look for a future products strategy. Rather than simply apply his own knowledge gleaned from years with General Motors, Delphi, and EnerDel, John got on the phone and, after many days' effort, pulled together an innovation workshop. This company doesn't make cars, per se, but rather vehicle components. The resulting RMI workshop wasn't your typical green building design event either. It was a far-ranging "group-think," in which the firm's representatives could explore trends, products, and challenges in the auto industry.

"We came up with several strategies that fall easily into their core competencies," John said. "The really weak link in the powertrain for advanced vehicles—in cost, performance, mass, and investment strategy—is the battery. It represents 60 percent of the cost, more than 50 percent of the performance, and it affects that ever-important weight equation."

Not surprisingly, that piqued the interest of company executives at the event, and in no time event attendees were zeroing in on a new product strategy that could be part of a whole-system solution for big lithium-ion batteries.

"One of the things I'm trying to do at RMI is connect the dots between America's major players, and that could ramp this up as fast as possible," John said. "I'm trying to marry firms that do packaging and manufacturing with firms that do materials processing and chemistry."

So far, he seems to be succeeding.

John is currently in touch with a firm that has developed a lithium-ion sports car for production (www.teslamotors.com). He is also working with officials from a U.S. state government wanting to invest in entrepreneurial technology start-ups. He is talking to companies that make the packs that hold the batteries and firms that make the connection devices so they can be as easily assembled as Model Ts were in Henry Ford's production line. And then, there's the new product that his innovation workshop client may begin producing itself: the batteries.

Why is this little adventure coming together so quickly?

John is quick to point out that there are all kinds of projections for the size of the coming lithium-ion battery business, but under nearly every scenario, the prize is enormous.

"A battery pack company I know has estimated that their business sector alone is worth $800 million in annual revenues," he said. "There are other estimates for other parts of the business, but it's happening, and it's a key step toward the lightweighting of vehicles that is so necessary for our future."

Just think: transportation fuel efficiency, reduced fuel consumption, oil independence, national security, and the reduction of greenhouse gas emissions—not to mention, the development of a robust new business that could move overseas jobs in the oil sector to manufacturing facilities right here at home—all because of a battery.

No wonder John's charged up.

Embedding RMI Recommendations in the Military

By Marty Pickett

Much of RMI's research and work over the years has been applicable to and usable by the military. In fact, RMI has consulted on specific military projects in the past, such as auditing and recommending energy and fuel efficiency and savings potential on the *USS Princeton* (2000–2001); teaching at various military staff colleges for more than two decades; serving on Defense Science Board task forces to examine platform efficiency (1999–2001) and energy strategy (2006–2007); collaborating with the Air Force Academy and Hickam Air Force Base on building design and efficiency; and being on a team to "green" the Pentagon building soon after RMI's "Greening the While House" effort—as well as many other things.

RMI's *Winning the Oil Endgame*, published in 2004, specifically targeted measures for radical resource efficiency that could be implemented by the military, the largest user of oil in the United States. How could RMI ensure that such bold changes would happen? RMI's approach and recommendations would need to become an integral part of the military's policy and thinking from the Pentagon down.

What better way to embed RMI's work into the military than to have a former military career officer on our staff, living and working in Washington DC? In April, we hired former Navy Captain Scott Pugh to lead RMI's work with the Pentagon. He is focused completely on implementing the ideas of *Winning The Oil Endgame* from a military perspective. He works closely with Chris DiPetto, Special Assistant to the Director of Systems Engineering at the Pentagon, in the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. Having graduated from and taught at the U.S. Naval Academy, Scott is well versed in military strategy, thinking, and protocol.

Having Scott on the ground in DC has already proven effective. Recently, Scott and RMI CEO Amory Lovins were asked to participate in a Defense Science Board (DSB) task force to study Department of Defense energy strategies for a future characterized by less plentiful energy supplies. This DSB task force is chaired by Dr. James Schlesinger (who wrote a forward to *Winning the Oil Endgame*) and General Mike Carns, USAF (retired). It meets in Washington twice monthly and is expected to complete its work in early 2007. About twenty other energy, technology, and policy experts, including former CIA Director James Woolsey, are also on the task force. Thanks to earlier work by Amory and former RMI employee Odd-Even Bustnes, the DSB Energy Strategy Task Force will be examining many of the same energy-saving ideas included in *Winning the Oil Endgame*, and has excellent potential to give additional weight and credibility to RMI's recommendations. You can read more about the DSB Energy Strategy Task Force at **http://www.acq.osd.mil/dsb/taskforces.htm**.

