Summer 2011

Solutions Journal

Ford Dealership Goes Green

Raleigh Leads East Coast for EV Readiness

Energy Efficiency: RMI weighs in on the Jevons Paradox

Transforming Energy Modeling Together

Caltech's Linde + Robinson Lab: The Greenest Lab on the Planet?

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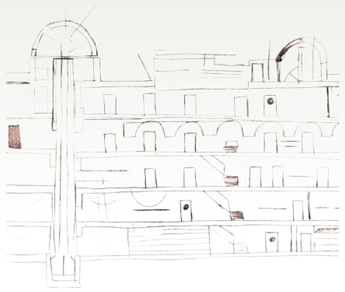

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"There was a time in the '80s and '90s when we were like, 'Well, get real,' but then LEED happened. Just look at the size of the USGBC: It is one of the biggest nonprofits in the world. It didn't exist 15 years ago. But the general population is waking up globally to the fact that the environment matters and it directly affects us and buildings are part of it. It's only growing."

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Collaboration in the Age of Energy *VUCA*

Here at RMI, we are seeing promising signs that lasting, long-term changes in our energy economy are on the horizon. These changes will be driven by decision-makers who wake up to the new energy reality and executed by teams of many stakeholders who collaborate at a new level of depth and understanding.

Events in the Middle East remind us that our oil supplies, and oil prices, depend on variables far out of our control. Disasters in Japan are raising old issues about nuclear power. Meanwhile, natural gas prices in the U.S. are reaching historic lows. And these are just the headlines from the last few months. What's next?

Our energy supply systems have never been stable—with fossil fuel prices sometimes shifting by up to 50 percent and more in a matter of years or months—but it seems that we are now moving into an unprecedented phase of instability. Our good friend and innovative real estate developer Jonathan Rose likes to refer to the military term VUCA—volatility, uncertainty, complexity, and ambiguity.

People and organizations that survive, even thrive, in an age of energy VUCA will build resilience and strength by thinking and acting with longer-term perspectives. They will invest now in efficiency and renewable energy sources to get off the fossil fuel roller coaster. And they will reach across traditional boundaries so professionals of many different types can work toward shared goals.

This edition of *Solutions Journal* explores some extraordinary collaborations and partnerships behind bold energy innovation. To drive lasting change, smart players will reach out to an ever-expanding network of like-minded collaborators: colleagues, external experts, legislators, even competitors. Our energy systems are complex and many-layered, and our energy solutions must rise with the requisite scale and coordination to take them on.

How do you kick off energy efficiency in the vast Ford network of 3,000 dealerships? Ford Motor Co. engaged RMI to get the ball rolling. Three intrepid dealerships volunteered for pilot projects, and Jarrett-Gordon Ford Lincoln in Florida was the first to bring recommended changes across the finish line. The next step is a larger partnership to engage more dealers and drive more change.

RMI's innovative initiative Project Get Ready engages more than 15 cities and 40 industry players in a groundbreaking effort to accelerate adoption of electric vehicles. Raleigh, N.C., is a star participant, and our article here notes the surprising array of partnerships and collaborations the city has formed to propel this visionary change.

Finally, when Caltech decided to renovate a 1932 laboratory, the project itself became a laboratory for energy breakthroughs. In typical Caltech fashion, they attracted some of the best minds and teams in the business—designers, engineers, scientists, construction professionals, lighting and fuel cell manufacturers, and many more—and the richness and depth brought by the collaborating teams correlated directly with the breakthroughs the project achieved.

This is collaboration in the age of energy VUCA: tackling big, thorny challenges with smart people and shared goals. Each of these projects involves multiple stakeholders engaged in a shared vision. Each one creates a better today with an eye toward an even better tomorrow.

We at RMI are honored to collaborate in these and many other projects, and we are equally honored to have you on this journey with us.

Best regards,

Michael Potts, President and CEO

All photography from BEM Innovation Summit by Allen Krughoff, Hardcastle Photography LLC 2011.

RMI Principal Victor Olgyay leads a breakout group exercise on collaboration at the BEM Innovation Summit.

RMI Convenes Innovation Summits

As part of its RetroFit Initiative, RMI convened two summits this spring: one to advance education, tools and best practices for whole building energy analysis and one to encourage financing for energy-efficient design. The summits brought together diverse partners and stakeholders with the goal of capitalizing on opportunities in each industry to support the widespread adoption of energy efficient building design and operation.

The RetroFit Initiative aims to encourage the retrofit of the U.S. commercial building stock to use, on average, at least 50 percent less energy by 2050 via the wide adoption of deep energy retrofits that save far more energy, even more profitably, than today's normal practices. (For more information on retrofits, visit RetroFit Depot, at retrofitdepot.org.)

Capital Markets Workshop

RMI and the Northwest Energy Efficiency Alliance (NEEA) jointly hosted the workshop "Energy Efficiency and Capital Markets" to explore ways to increase the availability of financing for deep energy retrofits (greater than 50 percent energy savings) for small to mid-sized office or retail buildings. Held in Boulder April 7–8, the workshop focused on actions RMI and NEEA could undertake to expand the market.

Limited financing options and a shortage of capital are a significant roadblock to energy retrofits in small- to mid-size commercial buildings under 50,000 square feet—which comprises 90 percent of all commercial buildings and more than half of the total floorspace. This often forces owners to rely on personal credit to finance the deal, according to RMI Analyst Roy Torbert, who helped organize the summit.

Participants in the discussion on facilitating energy-efficiency financing included banks, energy service companies, commercial real estate firms and utility-related organizations. The group brainstormed opportunities for RMI and NEEA to educate financial professionals, value energy efficiency more accurately, and develop new business models tailored to smaller buildings.

Chip Barnaby (Wrightsoft), DJ Hubler (Johnson Controls), Vladimir Bazjanac (LBNL), and Stephanie Hodgin (RMI) propose solutions to fill the gaps in available supporting resources for energy modelers.

The Summit's Practitioner and Customer Panel brought together eight current customers and practitioners of energy modeling to discuss what they need from the building energy modeling industry going forward. The eight participants were Ellen Franconi (RMI), DJ Hubler (Johnson Controls), Peggy Yee (GSA), Bill Worthen (AIA), Gail Hampsmire (GBCI), Tom White (Green Building Services), Linda Morrison (Ambient Energy), Erik Kolderup (Kolderup Consulting).

Amir Roth gives a preview of DOE's roadmap for the future of energy modeling.

Energy Modeling Summit

On March 10-11 in Boulder, RMI convened industry stakeholders to share their vision of the future of energy modeling and how it can drive widespread solutions for low-energy buildings with reduced electric demand. RMI's partners for the Building Energy Modeling Innovation Summit were ASHRAE, IBPSA-USA, USGBC and IMT. *

Key participants in the summit included software developers of simulation tools and building information modeling products, expert building energy modeling practitioners and educators, key representatives from the Department of Energy and national labs, and decision makers from professional and industry standards organizations

In addition to hosting the summit, RMI has developed short-term tools and templates that will save time and increase the quality of energy modeling. And, in partnership with ASHRAE and IBPSA-USA, RMI has developed training and education materials, which the organizations have presented in a number of workshops across the country.

For extensive coverage of the summit and the issues facing the energy modeling community—including live blogs from the event, photos, short videos, and comments from participants—please see the BEM Summit page on RMI.org.

***ASHRAE:** American Society of Heating, Refrigerating and Air-Conditioning Engineers
IBPSA-USA: International Building Performance Simulation Association
USGBC: United States Green Building Council
IMT: Institute for Market Transformation

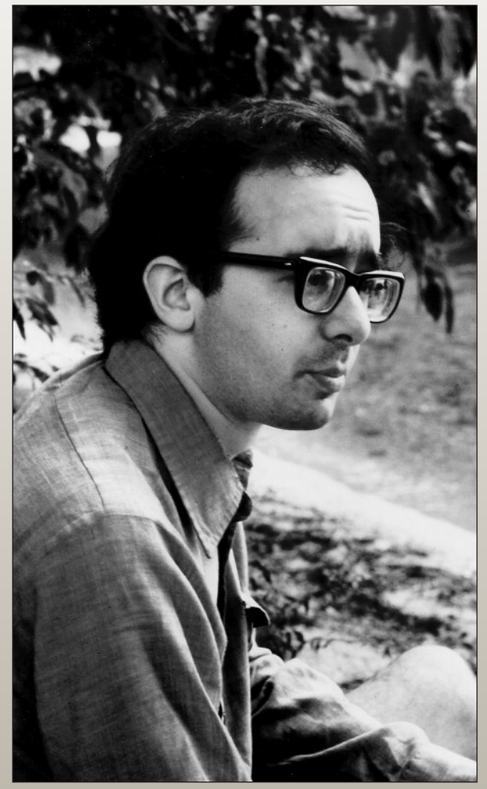
—Molly Miller

"Best of" Amory Lovins Arrives in June

U.K. publisher Earthscan is set to release *The Essential Amory Lovins* in June, featuring a selection of 34 essays, articles, white papers, poems, and letters written between 1962 and 2010 by RMI's chairman, chief scientist, and cofounder.

