Solutions

Journal

REINVENTING FIRE

After 27 years of innovation, Amory B. Lovins discusses RMI's Next Big Thing

Fall 2009

Also in this issue—

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Solutions Journal

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Reinventing Fire

By Amory B. Lovins

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If Necessity is the Mother…

"Necessity is the mother of invention." But who is the father?

Necessity alone falls flat. Our *need* to do something doesn't mean it's going to happen. Everyone *needs* to exercise more and eat better. We *need* to get more sleep. We *need* to pay down our consumer credit. But, as a society, we just *don't*.

Is it because we don't know they are necessities? No—plenty of healthcare professionals are unhealthy and plenty of bankers are deep in debt. They aren't oblivious or stupid. They struggle with conflicting priorities today that prompt them to push action out to the future…even in the face of certain necessity. So necessity alone creates a feeling of uneasiness and incompletion, but no action.

What's missing is the father of invention: urgency. It takes necessity *plus urgency* to trigger decisive action. There's nothing like an impending high school reunion to shave off a few pounds, or the possibility of a dream home purchase to clean up a credit record.

Today, most people and organizations agree that we *need* to shift off of fossil fuels to create a smarter, safer world fueled by efficiency and renewable energy. We *need* to stop wasting energy by poor design and bad choices. We *need* to improve our environment, our economy, and our national security. Is there any single issue that is more important for our future?

There are those who attempt to generate urgency by generating fear of the future. Hence the robust discussions about peak oil, energy wars, grid vulnerability, and climate change. These are important issues, but there are inevitably at least two perspectives on every subject, with smart people on all sides forming ranks to do battle. The dark, scary scenarios and the upbeat, cheery scenarios get polarized and over-simplified. Ultimately, these discussions often create more conflict than urgency—more heat than light. In any event, positive and sustained change rarely emerges from fear.

Another way to build urgency is to create a compelling vision of a positive future and a concrete roadmap to get there. This is the work of RMI. We speed transformational change by helping people and organizations understand what they need to do and how they can benefit.

Our new strategy, Reinventing Fire, targets the four sectors where fossil-fuel energy is consumed—transportation, buildings, industry, and electricity generation—and outlines a realistic path for each sector to make the transition from oil, coal, and ultimately natural gas to efficiency and renewables.

This transition faces monumental barriers, but we tackle them head on. As practitioners, we take a hands-on role in the actual work: we co-lead the design and retrofit of buildings; we consult for utilities to influence their resource planning; we crawl into ducts, delve into mines, and redesign factories; we help real-estate developers and high-tech companies and universities and automakers and trucking firms and military officers look at their work, and their world, in a different way.

When we dive into each challenging project, our eyes are set not only on its successful completion but also on the ten or hundred or thousand future projects it can trigger by providing a game-changing example of what is possible. We achieve this "amplification" by designing engagements so our partners can leverage shared findings into wide replication, so breakthrough results can be verified and publicized, and so key players will be motivated to accelerate additional change. When we help to transform the Empire State Building or a transportation fleet or the resource plan of a major utility, we are determined that all of our lessons learned build urgency that will trigger many more transformational events, at home and abroad.

Our new strategy aims to build this powerful urgency, over and over, to speed this most critical transformation. Necessity plus urgency triggers decisive action. Call it our own kind of blind date with destiny—bringing the mother of invention together with the father—to speed the invention of a better world by reinventing fire. We couldn't do it without your support.

Michael Potts
President and CEO

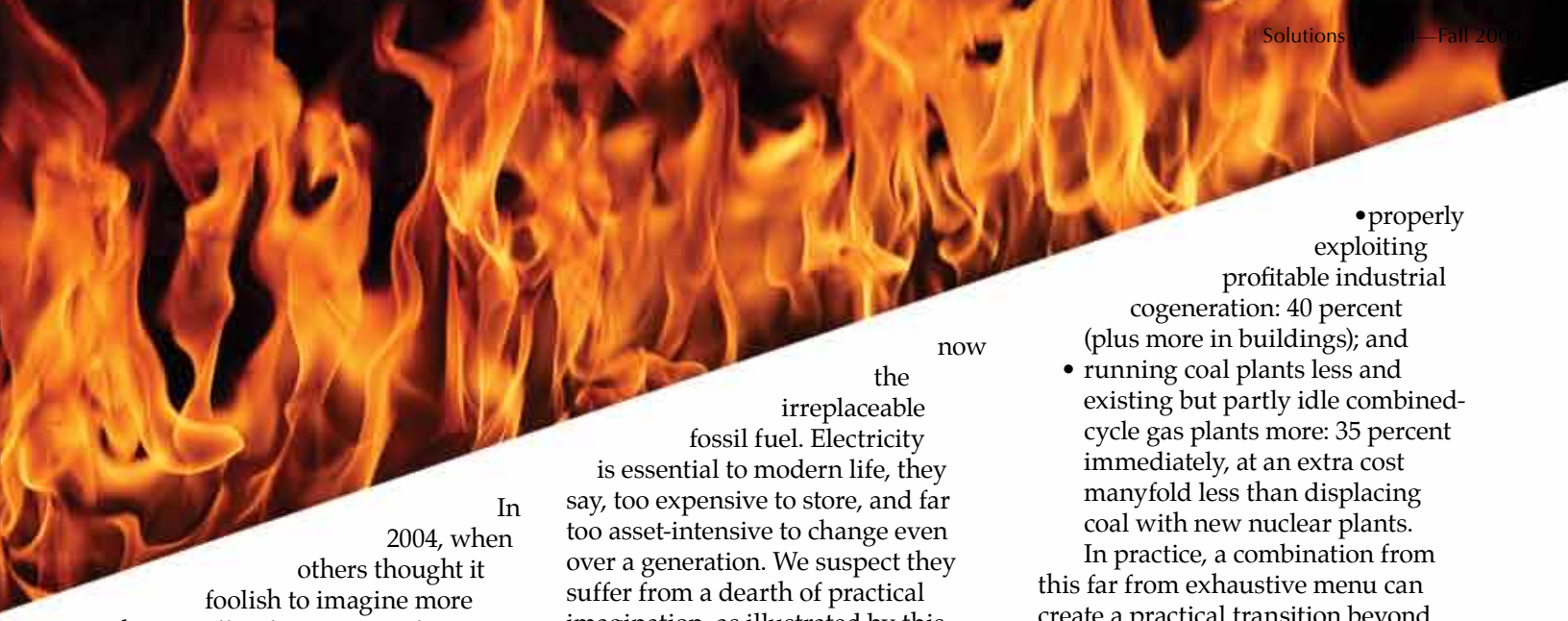
By Amory B. Lovins

Since 1982, Rocky Mountain Institute has been hatching gamechanging innovations to help make the world richer, fairer, cooler, and safer. Among other things, RMI has made important contributions toward achieving tripled-efficiency cars, trucks, and airplanes; laid many conceptual and practical foundations for electric and water efficiency, widespread renewable energy, and community economic development; devised profitable approaches to solving climate change, oil dependence, global insecurity, nuclear nonproliferation, and critical-infrastructure vulnerability; and forged (with Paul Hawken) a natural version of capitalism. We feel that all this work has prepared us well for what comes now.

RMI's Next Big Thing will bring together all of our 27 years of innovation and engage the world in our most ambitious and important work yet. Put simply, this effort is aimed at changing the way most people have been getting and using energy since the Industrial Revolution. With this project, we want to set in motion a movement to end the increasingly dangerous practice of digging up fossil fuels formed hundreds of millions of years ago from primeval swamp goo, then wastefully burning these fuels to form carbon dioxide that recreates those swamps' tropical climate. We will extend from oil to all fossil fuels our experience in envisioning and catalyzing energy systems that, in our Trustee Ray C. Anderson's words, take nothing, waste nothing, and do no harm. We mean to speed the transformation from pervasive waste to elegant frugality, from causing scarcity by inattention to creating abundance by design, from liquidating energy capital to living better on energy income. In short, we are Reinventing Fire: driving the business-led transition from oil, coal, and ultimately gas to efficiency and renewables. This fire in our belly will engage all of RMI's 88 staff, our global network of colleagues and supporters, and new advisors and partners from the private and public sectors.

Reinventing Fire aims to change minds and clarify choices by showing what exists, what works, what makes sense and makes money, what can change the world. Some may say this vision of moving past the centuries-old fossil-fuel era is implausible, too bold, too far. The same skepticism existed back in 1976, when national energy policy wasn't working, and I jumped in headfirst with a "soft path" vision reframing the energy problem around efficiency, end use, and least cost. This new logic was ultimately accepted and validated. Thanks to widespread innovation and the work of countless allies, U.S. energy use in 2000 was just 3 percent above the 1976 soft path graph in *Foreign Affairs*—even 1 percent below it per dollar of GDP. Still, progress is not coming fast enough, and energy remains a serious challenge for the U.S. and the world.

With Reinventing Fire, RMI hopes to engage our most credible and influential skeptics. By understanding the strongest counter-arguments, barriers, and doubts, RMI will shape its message and design its implementation plan to enlist the most powerful kinds of partners in speeding the transition away from fossil fuels. Reinventing Fire encompasses diverse activities, all aimed at eliminating fossil-fuel use and shifting toward radical energy efficiency and abundant renewable energy. RMI seems uniquely qualified for this challenge.