Marty Pickett is Executive Director of RMI.

RMI/ENSAR Built Environment Team Helps LEED NC v3.0 Upgrade

Since its creation in the early 1990s, the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system has been continually refined and improved. The LEED Rating System for New Construction (NC) is now going through another upgrade, to Version 3.0, and the Institute's Built Environment Team is contributing to the vision of a new and improved product.

"Ideas for the 3.0 upgrade have been germinating for years, but the formal process is just starting," noted RMI Sustainable Design Consultant Ashley Muse. "It's exciting because, over the last few years in particular, LEED has been thoroughly established as a tool for market transformation within the building industry. As more and more of the strategies used to meet LEED credits become best practice, there is a new opportunity to set the bar to encourage higher goals for responsible design and to continue to expand the issues addressed within the rating system."

RMI's Greg Franta, FAIA, recently took part in a workshop on the revamping of the rating system and those working on the upgrade have identified three questions they want to address with Version 3.0: "What is our current impact in the market and how do we expand that impact? What technical and scientific advances will improve LEED product performance? What service improvements will reduce transaction costs and other perceived barriers?" Version 3.0 is expected to be unveiled at the USGBC's annual Greenbuild conference in the fall of 2007.

Staff Spotlight

Jeff Ronning

"Why not make it better?"

After more than fifteen years, Jeff Ronning is still asking this question. "I'm really interested in improving things, making things more efficient," he says. "Efficiency to me is a no-brainer. It just makes sense." As the newest addition to RMI's Integrative Design Team, Jeff's dedication to efficiency and knowledge of hybrid vehicles is being put to good use.

Jeff grew up in Kansas and he definitely inherited the family engineering gene. His father, Richard, ran an engineering firm in Kansas City where he developed industrial dehydration process equipment, and his grandfather was a firm believer in efficient systems. As a child, Jeff loved to tinker, and his interest in how things work stayed with him into college. He graduated from Kansas State University in 1988 with a BS in Mechanical Engineering.

In 1991, he went to work for Delphi Corporation and focused his energy on developing the *EV1*, General Motors' hybrid car. Jeff worked primarily on the car's electric propulsion system while learning everything he could about the electric motor and the system that converted electricity for engine use. It was during this time that Jeff met and worked with John Waters, his current Team Leader at RMI. In 1995, he began to look at thermal management in hybrid cars. His specialty was engineering the batteries, electronics, and motor for proper cooling. Over the years he became an expert on hybrid-vehicle programs and did extensive analysis and testing on electronic thermal systems, fuel injectors, battery systems, fuel cells, and engines. In the late '90s, Jeff became an enthusiastic advocate of the plug-in hybrid, which can help reduce oil usage, and worked to build a model based on GM's *EV1*.

Jeff provided consulting services to RMI in January 2006, and realized that RMI was a group of positive, dedicated, and passionate professionals with whom he might like to be more involved. His interest in the company turned into a job opportunity when a position opened on the Integrative Design Team. He joined RMI full time in May 2006, and is already applying his expertise for RMI clients and finding new opportunities for customers who want to reduce energy use. Jeff's dedication to research, testing, and analysis, make him a valuable team member.

While Jeff's professional experience was growing, his family was growing as well. He and his wife Jennifer have six children, ranging in age from four to fifteen. With a smile, he says that his hobbies over the last fifteen years have been "pretty much raising children." The family enjoys many activities together, but one in particular is playing music. Jeff really loved playing violin as a child and all of his older children have followed in his footsteps. "My two older boys have definitely passed their dad as far as ability," he says, smiling. Together with his three oldest children, he has formed a quartet, and hopes to someday play chamber music for local weddings and parties.

At RMI, Jeff is becoming more involved with Integrative Design Team clients, and is currently heading up a series of tests on RMI's *Prius*, primarily to study its cooling system. His practical attitude towards efficiency, and the desire to keep building things better, motivates his research. And why not—to Jeff, it just makes sense.

—Isolde Stringham

Thank You, 3form!