The 384-page book (ISBN 9781849712262) is divided into nine sections: "Into the Wildness: Mountain Climbing, Wales, and Fighting a Copper Mine"; "Resources and Energy: Efficiency, Analysis, Policy, Potential"; "Nuclear Power: Fission and Confusion"; "Vehicles and Oil: Goodbye Crude World"; "De Architectura: Building Better, Building Smarter"; "Energy Security and the Military: Blood and Treasure (and Opportunities)"; "Business and Climate: Making Sense, Making Cash, Making Good"; "Miscellany: Letters, and a Poem"; "Final Thoughts: Choosing the Right Path."

For many fans of Amory's writing, his greatest contribution has been to help turn "environmentalism" on its head—creating a new sort of enviro-rationalism that uses empirical and logical rigor to make a powerful argument (even a business case) for more environmentally benign paths. Many of the selections were written in the 1970s, when the environmental movement was rapidly expanding; the section "Resources and Energy," areas in which Amory made his biggest mark, accounts for roughly a third of the book. The strong emphasis on economy and security reminds us, too, that Amory's focus, like RMI's, spans many diverse concerns and opportunities beyond environment.



"I hope this book brings a whole new generation of fans to Amory's thinking," says Cam Burns, the book's editor. "His thinking, documented long ago, is still completely valid today, especially in suggesting solutions that have only gained force and cogency over the years."

The book will retail for £19.95 in the U.K. and $34.95 in the U.S., and will be available from RMI.org.

Printing with Vision

RMI Printer Recycles Solvents

RMI partners with a wide variety of entities to help fulfill our mission, including ESCOs, utilities, policy leaders, and business leaders. But we also choose partners to help us conduct our own internal activities. For example, this magazine is printed on Forest Stewardship Council-certified, recycled paper with a vegetable-based ink by Visions Graphics in Loveland, Colorado. Vision was the first commercial printer in the region to become an FSC-certified Chain of Custody printer. This assures us that our paper comes from a forest the stewardship council has certified. The Council certifies forests based on sustainable forest management principles.

While many printers now offer FSC-certified papers, not many have installed a solvent recycler on site. In 2003 Vision Graphics purchased an EcoClean solvent recycler, which they use to recover and reuse press-cleaning solvents. According to Vision graphics' Mark Steputis, "We're doing all that we can to reduce volatile organic compounds and waste that would otherwise end up in landfills."

ON THE WEB

Nuclear Power: Join the Live Debate

By Amory Lovins

For four decades we have known modern energy systems could threaten civilisation in two ways—climate change and nuclear proliferation—so we must reject both fates, not trade one for the other. New nuclear build worsens both problems. It provides do-it-yourself bomb kits in civilian disguise. It reduces and retards climate protection by saving 2-10 times less carbon per dollar—and 20-40 times slower—than superior low- and no-carbon competitors. But taking economics seriously and buying those cheaper options instead can protect climate, peace and profits. **Comment at RMI.org.**

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RMI ONLINE

OUR E-NEWSLETTER

Sign up to receive our e-newsletter, Spark, in your inbox twice a month.

PLUG INTO NEW IDEAS

Check out RMI Outlet, Rocky Mountain Institute's blog, at blog.rmi.org. We explore topics critical to RMI's mission to drive the efficient and restorative use of resources.

Contributors include RMI experts in our core practice areas, communications staff, and guest bloggers from the industry.

We encourage you to join our discussions and our community.

JOIN THE CONVERSATION

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MULTIMEDIA & VIDEO

Watch participants of last month's Building Energy Modeling Innovation Summit discuss barriers and opportunities for the industry.

Also online, read the BEM Innovation Summit participants' visions for the industry.

Plug-in Pioneer:
Is Raleigh Ready for EVs?

By Molly Miller

Raleigh is the East Coast leader in Electric Vehicle (EV) readiness, and its journey is one every American city will have to follow if we are to meet President Obama's goal of one million EVs on the road by 2015.

So far the city of Raleigh has installed three EV charging stations, two in front of City Hall and one by the convention center that will become a pilot solar-charging station. Raleigh hopes to install 10 to 12 more stations before Plug In, a conference focusing on EVs that it's hosting in July, and it plans to have 30 new stations before the year is over.

There are other charging stations around town that the city hasn't been involved with. Sixteen stations are operating on a green parking deck that's part of a LEED Platinum building the North Carolina State Energy Office is constructing. And the city of Raleigh, the local utility (Progress Energy) and a nonprofit advocacy group called Advanced Energy are working together to help Raleigh residents install residential chargers.

Most of the chargers Raleigh will install this year will be downtown in public parking garages or near North Carolina State University's Centennial Campus. Those will be part of a bigger wave that will bring more than 350 recharging stations to North Carolina, most financed by federal stimulus money. They will provide free electricity, though drivers will need to pay the parking meter.

Getting ready for EVs includes installing enough charging stations, of course, but there's a lot more to it than just having the power to run the cars. Almost every city department needs to be involved. For example, once the stations are installed, who will maintain them—parking folks, the utility, others? Raleigh, along with many other American cities, is figuring that out.

The city's plug-in vehicle deployment efforts got started in 2009, when Raleigh and the North Carolina Research Triangle Region joined RMI's Project Get Ready, an initiative to help U.S. cities prepare for plug-in vehicles. Raleigh was one of the first three Project Get Ready cities. Project Get Ready is now working with more than 15 cities and a diverse group of technical advisers that includes automakers, electric utilities, charging station providers, academic institutions, and other nongovernmental organizations.

"There is no substitute for shared learning when building and pursuing an EV-readiness strategy," says PGR's project manager, Matt Mattila.

Raleigh assembled an interdepartmental team to tackle issues such as streamlining the permitting and installation process. The team includes representatives from the city's departments of transportation, sustainability, development services, permitting, administration and public affairs, as well as from utility Progress Energy and energy adviser Advanced Energy. In addition to working together on the infrastructure, they educate residents about plug-in vehicles, work with auto dealers to ensure vehicle availability in the North Carolina market, and explore opportunities for job growth and economic development related to plug-in vehicles.

The city is also working with shopping mall operators and other real estate owners to locate charging infrastructure on these properties. Progress Energy and Advanced Energy have received grants to install additional charging infrastructure throughout the Research Triangle region and will collect data from these stations.

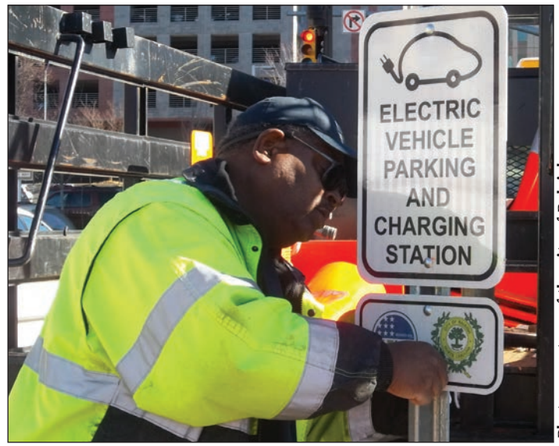
Permitting & Mapping | Raleigh aims to streamline the process of installing a residential or public charging station. Its permitting process is called a "walkthrough" because the city's permit staff walk the applicant through the process. Getting a permit takes about an hour, and inspections can be performed the day after installation. As a result, a residential customer can complete the entire assessment, permitting, installation and inspection process for a simple home-based project in as few as two days. The city plans to switch to an even faster online permitting process as staff and electricians become well versed in installations.

Raleigh is currently focusing on sustainability mapping, which will show green roofs, renewable energy installations and locations of charging stations. The city will also collect data from the charging stations to see how many kilowatt-hours have been used and how many times a vehicle has plugged in.

Education & Communication | As one of the leaders in EV readiness and as a participant in Project Get Ready, Raleigh considers part of its mission to be the sharing of best practices and lessons learned with other cities.

Raleigh's Office of Sustainability has made two how-to videos on installing charging stations and has held a training for electrical contractors. Raleigh is also sharing information with Plug in Carolina in South Carolina.

Raleigh will be sharing more of its best practices at Plug In 2011 Conference and Exposition, (plugin2011.com), sponsored by the Electric Power Research Institute, to be held July 18-21 in Raleigh. The conference, previously always held in California, promises in-depth discussions about vehicles, component and infrastructure technologies, results of pilot programs, customer surveys, battery-electric and plug-in-hybrid vehicle readiness plans, and the challenges and opportunities that lie ahead. ◆



Photos courtesy of the city of Raleigh

Project Get Ready

If adopted at scale, electric vehicles could provide significant improvements for the environment, the economy, and national security. Plug-in vehicles create dramatically less tail pipe emissions, or none at all, compared to internal combustion engine vehicles. With nearly 1,000 fewer moving parts, they require less maintenance. With lower operational costs, electric vehicles compare favorably from a total cost of ownership standpoint. They also offer a real opportunity to reduce spending on oil.