In 2004, when others thought it foolish to imagine more than small reductions in oil imports, RMI laid out a detailed plan to displace oil altogether at an average cost of just $15 per barrel (www.rmi.org/rmi/Winning+the+Oil+Endgame), then worked with select institutions to get that transition underway. Today, with the help of powerful and scary climate-change findings and the global financial crash, the U.S. may finally be starting to kick its oil habit. In 2009, the *Wall Street Journal* reported (online.wsj.com/article/SB123957686061311925.html) that "many industry observers," including Exxon-Mobil, agree U.S. gasoline demand has peaked and is headed down indefinitely. Deutsche Bank says world oil use will peak by 2016, then decline; OECD oil use has already trended down for the past 15 quarters. Still, oil remains important and politically potent. Economic woes at home and conflicts abroad remind us that the end of the oil age cannot come fast enough. Through our Reinventing Fire initiative, RMI aims to help put oil solidly on track to become, over the next few decades, no longer a strategic commodity—much as (Jim Woolsey reminds us) refrigeration did to salt. We've been predicting for two decades that oil would become uncompetitive even at low prices before it became unavailable even at high prices; now it's time to make that trend unarguably irreversible.

Much as cold warriors cast about for a new enemy after the Soviet Union collapsed, many feel that coal is now the irreplaceable fossil fuel. Electricity is essential to modern life, they say, too expensive to store, and far too asset-intensive to change even over a generation. We suspect they suffer from a dearth of practical imagination, as illustrated by this list of what approximate equivalent percentage of U.S. coal-fired electricity could be saved by:

- using electricity only as efficiently (per GDP) as the top ten states averaged four years ago: ~60 percent (ert.rmi.org/cgu/index.htm);
- systematically using electricity with cost-effective efficiency: 100–150 percent, at a lower cost than just buying the coal;

We mean to speed the transformation from pervasive waste to elegant frugality, from causing scarcity by inattention to creating abundance by design, from liquidating energy capital to living better on energy income.

- adding windpower in available windy sites: over 400 percent, at or below wholesale power prices;
- building just the windpower now stuck in the interconnection queue: 50 percent;
- properly exploiting profitable industrial cogeneration: 40 percent (plus more in buildings); and
- running coal plants less and existing but partly idle combined-cycle gas plants more: 35 percent immediately, at an extra cost manyfold less than displacing coal with new nuclear plants.

In practice, a combination from this far from exhaustive menu can create a practical transition beyond coal, with cleaner air, right-side-up landscapes, more jobs, greater energy security, and lower electric bills.

Our experience convinces us that the world is short not of oil but of innovation, not of gas but of gumption, not of coal but of courage. RMI's latest energy goal is our boldest yet, but our team and our toolkit are also more capable. Back in '76, allies were few and far between. Today, as Chief Scientist I'm blessed with an unusually experienced and imaginative team, plus outside collaborators across all facets of society. Stephen Doig and Robert "Hutch" Hutchinson have joined RMI's leadership team to help focus our work and sharpen our impact. Our "middle bench" has gained strength with many practitioners who are now experts in their own right and have a collective tenure measured in decades. And there are plenty of rising stars: RMI is attracting more high-caliber recent graduates than ever before.

It's not just our team that has changed. The world has never been more receptive to our ideas. Though an immense amount of hard works remains, we see strong empirical evidence that it's now feasible, and there's a strong business case, to get the United States and the world completely off fossil fuels. Tapping, in particular, the two biggest motherlodes of energy, efficiency and the Sun—a free, reliable, well-engineered fusion reactor appropriately sited 93 million miles away—can replace the flames

and, over decades, douse the embers of coal, oil, and ultimately natural gas.

Energy Efficiency

Wringing far more work from our energy by substituting brains and technology yields the best services with the least cost, harm, risk, and hassle. Efficient use is generally the largest, least expensive, most benign, most quickly deployable, least visible, least understood, and most neglected opportunity in the whole economy. Efficiency can save half of U.S. oil and gas at about a fifth of their current price, and probably three-fourths of U.S. electricity at about an eighth of its price. RMI is speeding the expansion of this vast "efficiency resource" by showing how whole-system design integration can often make very large (sometimes even tenfold) energy savings cost less than small or no savings. This way to turn diminishing returns into expanding returns is the focus of our parallel 10xE (Factor Ten Engineering) effort, which supports Reinventing Fire's efficiency analyses.

Besides inefficient end-use devices, conversion from the primary fuels we dig up or the natural energy we capture to the delivered energy we convert into services like hot showers and cold beer loses an astounding amount of energy. Waste heat in the electricity system is the biggest single U.S. energy use, accounting for 28 percent of primary energy consumption and nearly half its growth: our power plants discard as waste heat more energy than Japan uses. We should either use that wasted energy (as Europe profitably does) or design it out (most renewables make no waste heat and require no cooling water).

As we embark on speeding the transition to the efficient use of renewable energy, we can be cautiously encouraged by history. Over the past few decades, the U.S. and many other countries have shown that the supposedly iron link between energy growth and economic growth can be not just reduced but reversed. In 2006, America's absolute use of total energy, oil, gas, and coal even went down, because energy intensity fell more (3.32 percent) than the economy grew (2.78 percent). Today America enjoys more than doubled GDP, but consumes one-half less energy and oil, two-thirds less water and directly used natural gas, and 18 percent less electricity to make a dollar of GDP than in 1975.

While directionally correct, this trend is not yet strong enough. The U.S. is still an incredibly energy-intensive society. Denmark just grew its economy 56 percent without using more energy. Japan wrings 2–3 times more work from its energy than the U.S. does, yet has shown how to triple energy productivity again. Reinventing Fire requires unlocking the full potential of energy efficiency. The relative lag in electricity savings as compared to oil, gas, or water has some difficult causes we'll need plenty of help to address: perverse regulatory incentives, higher subsidies, antiquated pricing, and unusually pervasive barriers to efficiency, such as the split incentive between landlords and tenants. But saving electricity, the costliest form of energy, offers special leverage in saving not just money but also carbon, because saving one unit of electricity saves three units of power-plant fuel, half of which is coal, the most carbon-intensive fuel. Both in buildings, which use 70 percent of U.S. electricity, and in industry, which uses 30 percent, we have compelling case-studies, market insights, and implementation innovations to take to scale.

The Supply Side

Once we use energy in a way that saves money, supply becomes much easier, and important synergies emerge between efficient use and renewable supply. Solar energy provides all renewable and nonrenewable energy (except tides, which are mainly moon-powered, and geothermal, which provides 0.2 percent of the Earth's warmth and is fed by radioactivity). Every 70 minutes or so, the sun supplies the Earth with enough energy to run global civilization for a year. An average square meter of land receives each year as much energy from the sun as is in a barrel of oil, and it falls reliably, freely, and relatively evenly on rich and poor alike. The energy-intensive U.S. uses about 4,000 times less electricity than it receives solar energy; the world, about 10,000. The world's electricity use could in theory be provided 20 times over just by modern 20-percent-efficient solar cells on the rooftops of buildings in the 1 percent of land area that dense cities already cover. Solar power is always in stock, never runs out (even at night when it's shining elsewhere), is safe, and never threatens us with terrorist plots. The sun also causes wind, which could cost-effectively provide over 35 times global electricity needs, particularly at night. Sun and wind are the fastest-growing global energy sources: windpower was the biggest addition to power generating capacity in the U.S. in 2008, and in Europe in 2007–08. Sun and wind in 2008 added, respectively, 6 and 27 of the 40 billion watts of new renewable power worldwide (excluding big hydro dams). Sun powers photosynthesis, which can produce the biofuels for

Reinventing Fire is based on RMI's 27 years of work on real-world, economically viable solutions for energy efficiency and renewable energy. It is the foundati

efficient mobility without interfering with food and fiber production or destroying natural ecosystems. Solar warmth already does 98 percent of our space-heating: without it, the Earth's surface temperature would average not 15˚C but nearly –273˚C. Reinventing Fire is about putting the sun's benign warmth to efficient use in vehicles, homes, factories, neighborhoods, planes, electricity systems, ships, appliances, trucks, and cities, with all these devices, systems, and social orders sharing power and information to create mutual value.

Information Technology

But the Reinventing Fire story is not just about efficiency, the sun, wind, and other renewables. In the third of a century since the soft energy path, a powerful new force has begun to reshape society: modern information technology (IT). Putting IT to work can speed the leap from fossil fuels to efficiency and renewables. In the past 15 years, the digital age has brought us software that designs practically everything and can be reshaped to design in efficiency, plus tools that let us see and understand the entire energy system, from upstream at the power plant to downstream at my computer. It can also be effectively controlled at a distance. Thirty years ago, few utility managers thought about influencing a home's or a factory's power consumption. Now, many smart utility managers are doing just that, sniffing out places—swimming pools, water heaters, air conditioners, manufacturing equipment, commercial lights—where sharing information with consumers to inform smarter choices can retime use, cut costs, and curb emissions. The Federal Energy Regulatory Commission has

RMI's New Program Directors

As RMI embarks on Reinventing Fire, Program Directors Robert ("Hutch") Hutchinson and Stephen Doig, along with Chief Scientist Amory Lovins, will jointly lead the Institute's various initiatives. As Coleaders of RMI's Research & Consulting work, their task is to drive higher levels of impact, develop a strong talent pool, and to help RMI's people become future leaders.