The Institute sends out a big thank you to 3form, a Salt Lake City firm that makes environmentally sensitive (and beautiful) building and architectural products. 3form has decided to donate 10 percent of the proceeds from its Reclaim products to RMI. Fifteen years ago, 3form founder Ray Goodson devised a way to make incredibly attractive architectural elements via a process in which sheets of 3form's *eco*resin—made with 40 percent recycled glycol-modified polyethylene terephthalate (PETG)—were pressed together to encapsulate organic materials like sticks, grasses, and leaves. Today the firm makes hundreds of products based on its patented resin encapsulation technology, including panels, work surfaces, and furniture. Reclaim is a portion of 3form's business that recycles damaged or unwanted panels for reuse in other applications. "We are proud to support an organization that fosters environmentally responsible business practices," Ray said. For more information on 3form, visit **www.3-form.com**.

Editor's note: This summer and fall, RMI is playing host to twenty-one interns and fellows. Here, they tell us what they're up to.

Caroline Fluhrer
MAP Intern

Last May I finished up my undergraduate and master's degrees in engineering at Stanford. Thanks to the MAP fellowship program, I'm able to spend six months working with both the Built Environment and Energy & Resources Teams in the Boulder office. My projects thus far have included a conference paper on Factor 10 Engineering for Sustainable Cities and a chapter on Integrated Design for the National Council of Architectural Registration Boards. I'm also researching barriers to achieving greater energy efficiency in corporate real-estate projects. I'm from Seattle, so I enjoy spending weekends exploring Rocky Mountain National Park and other amazing Colorado places with my fellow interns and roommates.

Vanessa Frey

This summer I worked on biofuels issues out of RMI's Kona office. Much of my time was spent analyzing Hawai'i's biofuels production potential as part of the state's Energy Strategy. I also helped organize a biofuels summit in Hawai'i, where influential players from the public and private sectors identified ways to overcome barriers to biofuels development within the state. Finally—as a New Jersey native and a recent migrant to the Midwest (I am an MBA/MPP student at the University of Michigan)—I thoroughly enjoyed every palm tree and ray of sunshine the Aloha State had to offer.

Josh Hatch
MAP Intern

I am thrilled to be a part of RMI. Coming straight from completing engineering degrees at Cornell (BA) and Stanford (MS), I have been assigned to both the Built Environment and the Energy & Resources Teams. For the Energy & Resources Team, I have been working on a long-term energy strategy for Hawai'i—researching historical data and estimating the future potential of efficiency and biofuels—as the state tries to achieve fossil-fuel independence. The Built Environment Team has me analyzing green building projects pursuing LEED certification. Additionally, I am developing a database of energy-efficiency measures for buildings. With five months of my fellowship still ahead, I am hoping to take these projects to fruition and become involved with other projects as well.

Stephanie L. Johns
Konheim Fellow

I am a fellow with the Integrative Design Team (IDT) in Snowmass. My degree is in engineering science and I have a minor in earth sciences. Before coming to RMI, I completed a semester program in sustainable design at the Ecosa Institute in Prescott, Ariz. My work here has involved research and data collection to support the ID Team. The Team's current effort focuses on the implementation of *Winning the Oil Endgame* in the transportation arena, and my tasks include research into plug-in hybrid vehicles, advanced batteries, and heavy-truck efficiency. I also take part in various other initiatives and client work. My work not only supports IDT projects, but also helps keep RMI knowledgeable about recent advances in technology and industry, such as the latest advanced batteries.

Jonathan Kevles Frantz Intern

I began work at RMI on July 5 and immediately hit the ground running, assisting Michael Kinsley in preparing materials for a July staff retreat and a National Solutions Council (NSC) meeting. The materials were for Michael's presentation on "Sustainable Communities," and the central question posed to NSC members and RMI staff was, "What should RMI's role be in the growing field of work in helping cities achieve sustainability?" The materials and presentation have since generated an exciting conversation about this question, and will help me over the next six months as I develop a business plan for this expanded area of work for the Institute.

Nils Lehmann

I recently graduated with a master's degree in mathematics from McGill University in Montreal. Working with Kyle Datta and other members of RMI's energy group, I currently apply concepts of financial risk management to the energy sector. One of our particular interests is to show how utilities can hedge against fossil fuels risks by investing in renewables. I am currently based in RMI's Kona office and will conclude my internship at Snowmass. Working for RMI is both great fun and a wonderful learning experience. Coming to Hawai'i as a German during the 2006 World Cup proved to be a great choice, as Kyle's enthusiasm for soccer has already led to two fun encounters with Kona's organic farmers.

