

Solutions

Journal

SUMMER 2017
VOL. 10 NO. 1



*Windows of Opportunity Transformative Solutions Rigorous Research and Analysis
Leading-Edge Thinking*

*Climate Energy Health Security Energy Markets Investment Brighter Future
Whole-Systems Design*

Accelerate and Scale Solutions

Shift from Fossil Fuels Think-and-Do Tank

Thought Leadership Answer the Global Call

Create a Clean, Prosperous, and Secure Low-Carbon Future

Build Our Community Community Goals

Energy Innovation Center

Low-Income Energy Access

Modeling Policy Impact Transforming Global Energy Use

Need Normalizing Energy Market Driven

Are Microbusiness Cases Reinventing Fire

Business Cases Clean Progress

Scale Market Solutions Energy Performance

Thinking Under Market-Based Solutions

Creating a New Pathway to a Clean and Secure

Low-Carbon Future Restore the Use of Resources

Alliance Partners Enhance our Climate

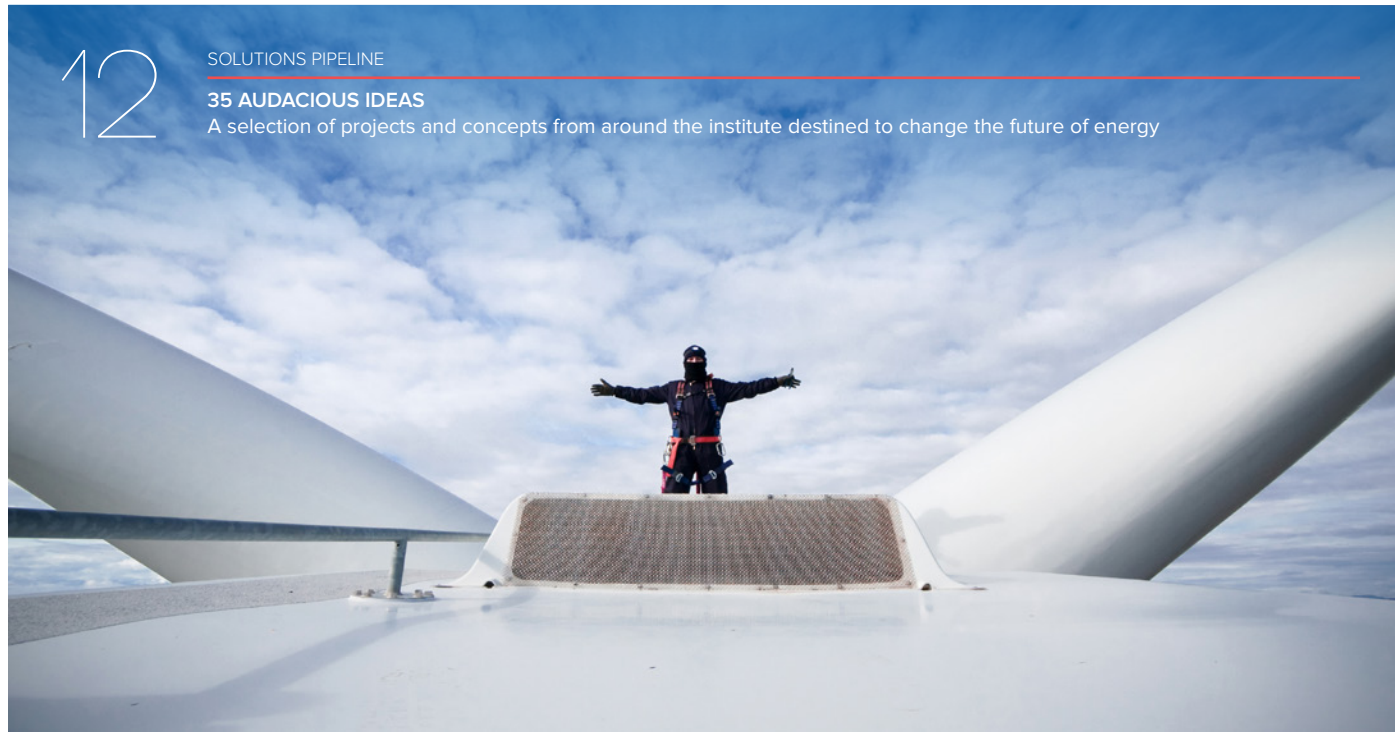
Change Solutions Engages Decision Makers

years & counting



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Our Printing and Paper

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THE PAST IS PROLOGUE

35 years of impact have set the stage for accelerating the energy revolution

By Jules Kortenhorst

This April marked the 35th anniversary of Rocky Mountain Institute's founding in 1982. As I survey the past three and half decades and try to peer as far into the future, I am filled with amazement at how far the energy transformation has come, with urgency because of how much it is now needed, and with optimism about the gathering strength of the energy revolution. While it is true that the current U.S. federal government administration is not leading the effort to transform the world economy to a low-carbon, resilient, and sustainable future, the transition is now global, widely supported, increasingly cost-effective, and therefore irreversible.

In this child's lifetime, wind turbines became cost competitive with fossil fuels.