Prior to joining RMI, Hutchinson was Managing Director at Pronghorn Ventures, and a consultant to a number of venture-backed and not-for-profit companies in the alternative energy and social services fields. Previously, he spent 18 years with the Boston Consulting Group, where he helped set up several offices and the Global Energy and IT practices; he was also active in BCG's industrial and high-tech practices. Earlier in his career, he was a research engineer and program manager at Battelle's Pacific Northwest Labs, Exxon, and MPR Associates. He has lived and worked in Europe, Brazil, Mexico, Australia, and the U.S. and is fluent in Spanish and Portuguese. He has an MBA and MS in mechanical engineering from Stanford, completed graduate studies as a Churchill Scholar at Cambridge University, and earned a BE in mechanical engineering and mathematics from Vanderbilt University.

Doig, formerly head of RMI's Energy & Resources Team, brings to his new position extensive expertise in utilities and the electrical system. In recent years, Doig's team has developed wind energy models, helped design an efficient data center that needed no mechanical chillers, optimized an oil refinery for energy efficiency, and worked with utilities to implement efficiency and renewable energy. Prior to RMI, Doig worked at McKinsey & Company for nine years. There, he concentrated in operations work in the areas of lean manufacturing, as well as purchasing and network optimization. Doig is also an advisor to the Air Force, and an adjunct faculty member with the Wharton School of Business. He holds a Ph.D. in chemistry from the University of California, Berkeley, where he studied bacterial photosynthesis; he also holds an AB in chemistry from Dartmouth.

on of RMI's newly refined strategic focus to help the United States speed the transition away from fossil fuels.

Commercial Building Retrofits

When RMI joined a team developing a plan for a thorough energy efficiency retrofit of the Empire State Building (ESB), the Institute had not yet fully understood how a single iconic project could become both a catalyst and a template for others. But now, a year after the plans were completed, countless skyscrapers are following in the footsteps of the ESB. It shows that RMI's work on one special project—with a creative, dedicated team and the right follow-through—can affect energy consumption in an exponential way.

This viral effect is what we're hoping to achieve with our new Commercial Buildings Retrofit Initiative (CBRI). Specifically, RMI hopes to spur the retrofit of at least 500 buildings within CBRI's approximately five-year lifespan.

RMI is focusing on retrofits because roughly 20 percent of U.S. fossil fuels are used to power, heat, and cool existing commercial buildings; it's impossible to eliminate the need for fossil fuels without dramatically reducing these buildings' energy use. The stock turns over slowly, and major overhauls are relatively rare. But the kind of overhaul undertaken at the ESB, called a "deep" retrofit, can substantially improve the average commercial building's energy efficiency. We designed this initiative to share the techniques, and increase demand for them, as quickly as possible.

RMI will help building owners know what to demand in cost-effective retrofits and offer service providers the right approaches in suitable segments of the U.S. building stock. In collaboration with appropriate and carefully selected marketplace partners, the Institute will create, execute, publicize and accelerate the spread of deep, profitable commercial building retrofits. Replication will be supported by project examples, research directed at breaking down barriers in the marketplace, and targeted outreach.

As we complete the planning for this work, we are asking some questions. How can we have the widest-reaching effect? Can we prove the business case to someone with extensive property holdings? Can our analysis and audit process be speeded up after the first round? What kind of software and training tools can we offer to ensure whole-system solutions are implemented? How can we replicate insightful design solutions beyond the initial projects we tackle? What kind of financing and policy levers can we use to perpetuate our work? Finally, how will we know when we have done enough ourselves, and when we should step aside?

RMI's work on commercial building retrofits will be complete when we see the "snowballs" that we roll grow and gain speed toward our ultimate goal—retrofitting the entire U.S. commercial building stock to use, on average, 50 percent less energy by 2050.

—Molly Miller, RMI

found up to 188 billion watts of such "demand response" potential in the United States; we suspect there may be even more. As smart cars, buildings, and grids start exchanging electricity and information (see http://move.rmi.org/innovation-workshop-category/smart-garage.html), more generating and storage capacity will be aboard vehicles that customers bought anyhow to provide mobility 4 percent of the time and are parked the other 96 percent. Ultimately the electric capacity on wheels could far exceed the capacity now in power stations. Everything's then linked, smart, real-time, clean, profitable, and providing exactly what's needed when needed.

Information is also a key to the profound shift in scale now coming to the electricity industry, just as it came to telecommunications and computing. My cellphone has more processing power than the Strategic Air Command had when I was in high school. Electric utilities today are about where Ma Bell was when cellphones were invented. We no longer need big power plants to run a big economy (freakonomics.blogs.nytimes.com/tag/amory-lovins/) because smart chips and instant communication can link and coordinate many small generators whose lower costs, lead times, and financial risks have already helped win them more than a third of the global market for new power plants. Economic fundamentals, more than subsidies, explain why the world in 2008, for the first time in about a century, invested more in renewable than in fossil-fueled power generation.

Information technology has further transformed how renewables can mesh with each other and with the power grid. A prevalent myth holds that solar cells and windpower can't do much because they don't always work. (Neither does any other source of electricity: the various types of power plants differ only in the size, frequency, duration, predictability, and cause of their failures.) RMI's analysts have developed a unique simulation tool to explore how to integrate these variable renewables into utility

operations, backing out coal- and gas-burning stations whenever the wind blows or the sun shines. Diversifying wind and solar power across larger areas with differing weather, we've shown, can make them far more reliable. Our initial findings suggest that integrating variable renewables into the grid—just as utilities now integrate intermittent big power plants and cope with fluctuating demand—requires not new technology but new attitudes and operating procedures that can deliver better service at lower cost and make more profit with less risk. We're exploring where this could even require less storage and backup than utilities have already installed and paid for to manage the intermittence of their big thermal power stations. To help our utility partners (see p. 20) understand how to do this, RMI is now synthesizing with them a practical vision of the shape, stability, economics, and transitional path of an efficient, diverse, dispersed, renewable, resilient, economical, and climate-safe electricity system.

Global Change

The U.S. is only part of the puzzle. Surprisingly, this transition is starting to emerge (not yet fast enough but rapidly accelerating) in China. Energy efficiency powered 70 percent of China's economic growth during 1980–2001, and is now the top strategic goal for national development. The billion watts of coal power China recently added each week is now added only every 3–4 weeks. In 2006, China's distributed renewable power was seven times larger and seven times faster-growing than China's nuclear program (also the world's most ambitious). China now leads the world in four renewable technologies (to become five within months), and aims to lead in all. In 2010, China looks set to beat its 2020 windpower target; available windy sites in China can cost-effectively meet all its electricity needs, with no coal, through at least 2030. And using the highly fungible lightweighting, electric-drive, battery, and other innovations now spreading worldwide to displace oil, China plans by 2020 to electrify 80 percent of its new cars and light trucks. America must choose whether to make those advanced vehicles or buy them from China.

Modern society is built from fossil fuels. They are the root source of our society's wealth and power. But as their rising costs to our security, wallets, and habitat become ever more intolerable, we see one system dying and another struggling to be born. The inflection point at this moment in history is both evolutionary and revolutionary. The evolving tools to reinvent fire have at last caught up with the vision that has been hatching for decades. And it's a revolutionary moment because we can at last move beyond just conceiving answers to actually getting off oil, coal, and gas by integrating, articulating, and applying what we know. Today we need not convince the worl that Reinventing Fire is necessary. Instead, we must work together to make it happen. Hence, Reinventing Fire is a "grand synthesis" that will systematically combine decades of intellectual capital, both ours and others', into a practical map of the road beyond fossil fuels—then help the world head down that road with due deliberate speed. Integrating the latest developments that make getting off oil and coal even more attractive than we thought five years ago, Reinventing Fire weaves together a resilient, multi-layered web of connected, efficient, renewable replacements for fossil fuel, chiefly in the U.S. but in a global context.

The pieces of the most complex jigsaw puzzle in human history are falling into place. The world that we at RMI imagine (www.rmi.org/rmi/Videos), and that we strive daily to create, is starting to take shape. We need to form it even faster, because humanity, as Dana Meadows said, has "exactly enough time—starting now."

The energy solution is the master key to what Bucky Fuller had in mind when he asked this simple question: "If the success or failure of this planet, and of human beings, depended on who I am and what I do, then how would I be? What would I do?" Reinventing Fire is who we are at RMI, and it is what we must and will now do. Please join us on this exciting journey.

Amory B. Lovins is Cofounder, Chairman, and Chief Scientist of Rocky Mountain Institute.

Reinventing Fire: The Strategy

Reinventing Fire has two main goals: to create a clear and practical vision of a fossil-fuel-free future for the United States, backed up by quantitative analysis, and to map a pathway to achieve that future, led largely by business. This vision and pathway will offer a message of hope, put the spotlight on leaders, catalyze others to act, and inform and help to catalyze innovative policies. RMI also has specific programs to reduce fossil-fuel use, and specific initiatives within those programs to attack the knottiest problems. Reinventing Fire will complement, coordinate, and synthesize those efforts and accelerate change.

Ten months ago, after focusing our strategy on the profitable transition from oil, coal, and ultimately natural gas to efficiency and renewables, RMI examined the four sectors that use fossil fuel—buildings, transport, industry, and electricity. We analyzed each sector's usage patterns and barriers to change, gleaned lessons from RMI's 27-year experience, and shaped first generic programs, then specific initiatives, for each sector. These initiatives, and possibly others, are the major focus of RMI's work and investment for the next three to five years. Here, we briefly describe the sector-level efforts and specific initiatives chosen so far; others are being developed.