What Are You Doing?

Dan Leistra
Semmer Intern

I spent the summer in RMI's office in Kona, working predominantly on renewable energy issues for the Hawai'i Energy Strategy, a set of policy guidelines RMI is crafting in conjunction with the state's Department of Business, Economic Development & Tourism. One of my main tasks for this project was to build a mathematical model showing how energy technologies improve over time as manufacturers gain more experience and scale up their operations. The model also catalogued the potential for increased renewable energy use in Hawai'i, and predicted future prices for different energy options at various sites. I plan to continue working in the field of energy policy and economics as I finish my master's degrees in environmental management and business at Yale.

Elizabeth Lokey
Argosy Fellow

I'm an environmental studies Ph.D. student at the University of Colorado and I'm working with RMI's Energy & Resources Team in the Boulder office as an Argosy Fellow. I assist Energy Team members by doing research on a variety of topics, including the creation of a carbon offset standard, tools to assess the local economic benefits of renewable energy and energy efficiency, and the value of ethanol and biodiesel coproducts. Prior to starting my doctoral program, I taught middle and high school Spanish and science at Vail Mountain School for four years. I'm an avid traveler, kayaker, biker, teleskiier, and soccer player.

Eric Maurer
Stanback Intern

My work with the Built Environment Team has been incredibly diverse. I created and implemented an on-line survey concerning high-performance schools for the State of Hawai'i's Department of Education. Together with another Boulder intern, I conducted research on barriers to incorporating energy efficiency measures in corporate real estate. I also established energy, water, and waste baselines for a large mixed-use development and provided assistance on numerous LEED consulting projects. Away from work, I enjoy the camaraderie of my fellow Duke and Stanford interns while hiking and biking around Colorado.

Lisa Moravan

As an Integrative Design Team Fellow, I am involved in a variety of projects. I am the project manager on the Cuyahoga Regeneration Project, an urban renewal effort focusing on part of the Cuyahoga River in Cleveland, Ohio. I am also working with a major university to formulate its strategic investment plan in sustainable environmental enterprise systems and technologies. In addition, I am on the implementation team for RMI's roll-out of a new project management and resource planning software. Finally, I chair RMI's Continuous Quality Improvement (CQI) team, which monitors issues affecting RMI employees' quality of life. The team is currently writing RMI's core values statement by collecting input from all RMI staff and managers. No small task, but definitely a worthy one!

Susan Rich
Semmer Intern

As a recent graduate from Kent State University's Visual Communication Design program, I am excited about the opportunity to work with RMI's Snowmass-based Communications Department. Since arriving in mid-July my projects have ranged from "thank you" brochures for recent RMI events to more extended promotional and marketing pieces for the Institute. I look forward to creating new signs for the Institute's Headquarters building, as well as helping with a redesign of RMI's website. Since my recent move from Ohio, I have been enjoying hiking, biking, and traveling throughout Colorado.

Melissa Semcer
Stanback Intern

This summer, I have been fortunate to work on a variety of projects with the Energy & Resources Team and the Built Environment Team; however, my major focus has been on creating a model that examines the economics of producing biodiesel in the State of Hawai'i. Hawai'i is currently examining its alternative energy options to ensure secure energy resources for the future. I also recently found myself elbow deep in pasta salad in preparation for the NSC weekend in Snowmass—quite an experience! I am currently pursuing a master's degree in environmental management—focusing on environment and business—at Duke University.

Imran Sheikh

Since last fall I have had the pleasure of working with Amory, primarily on an engineering education initiative entitled Factor Ten Engineering (10xE). We are developing a casebook to teach engineering students and practicing engineers the methods and benefits of whole-system design. In RMI's consulting practice we keep seeing the same design errors over and over, and rather than correcting these errors in minute particulars, it would be far more effective to change engineering pedagogy and practice so these errors don't occur in the first place. Factor Ten Engineering should be instrumental in improving the mindware of future engineers so that they are prepared to design far more efficient (and more profitable) solutions.