In 2008, RMI hosted 80 representatives from automakers, utilities, technology firms, and retailers, for a charrette focused on the impending arrival of electric vehicles. At the time, several automakers had already announced plans to release mass-market plug-in vehicles. However, as charrette participants noted, communities were under-prepared for the nascent industry. Key stakeholders lacked adequate understanding of the necessary steps and their own roles. RMI therefore formed Project Get Ready (PGR) to help communities and industry leaders develop strategies for adopting vehicle electrification.

Since 2008, Project Get Ready has built an extensive network of community partners and technical advisers. RMI facilitators have created a national platform through which city government, electric utilities and private enterprise can all exchange lessons learned and develop best practices for incorporating this new technology.

Moving forward, PGR will continue to help communities prepare, but it will also track a range of issues on the ground. Working with its partners, PGR will be able to determine what is working and not working as the cars begin to enter the marketplace.

This is vital to the success of the industry. Challenges will almost certainly arise, necessitating swift response and correction. By identifying problems as they happen, PGR will begin to remove hurdles to future adoption. In the process, RMI will establish an understanding of how the electric vehicle impacts the grid, the transportation industry, and the driver.

—Ben Holland

Caltech's Linde + Robinson Laboratory to be First LEED Platinum Lab

By Cameron Burns

When Caltech officials decided to renovate a 1932 astronomy building that will house a new center for environmentalsciences,theythoughtlifeshouldmimic ideals—and thereby created what will be one of the greenest science facilities on the planet.

Photo by Bradley Smith of Caltech.

Photo by Eric Soladay of Integral Group

Exterior of Caltech's Linde + Robinson Laboratory.

When Caltech officials decided to renovate a 1932 astronomy building that will house a new center for environmental sciences, they thought life should mimic ideals—and thereby created what will be one of the greenest science facilities on the planet. Several RMI supporters and staff members worked with the design team on the Linde + Robinson Laboratory, which is expected to become the nation's first LEED Platinum laboratory in a historic building after it opens in July.

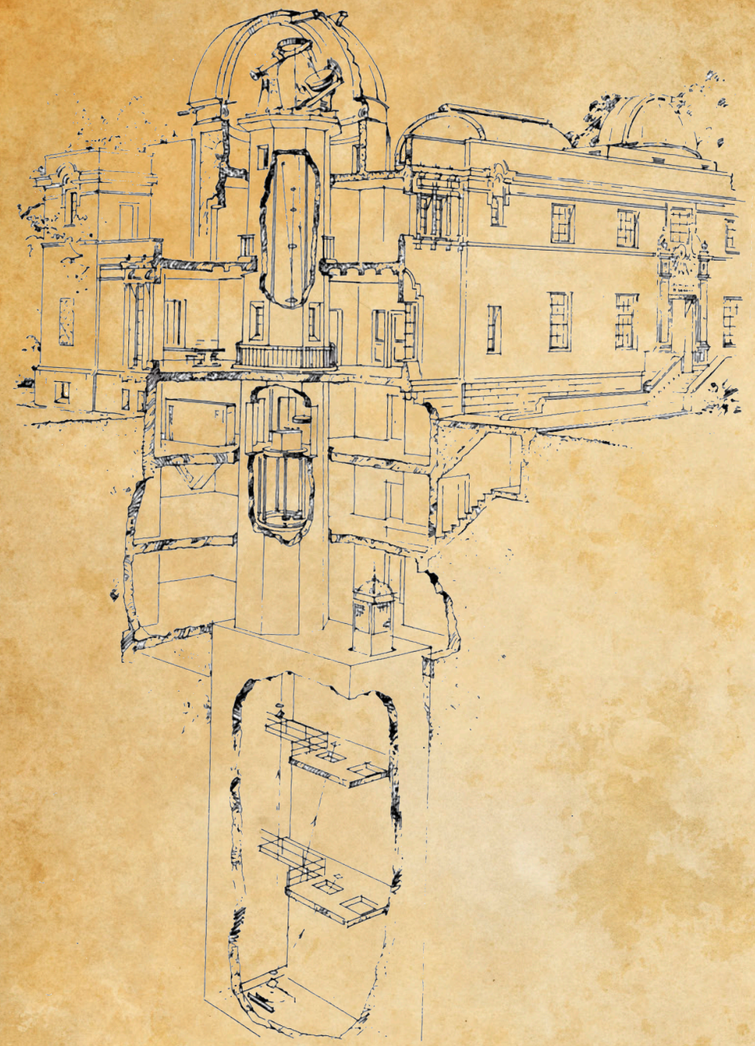
"The project demonstrated the power of collaboration among many highly talented people brought together by a vision to create something truly unique," says Foster Stanback, a green building enthusiast whose support made RMI's involvement possible.

Three years ago, Ronald and Maxine Linde established an $18-million endowment for the California Institute of Technology to create the Ronald and Maxine Linde Center for Global Environmental Science. They aimed to unite faculty from a variety of disciplines related to climate change, including chemistry, engineering, geology and environmental science. Caltech officials had long thought the Robinson Laboratory on Caltech's Pasadena campus could be retrofitted in some way, and by 2008 they decided it would be a great home for the environmental science center.

Caltech, which had decided to pursue a LEED Platinum rating for the building during an earlier feasibility study, put together a design team that included several members of what industry folks jokingly refer to as RMI's "green mafia"—RMI

Photo by Architectural Resources Group

Crew refurbishing the coelostat at the Caltech laboratory construction site.



Drawing Courtesy of Caltech Archives

Science of Sunlight

The most significant characteristic of the building is an enormous shaft that pierces it from roof to basement. The shaft, roughly 1.5 meters in diameter, houses a massive solar telescope that stretches through all five stories of the building (two of which are below ground level).

The roof is home to a coelostat ("seel-o-stat")—essentially two mirrors that track the sun and create a singular beam of sunlight that's bounced down into the building and bounced up again from the bottom of the building. Rumsey recalls going up on the roof to see it with George Loisos of Loisos + Ubbelohde and other daylighting experts: "They knew exactly what this thing was," he says. "They suggested we take this thing, recondition it, and beam the sun down into the basement floors, which they were converting into laboratories. And we figured we could also run the beam of light horizontally using fiber optics and partly light the labs."

And so they did, essentially turning a big portion of the old astronomy building into a massive Solatube. On the lower floors, the design called for reflectors and refractive optics, a "solar tower" and light-diffusing lenses, as well as a convex-mirror cluster at the bottom of the building.

To take further advantage of the sun, the roofs of both the Linde + Robinson center and the nearby South Mudd building will get new concentrating photovoltaic systems (~6-kilowatt and ~61-kilowatt, respectively).

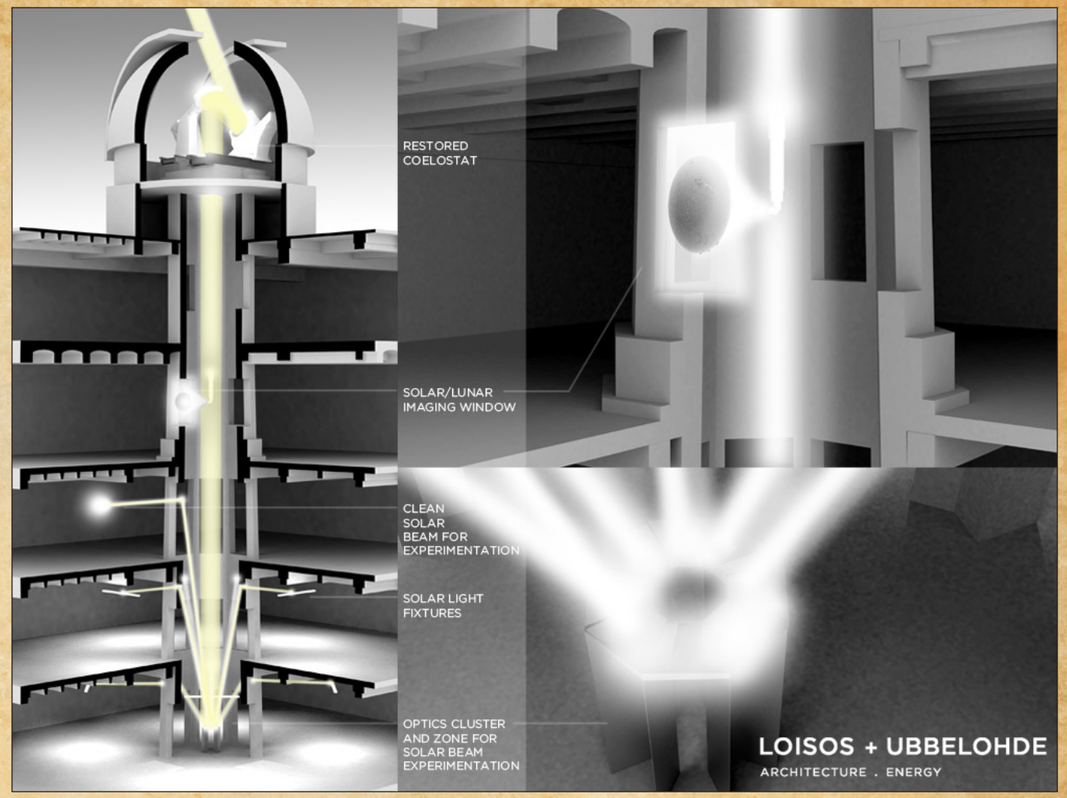
staff members and collaborators—as well as future occupants of the building (the scientists themselves).