Look at what markets, aided by pioneers like RMI, have achieved. In 2015, the world used

energy 32 percent more efficiently than 25 years earlier, even while the world economy more than doubled in size, according to the U.S. Energy Information Administration. And globally, renewables have been the leading new energy source for two years in a row, at decreasing cost.

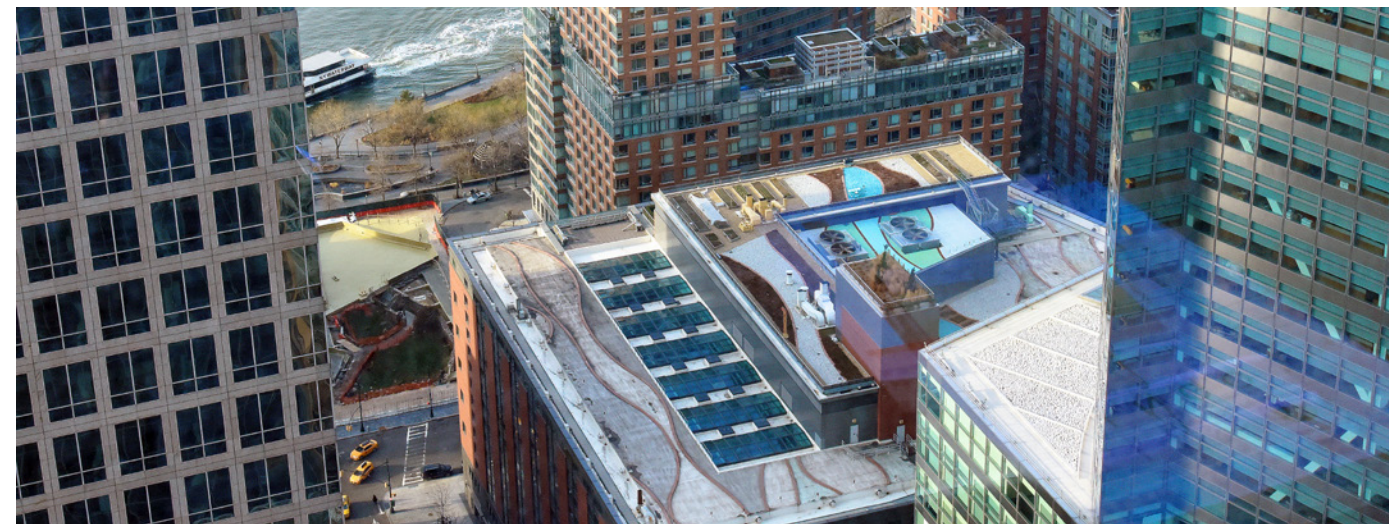
At RMI, we know that when markets lead, policy and politics follow. Last year's historic Paris Agreement is a thrilling development, but the vanguard of the energy transformation to renewables and efficiency will continue to be market based. That is why I'm confident that together, we can avert catastrophic climate change and achieve a clean, prosperous, and secure low-carbon future.

LOOKING BACKWARD AND FORWARD

In this issue of *Solutions Journal*, Amory takes stock of Rocky Mountain Institute's influence on the mobility, buildings, electricity, and many other industries over the past 35 years. And Sir Richard Branson describes how RMI's agility has been enhanced by the bold, entrepreneurial legacy of Carbon War Room, which merged with and now operates as part of RMI, weaving the innovative carbon reductions that are its hallmark into our DNA.

But the urgency of the present moment does not allow us to rest on our laurels; the planet's climate is at a crisis, which is why the past is merely a prologue to what we must do now, and in the future.

In our main feature article, "35 Audacious Ideas," you will read about dozens of ways we are working to accelerate and deepen our impact on the energy transition. Some are achievements of the present moment, whereas others are very ambitious—but attainable—plans for the future. And the projects show how our intervention model works to unlock markets in all sorts of ways.



LEED-certified buildings like this one (center) in Manhattan's financial district have become business as usual.

Sometimes we identify a new technology or solution to apply to energy, like the blockchain technology that underlies the bitcoin digital currency, which has the potential to transform the way distributed energy technologies like rooftop solar and demand response can be orchestrated and compensated.

Sometimes markets, or individual market actors, develop transformative technologies but don't have the long-term view or immediate incentives to see how they can work together to effect change that is more than the sum of its parts. Our work with the city of Austin, Texas, to pioneer a complete mobility ecosystem that will build toward electric, autonomous Mobility as a Service is an example of our whole-systems view.

And sometimes markets just don't extend far enough, and so RMI takes action. Solar energy is cheaper than ever, but it takes bold intervention to see that it reaches the populations that can benefit most from it—another project you'll read about in these pages.

SHAPING THE FUTURE

As I look to the next 35 years, I see with excitement the work that RMI is carrying out in China, where we are helping with a vast and ambitious energy transition, and I see with growing confidence our initial work on mobility in India. Although our work there is just beginning, our collaboration with the government and business leaders of that nation has been tremendously encouraging, and India's enormous strength in information technology and mastery of innovation promise much for our

support of its mobility transformation—another feature story in this issue.