Aaron Silverman

I am working with RMI's Energy & Resources consulting group in Kona. Our team, led by Kyle Datta, RMI's Senior Director of Research & Consulting, is collaborating with the Hawai'i government to formulate the state's long-term Energy Strategy. This is a very exciting project as Hawai'i has an abundance of natural resources to move the state away from its heavy dependence on imported oil. I have been analyzing the historical energy demands across all sectors as part of our efforts to forecast future patterns of consumption. This internship has been a valuable learning experience and will serve as a foundation for continued work in the field of sustainability.

Ankit Singhvi

What am I doing? Put simply, moving from one heaven (Hawai'i) to another (Aspen). In Hawai'i, I worked with RMI's Kyle Datta in developing a *WTOE* model for India, factoring in the demographics and dynamics of a one-billion-people-strong country. I was also part of the HES 2020 team, and focused on the processing and distribution of biofuels in the state of Hawai'i. Gripped by soccer fever, our group also played a couple of games with local organic farmers. Currently, I am at RMI headquarters, working with Amory on his potential visit to India and developing broad recommendations for the country in areas relevant for RMI.

Ryoto Uchida
Stanback Intern

I am a master's degree candidate in the environmental management program at Duke University. I have been working at RMI on a project to establish a carbon offset protocol that would harmonize a number of different regional greenhouse gas (GHG) mitigation programs in the United States (e.g., RGGI in New England and GHG programs planned in California, Oregon, etc.) by providing offset credits that are fungible among the programs in a credible manner. I have also been studying insurance products that are useful for the carbon offset projects, such as energy saving insurance (ESI), carbon-credit delivery guarantees (CDG), and replacement insurance for afforestation and reforestation (A/R) carbon offset projects.

Bryn Weaver

I joined the Energy & Resources Team in February 2006, and helped lay out a set of strategies for resource planning and energy efficiency measures for a Midwest utility in the context of their heavy reliance on coal and a risky future regulatory market. My work centered around comparing various greenhouse gas reporting protocols, evaluating carbon offset providers and the state of the carbon market, and recommending the least-risk strategy to plan for future growth while mitigating future impacts from a carbon-constrained power market. During the summer months I worked on models for transportation efficiency measures, methane-recapture projects, and assembled a greenhouse gas supply curve for a California utility.

Aaron Westgate

Amory has been a great inspiration in my life for years, and I am honored to have the opportunity to work with him. Ultimately, my job is to help make Amory more effective in his mission of saving the world, having fun, and making money by compiling and organizing his hundreds of papers on energy and other issues. No small task, but an exciting one that continually exposes me to enlightened thinking and problem solving. There are few places in the world where you can work to simultaneously eliminate resource wars, climate change, and the energy crisis. After I finish my work at RMI, I plan to continue globe-trotting, studying whole-system design, and working with communities of inspired people.

RMI Supporters

Contributions to RMI between 1 May 2006 and 31 July 2006

VISIONARIES
$100,000 & above
William & Flora Hewlett Foundation
Fred & Alice Stanback

PATHFINDERS
$50,000 - $99,999
Rachel & Adam Albright

INNOVATORS
$25,000 - $49,999
The Charles Evans Hughes Memorial Foundation, Inc.

PIONEERS
$10,000 - $24,999
Argosy Foundation
Ann B. & Thomas L. Friedman
The Alice P. & L. Thomas Melly Foundation
Mineral Acquisition Partners, Inc., Jane Woodward

INTEGRATORS
$5,000 - $9,999
Anonymous
James & Wendy Aresty
Molly Beattie & Tom Bedell
Jessica & John Fullerton
Colleen & Bud Konheim, in honor of Eric Konheim
The Philanthropic Collaborative, Richard G. Rockfeller
CoYoTe Phoenix
R.E.M./Athens, L.L.C.
The Streisand Foundation
Warren Wilson College

OPTIMIZERS
$1,000 - $4,999
3 Form, Inc.
Adobe Systems Incorporated
Anonymous (2)
Carolyn Brody
Robin & Dan Catlin
Charles Cunniffe Architects
Freddy & Rosita Choi, in honor of Eric Konheim
Cingular
Cottle Carr Yaw Architects
John & Marcia Donnell
Mary K. Dougherty & Erik Neumann, in honor of Eric Konheim
Earth Share
Doug & Peggy Graybeal
David Henry & Elaine Ply
Harold W. Janeway
Calleen & Francois Letaconnoux, in honor of Eric Konheim
Douglas & Susan Linney
Jacqueline Merrill & James E. Hughes, Jr.
Mary Sue & William F. Morrill
Morrow Family Foundation, Inc.
Refuge Sustainable Building Center, Inc.
Philip E. Richter
RMH Foundation
Sankyo Seiko Co., LTD, in honor of Eric Konheim
Susan & Ford Schumann
Bradford G. Stanback & Shelli Lodge-Stanback
Garret Swart
Wichita Falls Area Community Foundation – John Hirschi Donor Advised Fund
William B. Wiener, Jr. Foundation
B. Wu & Eric Larson