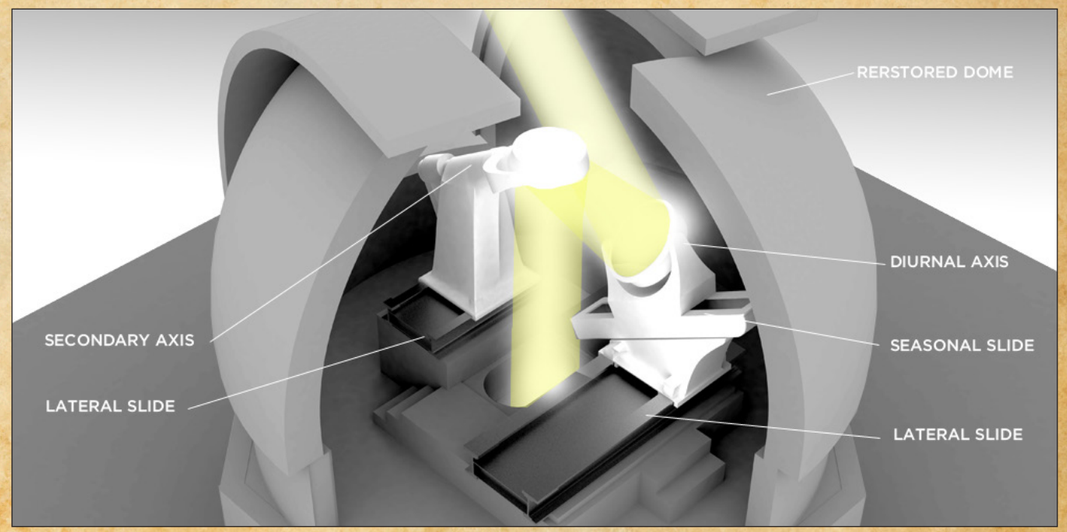
RMI Senior Fellow Peter Rumsey PE, a noted building/mechanical engineer, was part of the team that visited the old lab to see what they had to work with. "It was a very interesting building," he says. "There were a lot of astronomy symbols on the building, there was a sun built into the plaster on the outside, there were stars and zodiac signs painted elaborately on the interior ceiling. It had a lot of astronomy history—it was where they developed the Palomar telescope—but it was also a really interesting building in and of itself."

Chilling Out on Energy Use

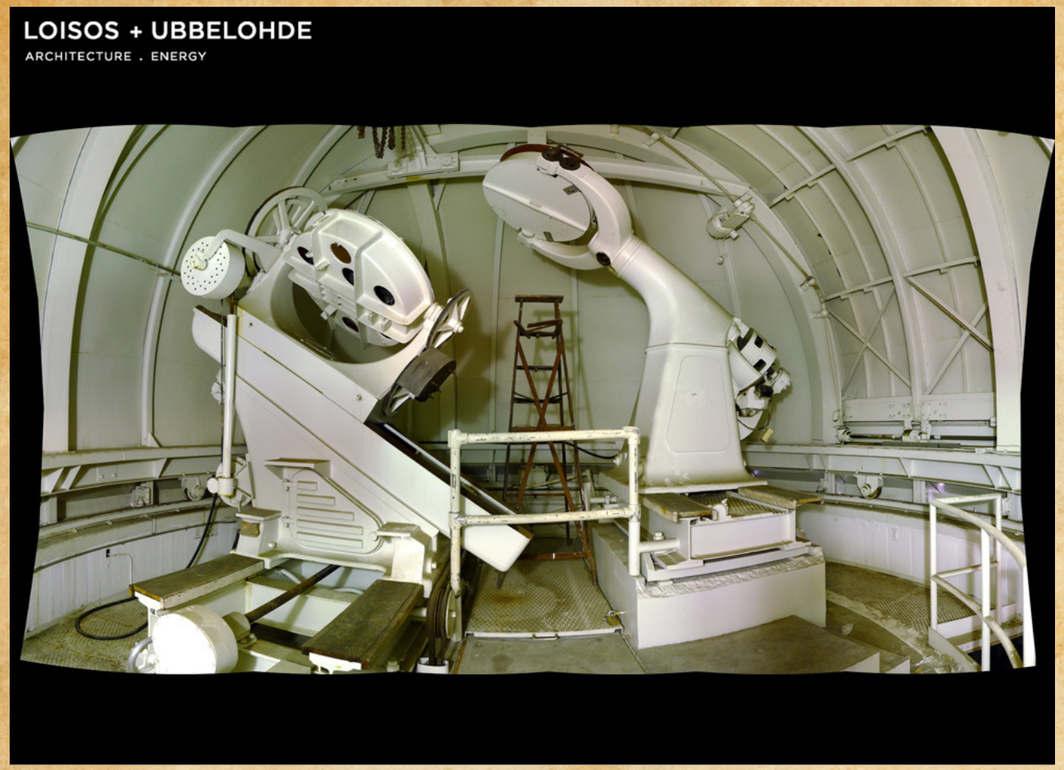
While labs use a lot of energy for heating and cooling, the Robinson Laboratory offered limited room for ductwork since it was designed for astronomy rather than as a lab per se. So the team turned to the most compact way to cool a space: water.

The vertical shaft from the old telescope drops through the building to about 50 feet below the





Images of the Active Daylight System in Caltech's Linde + Robinson Laboratory by Loisos + Ubbelohde.



Images of the Active Daylight System in Caltech's Linde + Robinson Laboratory by Loisos + Ubbelohde.

lowest basement floor, and the design team knew that lowest portion wouldn't be needed for the daylighting strategy. So they decided to use the bottom of the shaft for cold water storage. The cooling system also includes a cooling tower and a rooftop chiller.

Water will be cooled on the roof at night, then pumped into the bottom of the shaft, below the occupied lab space. When the building needs heating or cooling, a pump will move the water through radiant ceiling panels in the occupied spaces. Pumping water, when done right, can be much more energy-efficient than blowing air, and is also silent.

The design team also showed water innovation by rethinking the chiller's water temperature needs. Typically, a chilled-water cooling system uses water between 35 and 45 degrees, requiring considerable cooling energy. The team instead designed the system to use water in the 55–60-degree range, which means natural (outside) temperatures can cool the water for more hours per day than a typical system does—in short, a lot of "free" cooling.

Office Equipment

When the design team started doing the energy analysis on the building, they realized that plug loads (i.e., equipment) were one of the biggest uses. Building designers don't typically get a chance to consider the equipment that will be used in a building, the process was more collaborative than usual, and the Caltech scientists were supportive.

"Normally you don't touch that," says Brad Smith, Caltech's senior project manager, whose job it was to push the sustainable aspects of the design. "But the users said, 'Fine, if you can get us more energy-efficient process equipment, we'll take it.' So [the design team] called the manufacturers of mass spectrometers, who'd never been approached about energy efficiency."

Design team members quickly reckoned that the mass spectrometers' mini-chillers could be replaced with heat exchangers that use chilled water from the low-energy chilled-water system. "That saved a couple of residential homes' worth of energy," Rumsey says.

Entrance of Caltech's Linde + Robinson Laboratory.

Original light fixure in Caltech's Linde + Robinson Laboratory.

Photos by Bradley Smith of Caltech.

Interior of Caltech's Linde + Robinson Laboratory.

Likewise, the spectrometers' vacuum pumps were replaced with models that use about half the energy. The design team also noticed that the software running the spectrometers could be adjusted so the machines automatically power down (not switch off entirely) when not in use.

Working with the future occupants of the space, the design team was ultimately able to recommend changes to office and lab equipment that will reduce energy use by 60-plus percent over typical equipment in a facility like the Robinson + Linde Laboratory.

Fuel Cells and Chemical-Sniffing Fume Hoods

Caltech negotiated a deal with Bloom Energy so that Bloom's fuel cells will be used to partly power the building. One, a 100-kilowatt unit, will run on natural gas and provide continuous power (Smith hopes it can one day be converted to use methane from sources like landfills). The second, a 30-kilowatt hydrogen-powered Altenergy unit, will be used for backup during outages.

The lab's fume hoods (often responsible for a big chunk of energy use in labs) will come with a chemical-detection system: If the system can't smell bad stuff, it will throttle back the fans and reduce airflow, chopping energy use while ensuring safety. A standard lab hood uses as much energy as about five houses, so such controls are a big deal.