The Electrical Sector

Half of U.S. and two-fifths of global electricity is made by burning coal. Despite much talk about smart grids, electric cars, and solar and wind energy, coal fueled 41 percent of the growth in U.S. electricity generation during 1990–2004 (along with 36 percent from natural gas and 23 percent from running existing nuclear plants harder). Coal-fired generation peaked in 2005, then fell slightly while gas, nuclear, and renewables rose. But a more significant indicator may be new generating capacity, which has turned decisively away from coal; in 2008, windpower outpaced even gas-fired additions (a trend begun a year earlier in Europe). Most proposed U.S. coal plants have lately been canceled, and most of the rest are in doubt. But while traditional analyses focus on how to keep running coal plants but somehow fix them so they emit less carbon, RMI is focusing on something far less expensive and risky—replacing coal (and eventually natural gas) plants with efficiency and renewables.

Our analysts identified at least four fundamental barriers to developing a zero-carbon U.S. electricity system by 2050: no compelling vision and integrative plan on a nationwide (or an individual utility) level that demonstrates technical and economic viability, though some utilities' plans get partway there; insufficient progress in capturing, and often even in recognizing, known energy efficiency potential; an incomplete understanding of how to manage the many transitions required for full implementation; and public ignorance and disinformation about and some siting resistance to a low- or no-carbon electrical system.

RMI is developing a key initiative focused on the first barrier, combined with elements of the third. Currently called "Next-Generation Utility" (NGU), this effort will leverage a robust but user-friendly RMI graphical model of how a utility dispatches its resources to matching changing loads. The model is underpinned by research into each resource, and is being used in real-world exercises with large and small utilities to challenge the assumptions of many planners and operators. This tool, plus others still to be developed, will help utilities and regulators understand the relative risks, opportunities, and economics of organic, small-step-at-a-time renewable and efficiency vs. "big-bet" nuclear or coal sequestration investments. The goal is to identify and support leading utilities in developing paths to low- and no-carbon operations. Other potential initiatives—one focused on better efficiency programs and policies, for example—are also in development.

The Built Environment

Despite new technologies, codes, and design strategies, the U.S. building stock is not much more energy efficient (though arguably more comfortable) than it was twenty-five years ago—there is considerable room for improvement—and it still relies mainly on electricity made from coal, natural gas, and, occasionally, biomass. Three of the many barriers to efficiency that RMI has identified are the lack of a compelling "radical efficiency" business case clearly communicated to owners and tenants; a scarcity of skilled practitioners; and obsolete design processes and tools. While these barriers apply to all commercial and residential buildings, RMI plans to focus on how they harm efficiency in existing commercial buildings and new "production" homes (built many-at-a-time to closely related or identical designs) (see p. 10). While both efforts are in the planning stages, RMI's practitioners are excited by the opportunity to transform the efficiency profile of significant chunks of America's building stock. Both initiatives will emphasize "amplification" techniques to drive training and put tools in the hands of a fast-growing wave of designers, engineers, and builders, and to induce building owners, managers, and tenants to demand more comfortable and operationally inexpensive buildings.

The Transportation Sector

Transportation uses 70 percent of U.S. oil. Between 1950 and 2009, consumption of petroleum fuels increased by 65 percent, and although gasoline demand in the U.S. has lately declined, the sector is still about 98 percent dependent on fossil fuels. RMI identified five major barriers that must be overcome: vehicle-makers' business models and cultures block radical innovation, and incumbents are technologically conservative; some alternative technologies are costly and lack scale while the players pushing them are dispersed and often very small; transportation requires massive infrastructure that is difficult to change and seldom optimized for energy efficiency; the bulk of

customers have not yet embraced change; and some national and local policies are inimical to efficiency.

RMI's first planned transportation initiative focuses on fleet managers and owners, their choices, and policies influencing them and vehicle makers. This "Economic Buyers" initiative will help us understand the emerging market segmentation, and determine what technology options (including lightweighting) may be best suited to each segment and across segments, while helping shape fleet managers' demands in ways that save energy and money. These insights may, in later stages, inform additional product development, building on RMI's extensive history. We also plan to ensure that the policy work RMI began in *Winning the Oil Endgame*—around feebates, for example—is properly carried forward.

The Industrial Sector

Industrial processes use 31 percent of U.S. energy. Chemical industries, paper, metals, materials and resources, and oil refining—powered by coal (electricity), oil, and natural gas, and a small amount of biomass—are a major fraction of this use. Although U.S. industrial energy use declined in the last decade, efficiency has not improved uniformly and some fraction of the decline was due to outsourcing rather than technical improvement. RMI believes that many industrial processes—as well as the goods they produce—can be made much more efficient. Outside some segments of the chemicals and materials industries, companies face two main barriers: no widely replicable strategy for driving significant step changes in process efficiency, and a cautious, risk-averse attitude throughout the value chain. RMI's currently planned initiative for the industrial sector will focus on manufacturing process efficiency, using a structured technique based on starting with *theoretical minima* (derived from process physics and chemistry, not standard practice) both for energy-intensive "heavy industry" and for key producers of renewable energy equipment, like solar panels and systems (in order to drive down supply costs more quickly). RMI also hopes to work with one or two major players that are top industry energy consumers (chemicals, metals, papers, etc.) on transforming their business models so that they move away from extraction and/or use of virgin resources toward business models that reward both them and their customers for closing materials loops and for doing more and better with less for longer.

The Industrial initiative in particular will be linked to a design-focused initiative, already underway, called 10xE or Factor Ten Engineering (www.10xE.org). This initiative seeks to help train (and retrain) designers in the key techniques needed to simplify and drive out energy costs in practical designs. Because energy was long reliably cheap, a whole generation of design professionals in the U.S. have, to put it delicately, underemphasized energy in their approach to problem-solving. Their tools—largely software developed in the past 20 years—often reinforce this myopia. Collaborations between RMI, universities, and industry (including software creators) are already underway to develop tools aimed at transforming how designers practice and learn. Our field experience has shown numerous examples of radical energy efficiency at comparable or lower cost; now we aim to spread that practice very widely.

Institutional Support

These new initiatives will be supported by redesigned processes at the Institute, staffing changes, a strengthened program for outreach and practitioner education, and new accounting structures and financial and project management tools.

RMI is also developing a much stronger methodology to quantify the Institute's work and gauge our impact on fossil-fuel use reduction. The Institute will strive to show specific results of how RMI changed perceptions and practices, and how those accomplishments have led to greater resource efficiency and a more secure, prosperous, and life-sustaining world.

In short, our strategy is a fully activated and all-encompassing set of changes that clarify the direction and accelerate the pace of RMI's work so that the organization dramatically speeds the national and global journey beyond fossil fuels.


Photo: RMI Staff

A Special Message to our Supporters

If you are already an individual contributor to RMI, a foundation-based funder, or a corporate partner, or you're considering becoming a member of one of RMI's financial support groups, please take note of the following:

One outcome of RMI's internal strategic planning process, described in the accompanying articles, might be of particular interest. It is the creation of our new Program Review and Evaluation Panel, or what we call the PREP. The PREP will be a transparent system showing how initiatives are chosen and how RMI plans to fund the research and background fact-finding. Philanthropy and corporate sponsorship are crucial components of our initiatives' funding models—as is fee-for-service work with real-world clients, as we have always done.

Why is this internal change important? Simply because it will render RMI more efficient with our funding, whether that funding is restricted by our donors/partners or not. That is, the PREP is a logic-based system RMI's leadership can use to evaluate the immediate and ongoing value of our prospective initiatives, and allocate unrestricted dollars to them once key milestones have been passed.

RMI has been a careful steward of your funds, both restricted and unrestricted, throughout its existence. Yet the creation of the PREP represents a profound leap in that stewardship. It allows RMI to take its rightful place as both a preeminent thought leader in the transition from fossil fuels to energy efficiency and renewables, and as an appropriate repository of philanthropic funding as we help drive that transition.

We remain truly amazed, inspired, and blessed by your support.

Douglas G. Laub, J.D.
Vice President of Development

Putting Green Footstep to Use

RMI's New Calculator Helps Buildings Reach Net Zero

By Molly Miller

Why would anyone need to know the amount of carbon storage inherent in a scrub ecosystem, and how would he or she find out such a thing?

Officials with the Archbold Biological Station (ABS), an ecological research facility in the Florida scrub, wanted to know exactly that when they decided to build their Lodge and Learning Center inside ABS's 5,193-acre preserve. The ecologically sensitive location of the Lodge and Learning Center, as well as ABS's educational goals, inspired the project team to pursue carbon neutrality.