STEWARDS
$500 - $999
Marla & Joel Adams
Anonymous
Carter F. & Suzanne Bales, in honor of Eric Konheim
Jeff Banks, in honor of Eric Konheim
Markell Brooks
Sally Cole
Lois-ellin Datta
Kathryn Fleck
Stephen P. Hanson, in honor of Eric Konheim
Emily & Numa C. Hero, III
Peggy Hill & Julie Coy
The Arie Kurtzig Memorial Fund
Eve & Michael MacDonald
Connie Moak Mazur & Jay Mazur, in honor of Eric Konheim
Charles P. McQuaid
Gerard O'Neill
Hope & Paul R. Rudnick, in honor of Victor & Darlene Liss
SEED, Northwestern University, in memory of Phil Semmer
Gordon & Carole Segal
Philip & Dorothy Silber, in honor of Eric Konheim
Chris Smith & Toni Zurcher

IN-KIND CONTRIBUTIONS
Australian Artisanal, John Beatty
Mary Kay Boggs
Colorado Audio-Visual, Inc.
John Emerick
Bruce Katz
Darrell & JoAnn Lafitte
Snowmass Chapel
Mark Thomas
Val's Gourmet
Woody Creek Tavern

Earth Share

We also want to thank those individuals who have contributed to RMI through Earth Share, the combined federal campaign, and other workplace charitable programs. If you would like to have RMI as a charitable option in your workplace campaign, please contact our Development Department at (970) 927-3851.

The following people have notified us that they have included RMI in their wills and/or trusts. We are grateful to each of them.

Esther & Francis Bligh
Joanne & Mike Caffrey
Virginia Collier
Anne Cooke
Richard Ford
Stanton Klose
Erika Leaf
Joan Semmer
Joel Shapiro
Marge Wurgel & Keith Mesecher

Wills

Below is suggested wording for including RMI in your will. But we also suggest you consult your attorney.

"I hereby leave _____ percent of my estate (or a fixed amount, specific property, or the remainder of my estate) to Rocky Mountain Institute, a Colorado nonprofit corporation, whose purpose is to foster the efficient and restorative use of resources to make the world secure, just, prosperous, and life-sustaining."

National Solutions Council

Co-Chair Elaine LeBuhn • Co-Chair Douglas Weiser • Honorary Chair Kathryn Finley

Maryvonne and Curtis Abbott
Mary and John Abele
Rachel and Adam Albright
Pat and Ray Anderson
Anonymous (6)
Wendy and Jim Aresty
Molly Beattie and Tom Bedell
Pamela and John Blackford
Rita and Irwin Blitt
Wendie Kellington and Josh Bratt
Margaret and Andrew Brigham
Steve Campbell
Robin and Dan W. Catlin
Ann and Doug Christensen
Sally Cole
Bob Fox, Cook + Fox Architects
Hilary and Kip Crosby
Charles Cunniffe
Beth and Ravenel Curry
Lois-ellin Datta
Martha Davis
Susan and Jon Diamond
Marion Cass and Stephen Doig
Drs. June and David Ewing
The Fackert Family
Judith Barnard and Michael Fain
Suzanne Farver
Kathryn Finley
Kathryn Fleck
Angela and Jeremy Foster
Ann and Tom Friedman
Jessica and John Fullerton
Jennie Muir-Gordon and Mark Gordon
Dana and Jonathan Gottsegen
Christina Grandy and Llewellyn Wells
Diane Troderman and Harold Grinspoon
Christina and Christopher Guido
Margie and John Haley
Marcia and John Harter
Elaine Ply and David Henry
Jessica Herzstein
Judy Hill
Abigail and Mark Horowitz
Jacqueline Merrill and James E. Hughes, Jr.
Holly Hunt
Nancy Reynolds and Logan Hurst
Mary and Michael Johnston
Bruce Katz
Colleen and Bud Konheim
Karen and Thomas Konrad
Elaine and Robert LeBuhn
Nancy Gerdt and Glenn Lyons
Jane Sharp MacRae and Duncan MacRae
Betsy and Lou Matlack
Lee Melly
James T. Mills
Sandra and Michael Minaides
Barbara Mitchell and Robert Boyar
Cyndi and Jerry Mix
Karen Setterfield and David Muckenhirn
Kelly Erin O'Brien and Martha Watson
Melinda and Norm Payson
Marty Pickett and Edgell Pyles
Sara Ransford
Xiaomei and Joseph Reckford
Nancy and Cy Rich
Emily M. Sack and Robert J. Schloss
Seymour Schwartz
Joan Semmer
Toni Zurcher and Chris Smith
Srinija Srinivasan
Alice and Fred Stanback
Robin and David Swartz
Nancy Kitzmiller Taylor
Lynda and Douglas Weiser
Jane Woodward, Mineral Acquisition Partners
Sue and Jim Woolsey
B. Wu and Eric Larson