Collaboration Is King

The key to the new building's energy- and resource-efficient design, say design team members, was collaboration. Smith also emphasized how Stanback's support made RMI's involvement possible. RMI's Victor Olgyay, AIA, and Amory Lovins, Hon. AIA, participated in a design charrette and offered ideas during the early design phases, and RMI's input helped tease out unique, sometimes extreme-sounding ideas. The "firsts" the Linde + Robinson Laboratory is expected to achieve when it opens in July include:

- Lowest-energy physical science research lab in the United States;
- First lab with radiant cooling and compressor-free cooling 50 percent of the year;
- First LEED Platinum rating for a renovation of a historical research lab;
- First lab to achieve 50–60 percent lab equipment energy use reduction; and
- First lab to get 20 percent or more of its power from on-site photovoltaics.

And, of course, it will be the first building with coelostat daylighting.

All told, the building is expected to save 77 percent of the energy (6,134 MBtu/year) that a baseline design would have used and 73.6 percent ($190,212) of the cost of that energy each year.

"Many newer buildings incorporate many green features and advanced technologies," said Stanback. "The real challenge, though, is to retrofit many of the existing structures that can't simply be torn down. The final design plan that emerged from discussions between Amory Lovins, RMI Senior Vice President Greg Franta, the Caltech representatives, and the architectural firm resulted in a building that will truly inspire others about the possibilities for the green retrofitting of older buildings." ◆

Photo courtesy of Integral Group

Integral Group's Vision

RMI fellow Peter Rumsey discusses deep green engineering, the Amory Effect, and how the building industry is undeniably changing for the better.

RMI Senior Fellow Peter Rumsey leads the West Coast office of Integral Group, which is responsible for the mechanical engineering on the retrofit of Caltech's LEED-Platinum Linde + Robinson Laboratory. He has collaborated with RMI on the design of the Caltech lab and on dozens of other projects since the mid-'90s, and works regularly with RMI's RetroFit initiative, which aims to make deep energy savings in retrofitted buildings the new norm.

To increase knowledge-sharing and collaboration between Integral Group and RMI, last summer the two organizations pioneered an "externship" program. Integral Group engineer Hilary Price came to RMI's Boulder office for several weeks, while RMI analyst Caroline Fluhrer spent two months in Integral's Oakland office. "They really use integrative design to come up with more creative solutions," says Fluhrer of the team at Integral. "Integrative design is institutionalized there, and they continually focus on generating more creative and efficient solutions."

RMI's Molly Miller spoke to Rumsey about his collaborations with RMI and the challenges and joys of advancing the cause of energy efficiency and "deep green" engineering, as Integral likes to call it. Integral recently applied these deep green principles to its own office.

RMI: How did the retrofit of your new headquarters go?
Rumsey: It's an older historic building in downtown Oakland. Ninety-three percent of the people in the space have outside views. It has great air quality and great transit options. We have also installed a system to monitor plug loads. We got 101 out of 110 LEED points for a LEED Platinum building, and we did it on a tight budget, so we're very happy with it.

RMI: What's your history with RMI?
Rumsey: I started working on contract with RMI in the mid-'90s. We got involved with a wide variety of projects together over the years, and eventually our relationship developed into one of sharing information, not just doing the work. About five years ago, RMI's buildings practice asked me to be an RMI senior fellow (a loosely structured collaborative agreement between then-Rumsey Engineers, which has become Integral Group, and RMI).

RMI: Can you talk about how it worked collaborating with RMI on the Caltech lab?
Rumsey: The donors [Foster Stanback and Ronald and Maxine Linde] supported and pushed for the building to be a green building. The donors said, "This building can be something special, a low-impact sustainable building, and why don't we bring in RMI?"

We were already on board and working with the building when RMI came on. We were pushing on things and getting some resistance from some of the facilities people. Amory came in and said, "You can do more. You can push the boundaries further. Why don't you do more?" Suddenly the things we had been suggesting seemed really reasonable. Amory allowed us to push this building beyond just meeting LEED.

Amory gave a lot of support in the charette on "Let's look at the plug loads, in labs especially." Designers are generally told not to think about plug loads. So we proposed a plug load energy study, and we got 50 percent savings on plug loads. Now we've done some similar studies for other offices. The attitude generally is, build the building and the tenants are going to come later. We were talking to the tenants and equipment-makers during the design.

I don't think many labs, even new construction, will be as low-energy as this. People said, "You can't put a lab in this building. There's not enough space." But the results are as good as or better than most of the buildings that are done with new construction.

RMI: What can we in the deep green engineering world be doing differently to gain more traction?
Rumsey: We have got to get to the people who are really making the decisions: investors, developers, building managers. So often we are talking to architects. We all go to the United States Green Building Council (USGBC) conference, but we should be going to the real estate developers' conferences.

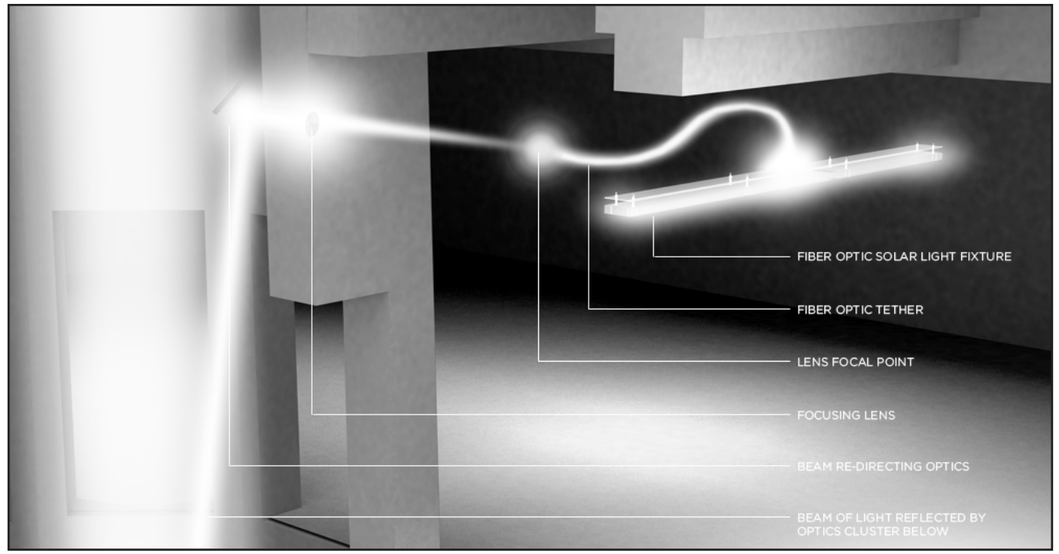
What the owners need to know is that you can do this, and it's not too expensive. They're risk-averse. In every project, when push comes to shove, we stick to the requirements that can't budge. The ones that are gray go by the wayside. I believe where there's a will, there's a way—the will isn't there.

Why did the Caltech building happen? Because Caltech and the donors said energy efficiency is not negotiable. The faculty also wanted this building to be green, and so we had the opportunity to talk to and work with the occupants, who happen to teach environmental studies, so they are aware of the impact of energy efficiency.

We have to communicate that the benefits go beyond energy savings. Most of these building owners pass energy savings on to the tenant anyway.

Photo courtesy of Architectural Resources Group

Piping design with gradual bends in Caltech's Linde + Robinson Laboratory building is more efficient than piping design with 90 degree angles because it reduces friction losses along the length of the pipe.



Images of the solar light fixtures in the Active Daylight System in the Linde + Robinson Laboratory at Caltech by Loisos + Ubbelohde.

So they just don't care about the energy savings that much. They do care a lot about lease rates and occupancy rates.

RMI: How can building owners and developers overcome the finance barrier? [An often-cited reason for not pursuing green building is that the value of investing in energy savings is hidden.]

Rumsey: I don't think there really is a finance barrier. Really, what I think is the owners have to decide they want to do it and then the money will fall into place. I don't think getting money is a problem. Maybe during the recession it has been a bit tough. But the owner has to say to the bank, "This is part of the upgrade of the building, and it will make it better."

At the end of the day, the owner and the banker are not worried about payback from energy savings. The payback is in the higher occupancy rates, not in the energy savings. Looking for an energy efficiency payback is artificial—I think people who are pushing for that are missing the point. We need more data that shows that green buildings have a higher occupancy rate.

In San Francisco, practically every building is getting the LEED EBOM rating [USGBC's rating for Existing Buildings, Operation & Maintenance]. All they have to do is get an Energy Star rating that is 75, so they are not doing much. LEED EBOM is too easy to meet—it's "light green." LEED EBOM needs to evolve; they need to raise the bar. In San Fran, if you don't have a LEED plaque in your lobby, your building is widely considered second-class.