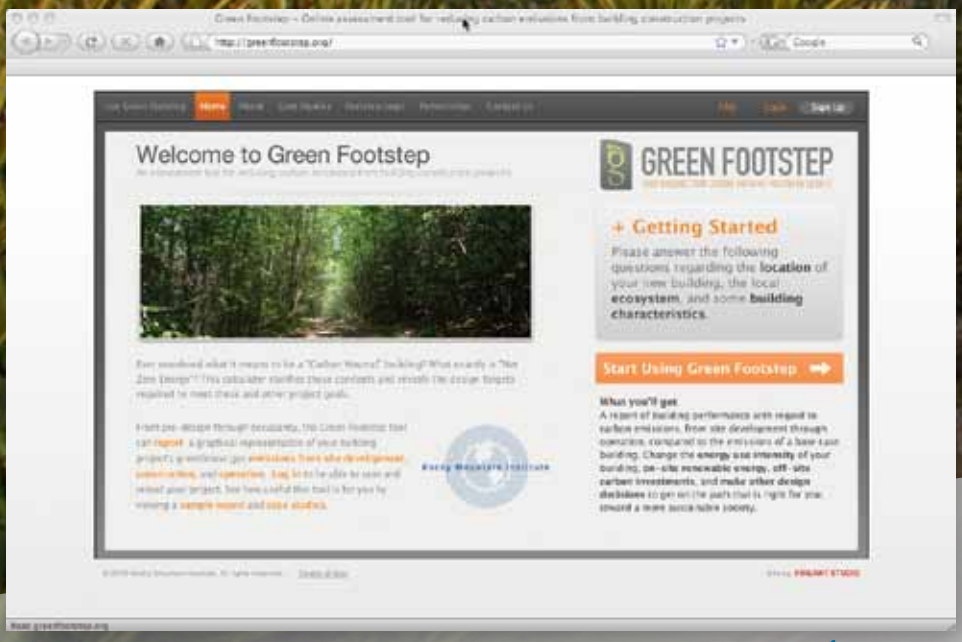
RMI has been working with ABS to achieve this and other goals (such as LEED Platinum), and as part of that work, we were able to gather accurate data on carbon storage in the natural ecosystem. How did we do it? Green Footstep.

Green Footstep, RMI's new carbon calculator, helps designers like Archbold's reduce a building's carbon emissions to zero, or as close to zero as the designer wants to go. Designers might even use the tool to design a building that actually achieves a net reduction in atmospheric carbon over the lifetime of the project. The tool is also useful to designers who are aiming for a given standard or target, such as a LEED rating or meeting the 2030 Challenge.

ABS was attracted to Green Footstep because of Green Footstep's ability to quantify a design's total carbon footprint as a result of site development (the change in carbon storage on the site due to the permanent removal or addition of vegetation), construction (the carbon emissions due to the raw material extraction, processing, on-site assembly, and transportation of building materials), and operation (the emissions due to the use of electricity, natural gas, and other fuels). Green Footstep produces a graph of the emissions over several years.

In real time, a designer can adjust design "targets" for a building, changing the carbon footprint in relation to a baseline footprint. These design targets include the percentage of native vegetation on the site, the energy intensity of the building, and the amount of on-site renewable energy. Green Footstep then produces a report describing how the carbon footprint of a project relates to global emissions reduction goals.

In the case of ABS, given the available roof area and budget for photovoltaic panels, load-reduction and mechanical system efficiency design targets were established to support the overall goal of carbon neutrality.



www.greenfootstep.org

"Green Footstep empowers designers to have an impact on larger climate goals by showing how a building fits into the bigger picture and by encouraging a net zero building or a footprint positive building that results in a net decrease in carbon emissions," said RMI Principal Architect Victor Olgyay. Olgyay created the first version of Green Footstep as an Excel file several years ago.

"The purpose of Green Footstep is to make it easier for designers to reduce the carbon emissions of their buildings," added RMI Consultant Michael Bendewald, who developed Green Footstep as a full-fledged interactive web tool and made it available to eager designers who are beginning to try it on their projects.

"It's really exciting to see a carbon foot-printing tool that's interactive enough to be meaningful to architects early in the design process," said Architect Vikram Sami, of Lord, Aeck & Sargent Architecture. "I look forward to using this to facilitate carbon footprint dialogues on projects in our office."

In addition to its functionality as a decision-making tool for designers like Sami, Green Footstep is also a great teaching tool. ABS also hopes to use Green Footstep to track and display the carbon lifecycle of the Lodge and Learning Center so visitors can compare it to carbon cycling in the scrub ecosystem. While still under design, the Archbold Lodge will offer accommodation to visiting researchers and students. The Archbold Learning Center will include display, meeting, and office space in support of Archbold's educational programs, which serve thousands of "K–12 through Gray" visitors annually. ABS hopes to use the building to raise local and regional awareness about climate change and the potential to address it through buildings.

Molly Miller is a Communications Specialist at RMI.

A storm approaches Archbold in late afternoon. *Photo by Alex Wild: www.alexanderwild.com.*

GREEN FOOTSTEP

YOUR BUILDING, YOUR CARBON, AND WHAT YOU CAN DO ABOUT IT

Clean Energy Is Coming… Brought to You by Heavy Trucks

RMI and Partners Form the North American Council For Freight Efficiency to Stimulate Higher Levels of Innovation and Investment in the Trucking Industry

By Kelly Vaughn

Having grown up in California, I return regularly to visit family and friends (and, yes, I do feel guilty about the fuel I burn on the way). Each time, every six months or so, I'm amazed by the changes I see: a high-school parking lot where once the sun beat down on hot asphalt now covered by carports with acres of mounted photovoltaic panels or a bare hillside now covered by a new windfarm.

In California, renewable energy seems to be propagating quicker than I can earn time off to go back. Coworkers share similar stories after visits to other states—visible and mounting evidence that the clean energy revolution is happening. But, members of RMI working in the mobility and vehicle efficiency sector are quick to point out that one important aspect of the revolution—heavy trucks—is anything but revolutionary.

Ironically, trucks carried the turbines that now stand on that hillside and the solar panels that now cover the high-school parking lot, and they continue to contribute greatly to the rapidly changing renewable energy landscape. But, the trucks themselves are grossly inefficient.

The recent adoption of renewable energy technologies has been some of the fastest in history (for example, existing solar capacity grew by 60 percent per year in 2000–2004 alone). The growth has been driven by investment, access to new resources, and cheaper, more advanced technologies.

The American Recovery and Reinvestment Act (ARRA) has focused heavily on clean energy development, and it is projected that tens of billions of dollars will be set aside for smart grids, investments in energy efficiency, and renewable energy and electric transmission technology loan guarantees. This level of investment and attention is usually reserved for advancing technologies that have already shown great potential—technologies that can contribute to "shovel ready" projects or can justify heavy price-tags in research and development.

Key to current investments in renewable technologies has been information. Luckily, investors, government entities, researchers, and suppliers all have several sources to turn to for access to for trustworthy information: the National Renewable Energy Lab's (NREL) Technology Transfer Office and the Energy Information Administration (EIA), to name a few.

The trucking industry, however, has been slow to adapt. Although the fuel economy of heavy trucks can be dramatically improved, recent efficiency innovation has been incremental, and the industry has failed to draw comparable levels of investment. Heavy trucks' average fuel economy actually decreased in the late 1990s and early

Today's trucks, if properly equipped, could experience a 25% gain in efficiency with a payback of less than 18 months (based on $3/gal. diesel).

2000s, as cheap fuel and a soaring domestic economy led to emphasis on capacity over efficiency.

So why does technology adoption thrive in the renewables sector while efficiency innovation in trucking struggles to reach the market?

RMI Principal Hiroko Kawai described the situation thus: "the freight industry, and the trucking industry in particular, has been burned by a snake-oil salesman approach to technology. There is little trustworthy information on different technologies that could help fleets make wise investment decisions. Technology producers share the same challenges; the dearth of reliable information stymies the adoption of their products."

What will the truck of the future look like? With the help of the NACFE, RMI estimates that a 200% increase in efficiency is attainable.

In short, there is no Technology Transfer Office, or Energy Information Administration for trucking.

The technology challenge, one of the major barriers identified at RMI's Transformational Trucking Charrette in April (see Transformational Trucking www.rmi.org/sitepages/pid106.php) to profitably doubling trucking efficiency, has since become a focus of RMI's researchers and a group of dedicated partners, including companies like Volvo, Eaton, Michelin, Walmart, and J.B. Hunt. According to members of this group, a lack of confidence in performance and an ineffective proof-of-business case make most industry players see investments in efficiency as unnecessarily risky.

To address these challenges, RMI and its partners recently established the foremost source of information on trucking efficiency technologies: the North American Council For Freight Efficiency (NACFE). NACFE will collect, assess, and circulate performance information from testing agencies and laboratories, collect marketing and user data, and provide understandable, up-to-date efficiency information to share with technology developers, Council members, fleet owners, and truck drivers. Think of it as a *Consumer Reports* for trucking—an independent entity that does the legwork to provide the information needed to make smart, educated purchasing decisions.

"By creating a freight system shaped by accurate information, the industry can capitalize on enormous economic opportunities," said Kawaii. "Efficient operations can set the stage for innovative improvements that are profitable and environmentally sustainable in the long run."

NACFE held its inaugural meeting in early November in Chicago, at the University of Chicago's Gleacher Center. There, freight industry stakeholders, truck OEMs, component suppliers, technology providers, innovation engineering firms, policy makers, NGOs, and research organizations began creating a "brand" for trusted, industry-accepted information on trucking efficiency solutions.

RMI's researchers think this will help fleet operators invest in new efficiency technologies because they'll be more confident that their efficiency investments will pay for themselves. "USCFE will help provide evidence of real-world economic benefits," said Kawaii.

RMI believes that the USCFE will help change the way trucks use fuel, the way they are operated, and how they fit into the bigger picture of our greater mission—to eliminate the use of fossil fuels. With collective knowledge, focused investment, and prolonged attention from industry leaders committed to sustainability, the trucks that help to drive clean energy may one day be clean themselves. My personal hope is to one day pass a truck on the highway and—just as I was with that high-school parking lot in California—be stunned at how much it has changed. Stay tuned.

Kelly Vaughn is a Public Relations Specialist at RMI.