Members of the National Solutions Council are:

• **Invited to participate** in various discussions with RMI staff and/or Board of Trustees about global issues.
• **Special invitees** to RMIQs (RMI's Quest for Solutions presentations) and other RMI events.
• **Sponsors** of regional RMIQ lectures or series.
• **Recipients** of advance notification of key upcoming RMI publications.

The NSC extends an invitation to all RMI donors of $1,500+ annually to join. Watch your mailbox for upcoming NSC events!
For more information about the Council, please contact Development at (970) 927-3851 or develop@rmi.org.

NSC Weekend "Best Yet"

BY CAROLINE FLUHRER

IF YOU MISSED THIS YEAR'S NATIONAL Solutions Council (NSC) Weekend, July 12–16, you missed one of the finest gatherings the Institute has yet offered. More than forty members of the Council came to learn about RMI's activities spreading the message of energy and resource efficiency and about our on-the-ground work implementing *Winning the Oil Endgame*. Like the NSC weekend in 2005, this year's event was also a chance for Council members to meet RMI staff (and vice versa) and learn how the Institute—with its multifaceted projects—functions.

In typical Rocky Mountain style, it kicked off with a trip to the Old West via the Snowmass Village Rodeo, where RMI Executive Director Marty Pickett and her husband Edgell Pyles greeted RMI's guests from horseback. Marty and Edgell are founding directors of the nonprofit Snowmass Western Heritage Association, which hosts the rodeo as a way to preserve western culture.

On Thursday and Friday mornings, NSC members chose from a variety of activities, including a tour of Fiberforge—an RMI spin-off developing advanced composites for the automotive sector—and a fascinating tour of green buildings in the Roaring Fork Valley. Over the years, many RMI supporters and friends have expressed a desire to participate in a charrette,[1] particularly a green building charrette. The tour was designed to sharpen Council members' knowledge of green building techniques and systems as, during the coming days, they were to get their chance.

The local green-building tour visited three buildings, two private residences, and one hotel, the Snowmass Golf Course Clubhouse, which in 2005 achieved Silver in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) building rating system and won the Colorado Renewable Energy Society's Renewable Energy in Buildings Award in the category of commercial buildings. The Clubhouse boasts an excellent combination of energy-efficient and solar design systems. The building's designers estimate the Clubhouse is 60 percent more efficient than similar, conventionally designed buildings. The homes visited were the residences of Charles and Dee Wyly and Jason and Kelly Elliot. The Wyly home is special for its air conditioning systems. Located near a spring-fed pond, the home uses the "cool" temperatures of the pond (about 55°F) to cool the home in the summer, and the "warm" winter pond water (about 45°F) to warm the home in the winter. Pipes and pumps help heat exchangers in the pond and the home dispel the wanted—and unwanted—heat and cold. It has been estimated that the pond system saves about 40 percent of the energy that would otherwise be necessary to condition the home. Additionally, the home boasts seven large masonry towers that, in the summer, act as chimneys and allow hot air to rise out of the house while pulling in lower, cool air.

Meanwhile, the Elliot residence is something of a local legend, as when it was built it boasted one of the largest photovoltaic arrays in the country.