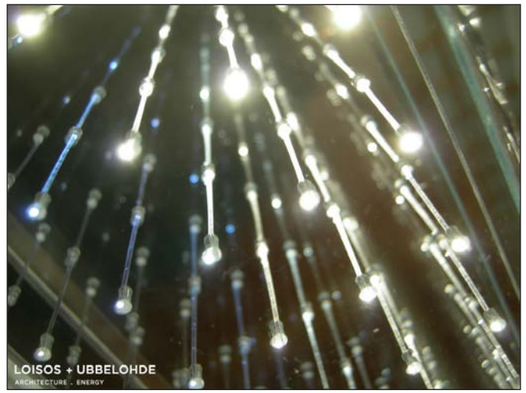
We're getting to the point where an energy-inefficient building will not get filled. In California the law states that buildings for lease must declare the energy use of the building. This is going to happen everywhere. We've got to provide the information to the developers and turn it into this competitive thing.

RMI: Have you ever tried a performance contract? [That is, offering a bonus to the design team members when they meet or exceed deep energy savings.]

Rumsey: No. People look at me like, "How are we going to work that out?" Because you design for a year, and you build for two years. So you do the work in year one and get paid in year four? You could do it on the performance of an energy model, but everybody agrees that energy modeling can be inaccurate.

It would be great if we could figure a way to get paid for the value we add. Our prices are the same as traditional engineers, but we spend more time than the traditional firm. Sometimes people realize we are providing a higher value, and so they are willing to pay a little more.

People have experimented with connecting the design/build team to energy performance, with a



Images of the Active Daylight System in Caltech's Linde + Robinson Laboratory by Loisos + Ubbelohde.

penalty if they don't hit the performance goal and an incentive if they go higher. Turns out the design team avoids the penalty rather than going for the bonus.

RMI: What are the other ways we could all do more and do better to overcome the barriers to achieving more energy-efficient designs?

Rumsey: Well, it is very easy to be critical, but there are so many positive things going on now. There was a time in the '80s and '90s when we were like, "Well, get real," but then LEED happened. Just look at the size of the USGBC: It is one of the biggest nonprofits in the world. It didn't exist 15 years ago. But the general population is waking up globally to the fact that the environment matters and it directly affects us and buildings are part of it. It's only growing.

"There's going to be a point 30 or 40 years from now when what people like Amory and I are saying about energy efficiency won't be important anymore."

When I go out and talk to young kids, there's even more acceptance and awareness around the environment. I know that's not always true in older folks…people like me [laughs]. Just look at politics around these issues. Some people are really on board, and some are not. But that skepticism is going to evaporate. Eventually there will be retrofit codes. This whole thing has a lot of momentum.

RMI: Do you have an environmental commitment that has driven you to push your team to pursue deep energy savings rather than traditional engineering?

Rumsey: I got interested in energy in the '70s during the oil shocks, when there were lines to get gas. I was really interested in energy policy, and Amory wrote this dead-on piece making the connection between the security of our nation and energy. I got motivated because of politics and the environment, but I have a passion for engineering.

Engineers hate waste and inefficiency; it's sort of in our DNA. Even in the '90s at ASHRAE, our conversations were about efficiency. In my early career, once I had saved half the energy of the building—on a bank I worked on in the Philippines—then, after that I look at every other building and I think, "It's irrational not to save energy." Now engineers are waking up. Chilled beams came along only six years ago, and once people saw them, they thought, "Well, of course we're going to do that." Developers are into not being cost-inefficient. There's going to be a point 30 or 40 years from now when what people like Amory and I are saying about energy efficiency won't be important anymore.

It's cost effective. It's practical. It's financially wise. We end up with buildings that are more comfortable to be in, and tenants like them. It just makes perfect sense that we push this harder. Innovation happens in small buildings, and then when it gets proven, people start to do it on a larger scale. Eventually there will be so much evidence that you won't be able to deny it any more. ◆

DEBATE

THE "REBOUND EFFECT": A PERENNIAL CONTROVERSY RISES AGAIN

Refuting the Jevons Paradox

BY CAMERON BURNS AND MICHAEL POTTS

There's an old economic theory that becomes a bone of contention about once a decade. It goes like this: when energy efficiency rises, people and industry use more energy—a phenomenon called "rebound." In an extreme form sometimes called "backfire," rebound doesn't just reduce but nullifies or reverses gains in efficiency.

Backfire was identified in 1865 by British economist William Stanley Jevons, who noted that efficient coal-fired steam engines so accelerated the Industrial Revolution that coal use rose, so it's often called "Jevons' Paradox."

Lately some advocates of this hypotheses have claimed that backfire is frequent if not inevitable. They assert that energy efficiency can't be expected to save much if any energy or carbon in the long run and is not therefore an effective mitigator of climate change (although they acknowledge that it does increase productivity and improve economic growth). This has provoked a strong response from many supporters of efficiency measures, including Amory Lovins, who consider that many of the arguments of backfire supporters are based on thin data and faulty conclusions.

The good news is that this lively debate demonstrates that strong support for efficiency has entered the mainstream. We at RMI believe that rigorous examination of all aspects of efficiency is fundamentally a good thing and of course welcome all voices to the conversation. Many of the key elements of this controversy are summarized below.

Jevons's old idea gained legs again in December 2010, when *The New Yorker* ran an article by David Owen, titled "The Efficiency Dilemma," suggesting the theory could apply to modern civilization on an economy-wide level.

Owen illustrates rising energy use in a variety of areas, notably refrigeration and space cooling. He details how his family went in 1954 from a "tiny, uninsulated freezer compartment" to a more modern model in the 1960s, while the 1954 freezer was put in the basement "mostly as a warehouse for beverages and leftovers" (later joined by a standalone freezer). Owen also notes that while fridges became 28 percent more efficient in 1993–2005, the average air-conditioned household saw energy use for cooling rise by 37 percent. Owen writes, "As *Losing Our Cool* [a book by Stan Cox] clearly shows, similar rebound effects permeate the economy," later noting that "all such increases in energy-consuming activity can be considered manifestations of the Jevons paradox." In short, Owen claims that those activity increases were caused by energy efficiency.

Rebound is not fully appreciated, he suggests, because "…Most modern studies of energy rebound are 'bottom-up' by necessity: It's only at the micro end of the economics spectrum that the number of mathematical variables can be kept manageable. But looking for rebound only in individual consumer goods, or in closely cropped economic snapshots, is as futile and misleading as trying to analyze the global climate with a single thermometer."

Not so fast, note a handful of energy analysts. Dr. David Goldstein of the Natural Resources Defense Council (NRDC) posted a devastating critique questioning Owen's conclusions on NRDC's blog, "Switchboard." Dr. Michael Levi of the Council on Foreign Relations and RMI Chief Scientist Amory Lovins also argue that Owen correlated more affluent lifestyle, not energy efficiency, to an increased use of energy, and that anyhow, correlation doesn't prove causality. Rebound is a real phenomenon, they agree, but it's nowhere near as big as Owen might suggest, and it's absurd to blame economic growth on energy efficiency.

"Owen confuses rebound with wealth effects, like richer people's buying cheap, inefficient air conditioners in uncomfortably inefficient buildings," writes Lovins in a response published by *The New Yorker* on January 17th. "Efficiency makes comfort cheaper but hardly affects that purchase, because future energy savings are poorly understood, diluted by capital cost, and heavily discounted—the same reasons efficiency is underbought."

Dr. James Barrett, chief economist at the Clean Economy Development Center, offers his own response to the article in his blog "Rebounds Gone Wild." Barrett adds some real data to Owen's argument on household cooling. His data show that per-capita real income rose 30 percent (meaning people "buy more stuff, including cool air"), homes got 16 percent bigger (more space to cool), and central air conditioning doubled, while the average central air conditioner use got only 11.5 percent more efficient. Thus air conditioning used more energy not because of greater efficiency but despite it.

"All of the increase in energy consumption for air conditioning is easily explained by factors completely unrelated to increases in energy efficiency," Barrett writes. "All of these things would have happened anyway. Without the increases in efficiency, energy consumption would have been much higher…. It's easy to be sucked in by stories like the ones Owen tells. The rebound effect is real and it makes sense. Owen's anecdotes reinforce that common sense. But it's not enough to observe that energy use has gone up despite efficiency gains and conclude that the rebound effect makes efficiency efforts a waste of time, as Owen implies. As our per capita income increases, we'll end up buying more of lots of things, maybe even energy. The question is how much higher would it have been otherwise."

Efficiency dilemma?...impossible.

Barrett concludes by quoting Yogi Berra, who said of a restaurant, "Nobody goes there any more. It's too crowded."

"The notion," says Barrett, "that we could get so efficient at using energy that we'd end up using more is about as valid as the idea that a restaurant could get so crowded that it was empty."

On the heels of *The New Yorker* article, The Breakthrough Institute (TBI), a California nonprofit, kicked off a technical email conversation about rebound engaging more than 30 participants, mostly energy analysts and some noted journalists. It ran intensively, with over 100 posts, in the last week of January. TBI then released a report called "Energy Emergence: Rebound and Backfire as Emergent Phenomena" (backfire is rebound greater than 100 percent).