Unlikely Partners

RMI and Duke Work Together to Create a New Energy Future

By Llewellyn Wells

Jim Rogers, Duke Energy's Chairman, President, and CEO, is the first to remind people that if his company were a country, it would rank forty-first in the world in carbon emissions—just a notch above North Korea.

As it is, Duke Energy is the third-largest carbon emitter in the U.S.—a dubious distinction if you believe, as Rogers does, that society needs and will soon require big carbon reductions.

Duke Energy's carbon footprint is driven by its heavy dependence on coal. But while burning coal is one of the biggest contributors to climate change, it has also allowed Duke Energy to provide low-cost, reliable electricity to 11 million people in the five states it serves.

To address this monumental task and strengthen the company's strategy for meeting customer needs in a carbon-constrained world, Rogers challenged his team to try to reduce the company's carbon emissions 50 percent by 2030. And Duke Energy's leaders responded. They wanted the best and brightest minds thinking about the problem, so in addition to their own team, they went looking for thought leadership outside the company.

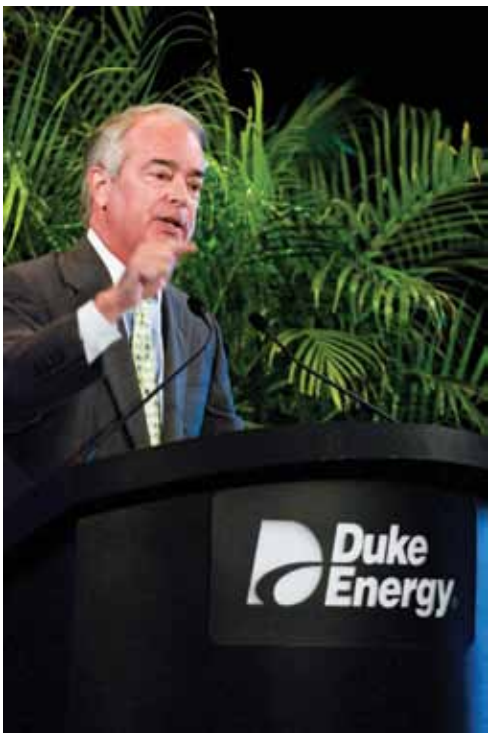
Enter Rocky Mountain Institute. Through conversations between Rogers and Amory Lovins, RMI's Chairman and Chief Scientist, it became clear that Duke's interests and RMI's research and consulting work were not only complementary, but synergistic.

According to Roberta Bowman, Duke's Senior Vice President of Sustainability, Rogers "does an enormous amount of listening to thought leaders and was aware of RMI. After having breakfast in Colorado with Lovins and RMI CEO Michael Potts, Jim came back excited about the possibility of his team working with RMI."

The new collaboration took some getting used to. Duke executives wondered if RMI really understood the challenges utilities face and could offer realistic, pragmatic ideas. Similarly, RMI's team wondered whether Duke Energy was really open to new ideas and change. These doubts and preconceptions aside, it quickly became apparent the two organizations were united by the same goal: a major reduction in carbon emissions.

"Duke was interested in our perspective on the status of low-carbon technologies, on their economics, and on how we think about planning for the future—given the huge number of uncertainties out there," said Lena Hansen, RMI Principal. "But they've thought about these things a lot, too, so our collaboration turned out to be exactly that—bringing the best thinking from both of our very different organizations to bear on the problem."

Recognizing that the electric utility industry is in a period of unprecedented change, one of the key topics that the group tackled was how to effectively plan for the future. For decades, the U.S. electric system has been based on large, central-station power plants serving customers who had little awareness or interest in how electricity was generated and delivered. Now, though, all those things appear to be changing. The costs of renewable technologies have come down;



Top: Although Duke's Belews Creek coal-fired station is equipped with state-of-the-art air pollution controls, there is no currently viable way to control carbon emissions.

Bottom: Jim Rogers, Duke Energy's Chairman, President, and CEO, is an aggressive proponent of carbon legislation. He advocates for bringing new jobs and technology to the local community at a recent Energy Summit in Charlotte, North Carolina to enable the transition to a low-carbon future.

Top: Duke is currently evaluating building new nuclear facilities, similar to its McGuire station shown here, to help reduce the company's carbon emissions.

Bottom: Duke is testing and deploying a variety of low-carbon projects, including solar panels that have been installed as part of an effort to implement new smart grid technology near company headquarters in Charlotte, NC.

customers are becoming more engaged in how they use electricity and where it comes from; and carbon legislation is on the horizon.

All this means that, for utilities, the future will look very different than the past. By taking a scenario planning approach, the team painted several pictures of how the future might unfold—and how Duke might best respond to each. Each scenario reflected a combination of possible trends:

- How engaged customers will be in their electricity usage;
- How costs might trend for different technologies; and
- Whether key technological developments, such as carbon capture and sequestration, develop or not.

The team looked at the potential and costs of a number of low-carbon resources, including energy efficiency, wind, solar, biomass, nuclear, and carbon capture and sequestration. While each of those resources offers considerable opportunities, each has its own risks and costs. Understanding the various scenarios will help Duke adjust its strategy based on changing conditions.

"[Our work with RMI] has helped us identify key sign posts associated with various scenarios," said Doug Esamann, Duke's Senior Vice President of Corporate Strategy. "That gives us options. We are still laying these options out in an appropriate plan. We have bits and pieces already embedded. Continuing to make it a connected, cohesive plan is the challenge in the face of an uncertain future."

In addition to making the right investment decisions, Duke must maintain reliable service no matter how the future unfolds—and that means matching electricity generation to demand, exactly, at every second. That becomes increasingly difficult as variable resources like wind and solar power are added to the grid.

RMI used its on-going research on the Next-Generation Utility Initiative and utility dispatch simulation model to help Duke think through how such a low-carbon system could work and what problems need to be solved.

Duke Energy's low-carbon efforts are on-going, and Stephen Doig, RMI Vice President and electricity program leader is optimistic. "[Duke's team] is as good as any I've ever worked with," he said. "My hope is that our collaboration with Duke will help them have the confidence to push further and faster on their low-carbon strategy."

"The challenge of producing energy for a low-carbon future is attracting some of the best and brightest talent around, and I think both RMI and Duke Energy learned a lot from this collaboration," said Bowman. "When you think about the magnitude of the challenge of climate change, it's an intellectual challenge, a technical challenge, a business challenge, and a human challenge. Being part of the solution appeals to our sense of mission and challenge at Duke Energy, and it's at the heart of what RMI is about as well."

Llewellyn Wells is RMI's Vice President of Outreach.

RMI2009

FROM IDEAS TO SOLUTIONS

REINVENTING FIRE

the RMI Way

Reinventing Fire in San Francisco

In *A World Lit Only by Fire*, historian William Manchester suggests the Middle Ages represented nothing more than 1,000 years of technological dormancy, stagnant creativity, and archaic societal systems between the fall of Rome and the Renaissance. Arguably, Manchester's well-titled history should have included the period between the Renaissance and present time—we're still clumsily burning plants to light and power our world.

At RMI2009: Reinventing Fire, RMI's three-day symposium October 1–3 in San Francisco, the Institute's leaders, collaborators, supporters, and staff shared a wildly hopeful vision of how our resource-guzzling society could run on clean energy and clever technologies that don't rely solely on combustion.

In his keynote address, Chief Scientist and Chairman Amory Lovins advanced this vision by describing RMI's concrete new strategy as one with the ultimate goal of "driving the profitable transition from oil, coal, and ultimately gas to efficiency and renewables" (see p. 6).

More importantly, over the course of two days, RMI experts presented evidence that the Institute is making real-world progress in the fields of energy and resources, the built environment, and the transportation sector.

RMI's Stephen Doig, Lionel Bony, Michael Kinsley, Sam Newman, Victor Olgyay, Caroline Fluhrer, Hutch Hutchinson, Hiroko Kawai, Mike Simpson, Matt Mattila, and others described RMI projects that are displacing conventional thinking about solar and wind energy, building and community design, nuclear power and distributed renewables, and energy efficiency and load management.

The strands of RMI's important work have always been the same color; today we are simply collecting them into a stronger fabric. On this and the following pages, we share just a few of the myriad ideas, stories, and comments that emerged during RMI2009.

The concept of Reinventing Fire seems to have sparked a few imaginations. The event drew more than 300 people; the Saturday night RMIQ keynote presentation drew more than 500. Clearly, the Institute's staff and supporters are not the only ones who believe the dark times are over and that we need not live in a world lit (and powered) only by fire.

—Cam Burns, RMI

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ET, IT, and a Combination of Both?

As the theme of RMI2009, and a term used to describe RMI's new strategic direction, it is not surprising that much discussion at the three-day symposium was dedicated to exploring what exactly Reinventing Fire means.

While clearly it includes many important strategies (see p. 12), according to RMI Chairman and Chief Scientist Amory Lovins, one important aspect of Reinventing Fire is that it "addresses both the supply side and the demand side." Indeed we have historically addressed the supply side by burning coal and oil to meet energy demands, he explained. Now, he pointed out, it's time to address the other end of the energy system. Driving solutions from both ends was a recurring theme throughout RMI2009.

Panelists representing organizations across the board—including Google, the Department of Energy, and Hewlett Packard, among others—agreed that as a society we need to leverage technology and focus specifically on the intersection of energy technology (ET) on the supply side and information technology (IT) on the demand side. Addressing the demand side, they said, was key to driving innovation.