After the tour, Council members had a chance to participate in informal meetings with RMI staff on a variety of current research and consulting topics, including sustainable communities, *Winning the Oil Endgame* implementation, and our ongoing work with utilities. On Thursday night, the Institute presented one of our RMIQ lectures—this one entitled "Strange Bedfellows"—featuring a panel discussion with officials from Wal-Mart, the Pentagon, Texas Instruments, and RMI talking about why

they work together.

Saturday was reserved for the next big event: a green building charrette. The jam-packed day came about because of frustrations expressed by Doug Weiser, Council Co-chair. Having completed his supposedly top-of-the-line energy-efficient home in 2003, he was surprised, three years later, to still be receiving substantial monthly electricity and gas bills. Even with features like a 3-kilowatt photovoltaic system, solar water heating, radiant floor heating, proper siting, and appropriate landscaping, total electricity consumption for the property was more than 200 kilowatt hours per day. To remedy the situation, Weiser called upon RMI's Built Environment Team and his fellow NSC members. As an extremely gracious host for the first ever NSC Design Charrette, Doug challenged the RMI/NSC team to brainstorm concepts to reduce the environmental impact of his family's home.

After presentations by several world-renowned green-building consultants, attendees broke into small groups facilitated by RMI staff. Guided by a "Sustainability Gameplan" worksheet, each group worked to generate goals, solutions, and challenges for the topics of environmental footprint, energy, water, and lifestyle—at the end of the day delivering a raft of ideas for Doug and his family, from lighting motion sensors to trombe walls. All were impressed with the charrette process and how its open exchange of ideas enhanced the creativity of the attendees.

The weekend wrapped up in typical Aspen fashion—with a picnic on the lawn beside the Benedict Music Tent and a concert by the Aspen Festival Orchestra and pianist Leon Fleisher and violinist Sarah Chang.

The Institute's Development Department is already planning the next NSC weekend as well as a celebration of RMI's 25th Anniversary with a goal of connecting Council members to RMI's far-reaching, all-important work. Council membership offers exclusive access to most aspects of the Institute's operations. And, the opportunity to network with other like-minded individuals has proven to be both popular and beneficial to members. For additional information about the Council, please contact the Development Department at 970-927-3851 or develop@rmi.org.

Caroline Fluhrer is an Intern with RMI's Built Environment and Energy & Resources Teams.

[1] An intensive workshop that enables design teams to use whole-system thinking to explore the interconnections among various building elements.

RMISolutions

RMI Solutions is published three times a year and distributed to more than 10,000 readers (by mail and online) in the United States and throughout the world.

Letters to the Editor

We want to hear your comments.
Please address all correspondence to:

Cameron M. Burns, Editor
Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654-9199
tel: (970) 927-3851
fax: (970) 927-3420
newslet@rmi.org
www.rmi.org

For reprint permission, please contact newslet@rmi.org. As a leader in promoting resource efficiency, RMI supports innovative recycled paper manufacturers. This publication is printed on New Leaf EcoOffset (100% post-consumer waste, processed chlorine-free) using vegetable-based ink. Contact New Leaf Paper for more information, (888) 989-5323.
No new trees were used in the production of this newsletter, and we offer paperless electronic delivery via our website or on request.

About the Institute

RMI is an entrepreneurial nonprofit organization that fosters the efficient and restorative use of natural, human and other capital to make the world secure, just, prosperous, and life-sustaining. We do this by inspiring business, civil society, and government to design integrative solutions that create true wealth.

Our staff show corporations, communities, individuals, and governments how to create more wealth and employment, protect and enhance natural and human capital, increase profit and competitive advantage, and enjoy many other benefits—largely by doing what they do more efficiently.

Our work is independent, nonadversarial, and transideological, with a strong emphasis on market-based solutions.

Founded in 1982, Rocky Mountain Institute is a §501(c)(3)/509(a)(1) public charity. It has a staff of approximately 50. The Institute focuses its work in several main areas—business practices, climate, community economic development, energy, real-estate development, security, transportation, and water—and carries on international outreach and technical-exchange programs.

RMI Solutions

Rocky Mountain Institute ◦ Volume xxii ◦ #3 ◦ Fall 2006

Features

In Every Issue

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654-9199

CHANGE SERVICE REQUESTED

NON-PROFIT ORG
U.S. POSTAGE PAID
PERMIT #90
GLENWOOD SPRINGS, CO