The report, described by TBI as a "review" of the literature, states in its opening lines, "Rebound effects are real and significant, and combine to drive a total, economy-wide rebound in energy demand with the potential to erode much (and in some cases all) of the reductions in energy consumption expected to arise from below-cost efficiency improvements."

The report goes on to state, "As this literature review demonstrates, multiple rebound effects operate at varying scales and their combined effect results in a complex, non-linear interdependence among the economic activity (GDP), energy demand (E), and energy intensity/productivity (E/GDP) terms of our formula: improvements in energy efficiency do not translate into straightforward reductions in E/GDP, but rather drive multiple mechanisms that feed back into and drive corresponding changes in both economic activity and energy demand. Relying then on a linear, direct, and one-to-one relationship between below-cost energy efficiency improvements and reductions in energy demand (and thus carbon emissions), as is common in contemporary energy and emissions forecasting and analysis, will consistently produce overestimates of the net energy savings and emissions reductions potential of such efficiency measures, with potentially dangerous consequences for climate change mitigation efforts."

Our deeper analysis of this report and its sources found that it relies most heavily on literature that actually notes major uncertainties in the size of rebound—notably the UK Energy Research Center's (UKERC) 2007 report *The Rebound Effect*. That volume's opening paragraphs explain, "The available evidence for all types of rebound effect is far from comprehensive. The evidence is better for direct effects than for indirect effects, but even this focuses on a small number of consumer energy services, such as home heating and personal transportation, within developed countries. Both direct and indirect effects appear to vary widely between different technologies, sectors and income groups and in most cases they cannot be quantified with much confidence. However the evidence does not suggest that improvements in energy efficiency routinely lead to economy-wide increases in energy consumption. At the same time the

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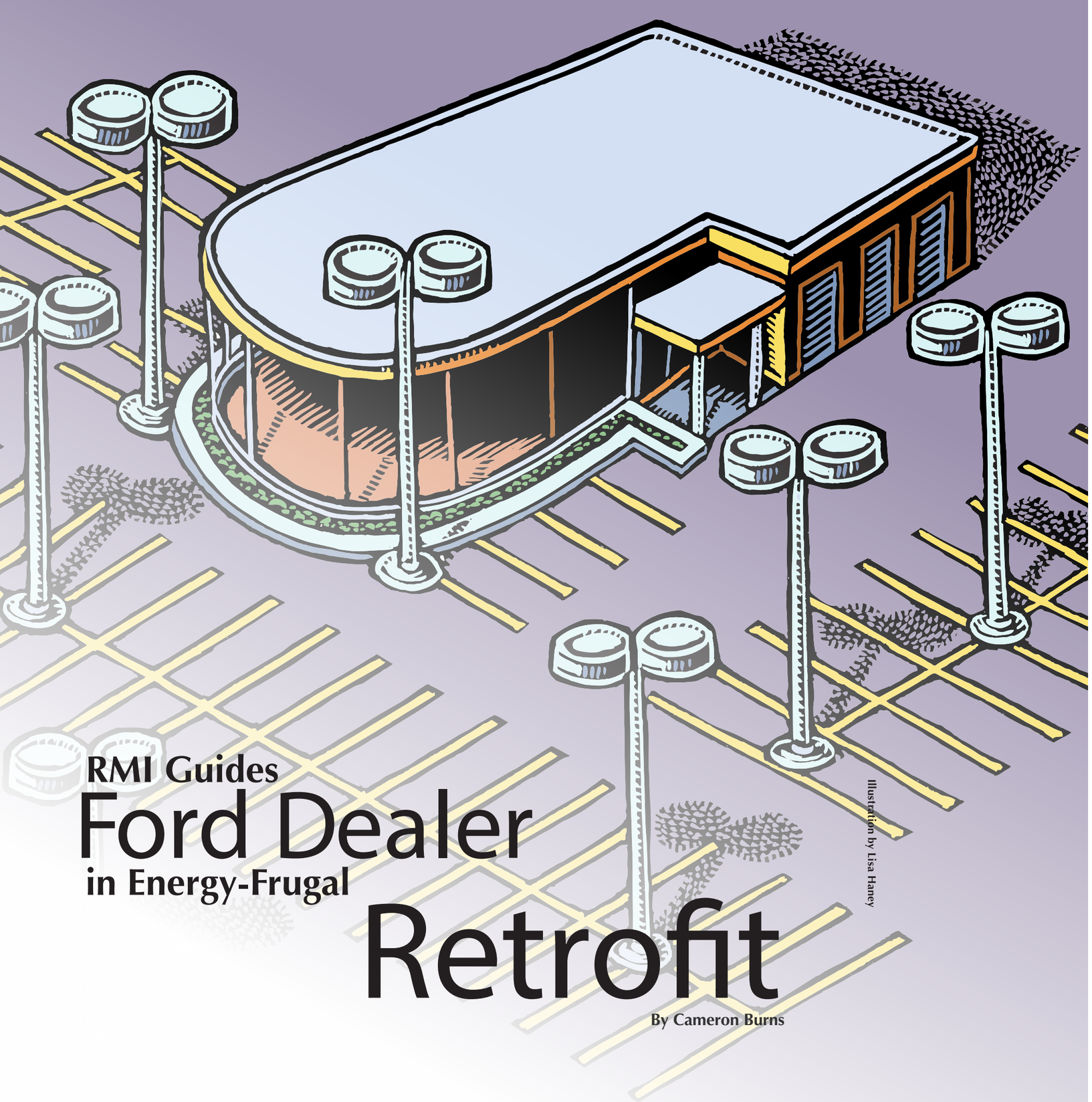

Illustration by Lisa Haney

RMI Guides

Ford Dealer in Energy-Frugal Retrofit

By Cameron Burns

"We get comments every day from customers about how much nicer the new dealership is—and saving money and saving the environment at the same time is pretty cool," says Brian Jarrett.

Jarrett is co-owner of Jarrett-Gordon Ford Lincoln, Inc. in Winter Haven, Fla., the first Ford dealership to go through Ford's Go Green energy efficiency retrofit program.

"I hadn't previously done anything to cut my energy costs, and I saw it as a good way to do that with some expert help," Jarrett recalls.

Soon after an initial meeting with RMI, Jarrett says, RMI sent engineers to conduct various modeling and testing procedures—"the roof structure, the energy consumption, the water, the walls, thermal energy coming into and out of the building." Several months later, Jarrett received "a very detailed, very aggressive script to follow to become energy- and water-efficient."

For a 40,000-square-foot commercial facility in the sunny and humid Florida climate, it's not hard to guess the two biggest areas for energy improvements: cooling and lighting. RMI staff members suggested replacing the roof with a superinsulated roof and a white membrane to reflect the sun's heat, and replacing all the heating and cooling units with very efficient but smaller ones. The roof was replaced last summer.

Jarrett recalls. "When we put the new roof on, it lowered the temperature inside by 10 degrees."

The retrofit also addressed thermal comfort in the service bay, which had no heating or cooling. The dealership replaced several relatively ineffective midsized ceiling fans with two high-air-volume but low-velocity fans (16 to 18 feet in diameter), saving more than $1,000 a year.

To address the huge lighting energy use (38 percent of the energy bill) RMI recommended Solatubes—internally reflective daylighting tubes—in every office and hallway, and even in the parts warehouse. (Because the service department doesn't have a drop ceiling, it used skylights instead.)

"If there are no clouds in the sky, we don't need any electric lights," Jarrett says. "Around 10 in the morning, the lighting control panels will shut the lights off, and around 4:30 in the afternoon the control panel will start turning some of them back on again. Through the middle portion of the day, there's not a single light on in the store."

According to RMI buildings analyst Mike Bendewald, the goal was to provide electric lighting only where it was needed and to create, as he terms it, "daylight autonomy."

"We suggested taking down some fixtures, replacing others, reducing the amount of electric light in some areas, and providing accents in certain places," he says. "We also recommended adding controls like occupancy sensors and daylight sensors."

Before the retrofit, the dealership had monthly electric bills of just over $5,000; now it pays just over $2,000. And the collaboration between Ford, the dealership, and RMI, says Jarrett, produced a very appealing building for both occupants and customers.

"The light is much more natural," he says. "When we turn on the electric lights, you get a more yellow color than you get from the actual sunlight that comes through the office Solatubes. So it's a lot cooler, more natural feeling. And the air conditioning system works much better than our old one, so our environment's much cooler. We have skylights in the showroom, so the cars are all sunlit. It's a much different look than we used to have. Even with the lights on, it still felt like you were inside—now it feels like you're outside."

RMI is now hoping to collaborate with Ford on a second phase to address the rest of its dealerships.

"It's been a long project, but it's been a rewarding one," says Jarrett, "and now that we're finished, I think everyone, both employees and customers, is really excited to see this finished product." ◆

Go Green: Ford Leads Dealership Efficiency

Photo by George Aycrigg, courtesy of the *News Chief*.