Currently, a great deal of research and investment is dedicated to ET. "Look at Silicon Valley," said Marc Porat, Chairman of Serious Materials. "There is a lot of comfort and familiarity with a focus on the supply side, so you see a lot of investment there."

Google's Director of Climate Change and Energy Initiatives, Dan Reicher, however, said innovation in terms of delivering information to consumers—a part of the equation that many experts believe is under-addressed—is key.

"We have the potential to change the relationship consumers have with energy," said, Reicher. "People need access to information about their consumption and potential savings."

Take buildings. Thirty-nine percent of total energy produced in the U.S. (the supply side) is used to operate buildings. Lighting, heating, and cooling are, for example, huge energy users over which building occupants have direct control. When Google introduced smart metering, Reicher said, they saw an immediate reduction in energy use. "Just by having the information in front of them, people's behavior resulted in a 5 percent energy reduction," he said.

To Google and others, the biggest bang for the buck has been offering real-time information about energy use, whether it is in individual homes, commercial buildings, or electric vehicles.

"Over the last couple years, we have seen how the consumer and the future consumer [are] moving in a different direction, and they have been an accelerating force in this convergence of ET and IT," said Matt Kistler, Senior VP of Sustainability at Walmart. "People are waiting for the silver bullet—the right energy innovation, or the right technical fix—instead of starting with the low-tech, low-hanging-fruit-types of solutions."

If today's consumers were more aware of what's

possible and encouraged by what is coming, we would have enormous potential to change the direction of the new energy economy, and to build a new information economy, panelists agreed. Reinventing Fire means keeping sight of the big energy picture, but also using information and deploying clever combinations of solutions we already have to drive change.

"The bottom line is that CO_2 is going up faster than we can stand," noted Bill Joy, a partner at Kleiner Perkins Caufield & Byers. "Clearly solutions aren't diffusing fast enough to meet the climate crisis. You have to go seek out the innovators and enable them."

—Kelly Vaughn, RMI

Industry Is Finally Catching up: *Natural Capitalism* at Ten

Ten years after its release, *Natural Capitalism* (www.natcap.org) is clearly still a thriving notion. Today a wide range of companies use the four principles of "Nat Cap" to boost operational cost savings and stretch manufacturing resources.

That sentiment was expressed by five industry leaders—Ray Anderson, Paul Hawken, Janine Benyus, Carl Bass, and RMI's Amory Lovins—during an RMI2009 plenary session at the Westin San Francisco Market Street Hotel.

Hawken kicked of the discussion by noting that Nat Cap essentially falls under the umbrella of biomimicry (imitating the natural world in human-made systems). Anderson, the founder and chairman of Interface, the world's largest carpet manufacturer, reflected on his decision to send his Entropy carpet design team out into the woods to consider how nature made floor coverings. The modular carpet tiles, which mimic the randomness of nature, revolutionized the industry.

But it was Benyus, whose ground-breaking work with biomimicry was laid out in a 1997 book of the same title, that caught the crowd's attention by describing her recent visit to six communities that want to become centers of biomimicry commercialization.

"Biomimicry is happening in all sorts of places in industry," she said, noting that certain self-cleaning paints, glass, tiles, and fabric finishes are now designed based on the lotus plant's leaves (see www.biomimicryinstitute.org/case-studies/case-studies/toxics.html).

Two things excite her most about the movement to incorporate transformational design into industrial processes. "One is the profusion of good ideas and the other is the ability of the Internet and technology to spread them quickly and get them into the right hands," Benyus said. "There's no time like now to get them out."

Bass, CEO of Autodesk, said that the key to getting people to design more efficient products and systems was to offer the right information—exactly what he's been doing with his software.

"There's huge leverage for changing what's going on in designers' heads when you change what's on the


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[computer] screen," he said, noting that "…people who do buildings and infrastructure—their world has changed."

Hawken noted that today, resource productivity, one of Nat Cap's four premises, is a no-brainer. "That's where the money's lying on the floor," he said. Hawken added that, at Walmart, for whom he recently consulted, company employees were as well-versed on the finer points of waterless urinals as any urinal specialist at an NGO.

"We've seen a lot of this stuff going on," Lovins said. "It doesn't make the news but it is enormously encouraging when you see what kind of leverage it has."

Natural Capitalism's 10-year anniversary edition will be published in the UK by Earthscan in the coming months.

—Cam Burns, RMI

Smart Garage: Driving Change Faster

Exactly a year after RMI hosted the Smart Garage Charette in Portland, a group of industry experts convened at RMI2009 weighed in on where the U.S. stands in making an electrified vehicle fleet a reality.

The good news: the technology is already in use, the government is firmly behind the effort to make the grid as efficient as possible, and the electric infrastructure to do it is here.

The bad news?

There's still a lot to be done, from scaling the technology to changing the mindsets of manufacturers and consumers in order to remove the barriers to an electric fleet. The basic concepts are working in pilot programs across the country, but the system is a long way from being ready for one million electrified vehicles by 2015.

"To make the grid more efficient is my overarching objective—reduce costs, reduce carbon, and make it better for consumers," said Jon Wellinghoff, chairman of the Federal Energy Regulatory Commission (FERC).

Wellinghoff said that an electric fleet can have a positive impact on the grid when cars are plugged in both during the day and at night. The key, he said, is to view electric cars and hybrids as part of a whole system.

In 2007, FERC already proved it. Using a converted Toyota Scion, FERC engineers found they could share information between the car and the grid and deliver critical services that could help keep the grid stable.

Calling it the "cash-back car," Wellinghoff said the new paradigm could turn transportation vehicles into grid appliances. "Ultimately, if you can do this at scale, to step it through a fleet on a megawatt scale, you have the ability to make payments back to the grid, up to $1,500 per year per car," he said.

While federal agencies like FERC appear to be slowly making the leap, the gap in the minds of manufacturers and consumers may be a lot harder to bridge.

"There's still a lot of space between concept and showroom," said Chelsea Sexton, a co-founder of Plug-In America. While enthusiasm is high and "every automaker is working on a plug-in car," she said, consumers, manufacturers, and policy are still not aligned enough to create large-scale transformation. "We're getting

almost into a constipated place of not doing anything," she said. "But we have to start with the cars."

Jon Ferris, the E-Flex Planning Manager at General Motors, said that consumers are still leery about electric cars' capabilities.

"As great as the vehicle might be, we also have to ready the marketplace," Ferris said. "We have to do the external enablers that ensure it's a mass-market program and not just a niche product."

For years, Sexton said, the auto industry pointed to a lack of consumer demand as evidence that electric or plug-in hybrid vehicles were unwanted.

"Wait a minute," she said, "how many of us looked at a Walkman 20 years ago and said, 'I wish that was the size of a deck of cards and I could watch TV on it.' None of us knew to ask for an iPod then, but once we had one, we all got damn used to it."

—Rebecca Cole, RMI


1


2


3

See it Live: Integrated Design Solutions Video Debuts

There's nothing like seeing something with your own eyes. Just as there is nothing like hearing first hand about integrated design in buildings. RMI created the video *High-Performance Building: Perspective and Practice* (http://bet.rmi.org/video) last year to bring faces, voices, and pictures to people interested in the benefits of green building. The video has been a tremendously popular and powerful way of making the business case for green building.

Now we see a need to go beyond the why and get more into the how, so RMI recently produced a new 30-minute video for design professionals that provides a more in-depth look at high-performance design.

The how is not just about technical solutions. The largest piece is attitude and process. The video, *High Performance by Integrative Design*, **includes examples of how high-performance design elements such as daylighting, energy efficiency, renewable energy, and other strategies can be integrated for optimal performance. The video shows all the players, from the architects and engineers to the facilities and operations mangers, working together in the design process. Viewers can also experience charrette discussions on real projects.**

The video will be educational for practitioners and may even be used in workshops and classrooms, but above all it will be inspirational, showing real examples of outstanding integrated design elements and practices. The video will debut this winter; watch rmi.org for a link and additional details.


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Victor Olgyay: The Passionate Educator

By Jonah Bea-Taylor

At heart, RMI Principal Architect Victor Olgyay is an educator. Dedicated to developing a better understanding of how to integrate building design with natural and human environments, Olgyay is on a passionate mission to find a sustainable balance between how we live, work, and build within the earth's many complex systems.

During the past 30 years, Olgyay has seen remarkable progress toward more sustainable approaches in the building industry. But, he knows, there are still huge knowledge gaps. For Olgyay, this disconnect—between a desire for change and a real understanding of the opportunities—is a driving force behind RMI's new initiative to retrofit existing commercial buildings. With simple retrofits, the vast majority of existing buildings could save significant amounts of energy. Realizing those retrofits in an effective way is "the $20 bill left on the sidewalk," he said. "There are many different aspects to this that we need to start to working on now…the potential is really exciting."

Olgyay comes from a family of architects. His father was a professor who worked on the cutting edge of bioclimatic design, and Olgyay remembers growing up surrounded by sun machines and architectural drawings.

He credits the humanistic perspective of economist E.F. Schumacher for inspiring him to help make buildings more livable and low-impact. "Schumacher… first opened my eyes up to the significance our work has," he said. "Our work is meaningful and can be an opportunity for positive social effect."

Putting Schumacher's perspective on appropriate technology for low-impact, local solutions into action brought Olgyay into the early passive solar-design movement. Small organizations across the country, like the Boston Solar Energy Association with whom Olgyay worked, first brought attention to the energy-saving potential of passive-solar design. At that time the goal was to create leading examples that would both inspire and provide evidence to prove solar homes were possible.