Brian Jarrett at his dealership in Florida.

RMI's RetroFit Initiative encourages the widespread adoption of deep energy-saving retrofits in existing buildings. One of its first projects involved collaborating with Ford Motor Co. on a pilot program to improve the energy efficiency of Ford dealerships in diverse climates. Ford is working to expand this into the Go Green Dealer Sustainability Initiative, a voluntary program for Ford and Lincoln dealers designed to cut operating costs and reduce carbon footprints. It would also enhance reputation, showcase the company's philosophy and perhaps even boost sales.

As part of the pilot program, RMI undertook comprehensive energy and water audits on the dealerships, created energy and daylight models to evaluate a variety of energy efficiency measures (individually and as "bundles"), analyzed lifecycle costs, and combined the Institute's recommendations into a business case. RMI also conducted a charrette with key Ford stakeholders to review business case findings and identify areas in which to expand the program across the portfolio and advised dealerships on implementing the measures.

"The Ford project is a perfect example of how, within RMI's new strategy, we can have a far greater impact than with a one-off building consulting project," says project manager and RMI senior consultant Cara Carmichael.

Certain efficiency techniques demonstrated in the pilot projects can be applied very widely, since many of Ford's 3,000-plus dealerships share similar characteristics even though they range from 2,000 to 60,000 square feet. As more dealerships volunteer to participate, "the results of our work have the potential to be implemented on a large scale," Carmichael explains.

"In keeping with Ford's commitment to the environment, this program is a great fit for our dealers because it provides a variety of energy-efficient improvement options regardless of the current age and design of the facility," says Sue Cischke, Ford's group vice president of sustainability, environment, and safety engineering. "This allows all dealers the opportunity to participate in improving the energy efficiency of their facilities and gives them flexibility in making choices that are right for them and their dealerships."

Dealers interested in participating in the Go Green Dealership Sustainability Initiative receive a comprehensive energy assessment from experts in Ford Land's Energy Department. Then Ford Land's Dealership Real Estate Department reviews the available energy-saving options with the dealer and tailors a program to meet that dealer's needs. Solutions are wide-ranging, and dealers can implement them in both existing and planned facilities.

"We applaud Ford for its energy-efficiency leadership," says RMI Chief Scientist Amory Lovins, "and for showing that wise energy use is not only about vehicles. As participating dealers save energy and set a highly visible example in their communities, the benefits will flow to their bottom lines, the prosperity of their customers, and the whole planet."

—Molly Miller

Continued from page 22

evidence suggests that economy-wide rebound effects will be at least 10 percent and often higher. Rebound effects therefore need to be factored into policy assessments."

Critics of TBI's sweeping assertions generally agree that rebound effects are real but generally much smaller than TBI asserts. In a response to another blog on NRDC's Switchboard, RMI Senior Fellow Dr. Jonathan Koomey explains the first of these two effects.

First, there is what he calls "end-use" rebound, which is what microeconomists have called the rebound effect. When a device becomes more efficient, people use it a bit more because it's cheaper. "In practice the size of this effect is zero or very small," Koomey says, "except in a small number of cases, like space heating or autos when it's modest (10–30 percent)."

Then there's what he calls the "respending effect," when the money saved from efficiency gets respent on other things. According to Koomey, this effect is in practice capped at 6–8 percent, the fraction of GDP that is energy related. "This is a macro effect that is independent of specific end-uses—if energy is saved from efficiency, then it is either respent or reinvested, and that will have some (small) effect on aggregate energy demand. If it is reinvested into efficiency, of course, then the result is different, but if it is spent, the 6–8 percent number is probably a good round-numbered quantification of the effect," says Koomey.

Finally, there's a rebound effect Koomey calls BTI. "Others posit that takes place because of the substitution of energy for other factors of production within firms, because energy services are cheaper inside those firms," he explains. "I still haven't figured this one out, but that's what we're initially focusing on in our discussions."

This last effect depends on the "elasticity of substitution"—a measure of how readily firms substitute energy for capital and labor. Having reviewed more than 200 studies of this quantity, a UK Energy Research Center report found, "The extensive empirical literature in this area is both confused and inconclusive and provides an insufficient basis for the assumed parameter values within energy-economic models." It adds that "more than three decades of empirical research [fail] to reach a consensus on whether energy and capital may be considered as 'substitutes' or 'complements'… While this [confusion] may be expected if the degree of substitutability depends upon the sector, level of aggregation, and time period analyzed, it is notable that several studies reach different conclusions for the same sector and time period, or for the same sector in different countries…. Moreover, the relationship between the elasticity of substitution and the rebound effect turns out to be far from straightforward…. In addition, since most empirical studies measure something quite different from the parameters within energy-economic models, the empirical basis for those models is further called into question...."

For now, the "big" rebound debate has quieted and become a structured exploration between the TBI camp, Koomey, Lovins, and other experts in several countries, but it will undoubtedly heat up again as their inquiries do or don't reach conclusions. While most credible energy experts agree that rebound is a real phenomenon, the question remains: Can it be as big as suggested by Owen and TBI?

"The normal burden of proof is on those advocating the existence of some unexpected and novel effect to show the underlying causal mechanisms that lead to that result, so the assumptions can be peer-reviewed," notes Koomey in a brief comment on the TBI report. "I can't prove that large rebounds don't exist, just like I can't prove that black swans don't exist in the absence of a perfectly accurate universal census of swan colors, but if someone brings me a black swan, the problem is solved. And that's what those of us skeptical about large rebound effects continue to request: Bring us a black swan!"

RMI and TBI agree efficiency is an important economic stimulant. If you think economic growth is good, as most economists do, then saving energy (and carbon) while also stimulating the economy is a welcome bonus, not a disadvantage: you get the economic growth with less, little, no, or negative energy growth, depending on how far and how fast you boost efficiency.

In our view, energy efficiency offers the all-important advantage of carbon reduction, and it can complement policy efforts (such as carbon caps or fuel taxes) that might deliver the same or better services with less total energy use. Certainly, it can bring energy use to a level where renewable energy can contribute more and sooner. Done right, energy efficiency will help us get to a richer, fairer, cooler, safer world. And its record so far is impressive.

"Energy savings have…offset 81 percent of the energy consequences of U.S. economic growth since 1975, and effectively 'fuel' half of today's G.D.P.," Lovins wrote in his *New Yorker* letter. "In eleven of the past thirty-four years, U.S. energy use fell; in nine of those eleven, savings grew faster than G.D.P. Paying attention to energy efficiency could achieve this every year—as we did with oil from 1977 to 1985, when G.D.P. rose 27 percent while oil use fell 17 percent." ◆

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May – July 2011

ASES 2011: May 17–21—Raleigh, NC
www.nationalsolarconference.org/solar2011/public/enter.aspx
The National Solar Conference is the longest-running educational event for solar energy professionals in the U.S. Now in its 40th year, the SOLAR 2011 program will be developed by solar energy experts in all topical areas—technology, buildings, policy, professional education, workforce development, and consumer education.

ULI Spring 2011: May 18–20—Phoenix, AZ
www.ulispring.org
The 2011 ULI Real Estate Summit at the Spring Council Forum is an exclusive, ULI members-only event. It will bring together top decision-makers and industry experts to discuss the future of real estate and how individuals and companies can successfully adapt for what is coming. Hear from leading researchers and practitioners. Share your challenges and learn from others during town hall sessions and highly-interactive roundtable discussions. Make new connections with key contacts from around the world and across every sector of the industry at one meeting.

Congress for New Urbanism: June 1–4—Madison, WI
www.cnu.org/cnu19
Drawing on the close relationship Madison has with its agricultural neighbors, CNU 19 will build on the theme of "Growing Local." The conference will explore linkages that urban communities have with local food production, the food economy and the infrastructure that has developed around this symbiosis.

ASHRAE 2011 Annual Conference: June 25–29—Montreal, Quebec
http://ashraem.confex.com/ashraem/s11/cfp.cgi
Alternative technologies, net-zero buildings, engineering tools, HVAC&R fundamentals and commissioning are among the topics that will make up ASHRAE's 2011 Annual Conference in Montreal, Quebec, Canada. With RMI Presenter, James Brew.

BOMA 2011: June 26–28—Washington, D.C.
www.bomaconvention.org/boma2011/Public/Content.aspx?ID=1459
The BOMA International Conference & The Every Building Show® is the one event of the year that brings together the foremost experts and resources in the commercial real estate industry. Building owners and managers from across the U.S. and around the world come together to discuss current trends, best practices and learn firsthand what industry leaders are doing to stay ahead.

Plug-In 2011: July 18-21—Raleigh, NC
plugin2011.com
Join us in Raleigh, North Carolina from July 18-21, 2011 for in-depth discussions about vehicle, component and infrastructure technologies, results of pilot programs, customer surveys, PEV/PHEV readiness plans, and the challenges and opportunities that lie ahead.