Another early mentor was pioneering lighting researcher William Lam at MIT. Lam was one of the first researchers to consider human perception in daylit spaces. Olgyay remembers that Lam took the somewhat esoteric and technical world of lighting, and "blew holes in the conventional wisdom" of thinking about foot-candles on a surface rather than the light people really needed to see. Lam encouraged Olgyay to take time off from his graduate studies to help Lam run daylighting experiments. Eventually, their work became the basis for a groundbreaking book, *Sunlighting as Formgiver for Architecture*.

Lam's work and Olgyay's advancement of it have influenced today's USGBC's LEED rating system, which allocates points not only for the amount of daylighting in a space but also views. "That connection to nature is actually an inherent human need," said Olgyay.

A perennial challenge is dealing with all the misinformation in the residential building industry. One of Olgyay's roles was to interview early celebrities in the field, including (in 1986) RMI Chairman and Chief Scientist Amory Lovins. "I think that the '60s actually won because here we are in 2009 and many of the renewable energy dreams we had have become reality. Anyone can buy PV and put on their roof; it has been codified now."

Olgyay's passion for advancing passive-solar design led to a tenured professorship at the University of Hawaii, and eventually a role as the School of Architecture's Director of Research. At the same time, he built a practice that applied innovative design and appropriate technology around Asia and the Pacific.

After getting married in Hawaii, Olgyay moved back to Boulder to start a family and began working with the late Greg Franta's ENSAR group, which eventually became RMI's Built Environment Practice. Franta was always looking to have a greater impact, and the connection with RMI was one way to effect higher-level innovation in the built environment. Together, RMI and ENSAR

developed "the ground view and the air view" of high-performance buildings.

Cara Carmichael, a Senior Consultant with RMI, also worked with Olgyay at ENSAR. "He is through and through a teacher," she said. "He has taught me a lot about not only the technical aspects of good buildings but also the delicate art of engaging, exciting, and influencing clients and designers."

RMI staff members also appreciate Victor's quiet humor.

"Victor is so very heartfelt, I was surprised to discover his reverence for just plain silliness," said RMI Communications Specialist Molly Miller. "No matter how serious the work we are doing, he always has time to pun and always takes time out to enjoy a witticism or to be just plain goofy now and then. I appreciate his levity."

Victor, working in 2007 with Greg Franta and Cara Carmichael.

Today Olgyay has two daughters who enjoy exploring the natural world, and are deep into the lives of insects—even building them little houses. Looking at his daughters' future, and how far building design has come, Olgyay remains positive.

"You have to be an optimist in your heart," he said. "If you have a visceral love for the planet, then your life and work is a manifestation of that love."

Jonah Bea-Taylor is a Consultant with RMI's Communications Team.

Amory to Offer Two Workshops At Esalen in December

RMI Chairman and Chief Scientist Amory B. Lovins will be hosting two unique workshops at Esalen Institute (www.esalen.org) this fall. The first, which he'll co-host with Chungliang Al Huang December 4–6, is "The Tao of Global and Personal Ecology."

For nearly three decades, Amory and Chungliang have shared a special kinship in the natural wisdom of the Tao, and they continue to merge in their shared living philosophies and ways of being. Many years ago, they collaborated on a calligraphic poster, "The Tao of Leadership," based on Verse 17 of Lao Tzu's *Tao Te Ching*. Now it is a collector's gem gracing the walls of executives' offices around the world.

The seminar will be an open dialogue between these two special friends. They will share their mutual respect and convergent ways to better harness the powers that be, whether from personal ecology or in consort with global politics.

Amory will also host "Advanced Energy Efficiency and Alternative Supplies for Profitable Climate Protection" at Esalen December 11–13. In this workshop, Amory will explain how half of America's oil and gas and three-quarters of its electricity can be saved more cheaply than bought. He'll describe dramatic advances in efficiency technologies, ways to combine and integrate them, and ways to market and implement them and the emergent revolution in low- or no-carbon energy supplies. This transdisciplinary workshop will be most useful to intermediate and advanced practitioners, executives, activists, and concerned citizens, and will emphasize opportunities and needs in the private sector, chiefly in oil (www.oilendgame.com) and electricity (www.rmi.org/sitepages/pid107.php).

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All event photos: S. Christian Low

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New Publications

RMI recently revamped our publications numbering system. Below are recent publications numbered using RMI's new system with old publication numbers, where applicable, in parentheses. To pull them up on **rmi.org**, please enter the publication number.

Pub No. 2009-12. Climate: Eight Convenient Truths." Amory Lovins's terse good-news bulletin, commissioned by the Congressional journal *Roll Call*, summarizes how climate protection can become a bipartisan economic and security bonanza.

2009-11. "Crystallized Pedagogy: Architecture as a Medium for Sustainability Education." Erik Bonnett and Victor Olgyay's paper for the 26th Conference on Passive and Low Energy Architecture, Quebec City, Canada, June 22–24, 2009.

2009-10. "Nuclear Nonsense." Amory Lovins's reaction to a chapter on nuclear power in Stewart Brand's new book *Whole Earth Discipline: An Ecopragmatist Manifesto*.

2009-09. "Four Nuclear Myths." A deeper look at the numbers behind Amory Lovins's "Nuclear Nonsense."

2009-08. "Assessing the Electric Productivity Gap and the U.S. Efficiency Opportunity." Natalie Mims, Mathias Bell, and Stephen Doig's paper describing the sizeable electric productivity gap between our top ten performing states and the national average.

2009-07. "'New' Nuclear Reactors, Same Old Story." Amory Lovins's commentary on integral fast reactors (IFRs) and thorium reactors, which, he says, offer no economic, environmental, or security benefits.

2009-06. "Does a Big Economy Need Big Power Plants?" (*New York Times* Freakonomics blog). Amory Lovins's blog on the evolution of power plants and the revolution—now occurring—in micropower. http://freakonomics.blogs.nytimes.com/2009/02/09/does-a-big-economy-need-big-power-plants-a-guest-post/.

2009-05. "Nuclear Power: Climate Fix or Folly?" Amory Lovins, Imran Shiekh, and Alex Markevich's description of how efficiency, renewables, and micropower are beating nuclear energy in the marketplace.

2009-04. "Sense and Response: A Bioclimatic Dialogue of Place." Victor Olgyay's paper describing how our increasing awareness of our ecological dependence has resulted in a Renaissance of understanding of how we should inhabit the earth.

2009-03. "Accelerating Solar Power Adoption: Compounding Cost Savings Across the Value Chain." Sam Newman, Stephen Doig, Lena Hansen, and Virginia Lacey explain how the basic tools of end-use efficiency, whole-system design, lean manufacturing, and economies of scale will boost the solar power technology industry.

2009-01. "RMI Top Federal Energy Policy Goals." RMI's 17 steps to reduce U.S. oil use and greenhouse gas emissions each by 50 percent in 10 years—while creating over three million jobs in the next four years, and rapidly generating economic benefits for the nation.

2008-22. "Intermittent Renewables in the Next-Generation Utility." Lena Hansen and Jonah Levine's paper for the PowerGen-RE 2008 Conference & Exhibition, February 19–21 2008, in which they evaluate the potential reduction in variability due to the geographical dispersion of wind resources across large geographic areas.

2008-21. "Spatial and Temporal Interactions of Solar and Wind Resources in the Next-Generation Utility." Bryan Palmintier, Lena Hansen, and Jonah Levine's paper for the Windpower 2008 Conference & Exhibition, June 3, 2008, which elaborates on previous studies on reducing the variability of renewable resources through optimized geographic distribution.

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RMI Event Calendar

December 2009 – February 2010

The Future of Smartgrid DSM Programs
Miami, FL
December 9–10
EUCI presents The Future of Smart Grid DSM Programs to address the many challenges presented by the federal government's allocation of $11 billion towards Smart Grid funding. There will be sessions dedicated to demand response (DR), energy efficiency (EE), public relations and outreach, consumer engagement technologies, and program pricing. This is a must-attend event for power companies needing to benchmark their conservation programs and technologies in preparation for the new smarter energy grid.

2010 Automotive News World Congress
Detroit, MI
January 12–14, 2010
It's a new era. The industry is preparing for economic recovery and growth. New opportunities are there, but you have to recognize them and learn how to take advantage. And the government is involved in entirely new ways. Attend the 2010 Automotive News World Congress January 12–14. Hear the industry's top executives explain how they will compete and thrive.

Clean Tech Conference 2010
Palm Springs, CA
January 20–21, 2010
The Clean-Tech Investor Summit is the premier clean-tech investment and innovation event of the year. Held each winter in Palm Springs, CA, the event brings together leading investors, Fortune 500 executives, entrepreneurs, and service providers for two days of high-level presentations, conversations, and networking. Attendance is capped at 500 registrants to guarantee the optimum networking experience. See www.cleantechsummit.com.

ASHRAE 2010
Orlando, FL
January 23–27, 2010
"It's not the heat, it's the humidity," is often used to explain the less-than-comfortable temperatures in tropical Florida. While the water-saturated air is perfect for hibiscus and alligators, humans have had to find their own ways to deal with the Sunshine State's humid conditions. What better place to discuss this year's conference theme: Building Sustainability from the Inside Out? Whenever the temperatures outside are too hot or humid to handle, ASHRAE ensures that indoor environments are comfortable and, most importantly, sustainable.