So RMI moves out into the world, and forward into the future, with resolve that our task is both an urgent and a vital one, and with hope that our efforts, with your help, will meet the challenge. Our theory of change begins with you, and supporters like you. Your support over the past 35 years helped us to find solutions, pioneer and pilot new energy approaches, and collaborate with diverse partners. And those partners—public and private, for-profit and academic, foreign and domestic—helped us to bring our solutions and our approaches to global scale, so that what was merely a gleam in Amory's eye 35 years ago is now rolling off production lines from Stuttgart to Detroit. With your help, the future belongs to clean, renewable, efficient, cost-effective energy. I know the best is yet to come.

Jules Kortenhorst is chief executive officer of Rocky Mountain Institute.

GET INVOLVED

Philanthropic support makes RMI's work possible. Join us by making a donation today to help create a clean, prosperous, and secure low-carbon future.

Give an unrestricted gift or target your gift to support an RMI project that addresses your passion.

WWW.RMI.ORG/DONATE



TAKING STOCK

35 Years of Influence...and Counting

By Amory B. Lovins

This year, as Rocky Mountain Institute turns 35 and I turn 70, what have we dared, done, won, lost, learned, and become? When RMI began in 1982, eight things were clear:

1. Energy is a “master key” to tangled emergent crises in resources, population, environment, development, economy, and security.
2. We could best create and spread breakthrough solutions in a [small, agile, collaborative, nonprofit think-and-do tank](#) with high talent, ambition, depth, quality, and repute; lacking a suitable one, we’d have to create it.
3. Though the right rules are vital and we must help devise them, [government should steer, not row](#): in market economies, business does the hard rowing. Business-led, market-driven change would outpace lagging policy as politics, especially federal, became more polarized, corrupt, gridlocked, and dominated by powerful incumbents.
4. To engage across a swirl of colliding interests, we must stay impeccably [apolitical, non-partisan, nonadversarial, and independent](#).
5. To serve a diverse and perhaps fracturing society, we must deliver no single outcome, but a broad slate of transideologically appealing benefits for all, and must [focus on outcomes, not motives](#).
6. Dwight Eisenhower said if you can’t solve a problem, enlarge it: expand its perimeter to encompass everything its solution requires. So to solve seemingly intractable systemic problems, we must not just innovate but integrate, creating [an actionable and compelling vision across boundaries](#).
7. Practical transformation in some of the planet’s biggest, most complex, most rigid systems is a subtle, decades-long strategic game demanding [relentless patience as well as continual tactical advances](#).
8. To sustain ourselves and inspire others, staying intrepid despite skepticism and tenacious through adversity, we must [live and strive in applied hope](#).

Those bets proved correct, served us well, and today confer unique advantage on RMI as we look to the future.

From the start, we envisioned a world thriving, verdant, and secure, for all, for ever. We still do. To build that world, the sharpest but most neglected tool was efficient and restorative use of resources. It still is. Now opportunities are getting bigger and cheaper, faster than they’re applied. Creating a clean, prosperous, and secure low-carbon future, though still a formidable challenge, is thus getting easier every day—and, we think, more convincing to those still steeped in fear and pickled in gloom.

With 35 years of foresight and insight, RMI has deeply influenced the vehicle, real estate, electricity, and many other industries, and laid many of the foundations for the new energy era now bubbling up. We’ve leveraged big changes in a global economy over 2 million times our budget, by putting the right ideas in the right heads at the right time, and by helping reframe problems, re-vision paths, bust barriers, re-mind designers, convene and collaborate, partner and pioneer, speed and scale. Much of this work has been recognized with awards, relationships, and reputation. Most entails close cooperation with industry partners. RMI did almost none of this transformation singlehandedly—many other important actors have helped at many critical stages—but our role in orchestrating and catalyzing major change remains unusual, if not unique.

Having reframed the energy problem around end-uses in 1976 (for results, see “Soft Energy Paths,” *Solutions Journal*, Summer 2016), I organized our analytic and practical work around the four energy-using sectors: mobility, buildings, industry, and electricity. All were linked to other issues and disciplines, so RMI’s first decade also made important contributions to water efficiency, regenerative agriculture and forestry, non-proliferation, security, and community economic

development. Leaving those aside, I recount here some highlights of how our energy-centric efforts have already achieved more than I’d imagined.

MOBILITY

RMI laid the foundations for, and continues to drive, today’s emerging transformation in how our bodies and goods move around the world.

Automotive: Vehicle electrification has gone from unimaginable to superior and (starting in 2017–2018) affordable. This could be further sped by making autos not just modestly but severalfold lighter and lower-drag, a shift RMI has led since our 1991 invention of the Hypercar® concept. Needing two to three times less energy to move the auto can correspondingly reduce the number of costly batteries required, speeding deployment by a decade or two; make cheap batteries ubiquitous; and facilitate vehicle-to-grid links (another 1991 RMI invention) and smart charging, so electric vehicles can help the grid integrate variable solar and wind power. We open-sourced our industry-validated Hypercar R&D to maximize competition, then supported seven automakers’ transitions via technical and strategic engagement. Our interventions sped Japan’s hybrid-car development and helped trigger the global industry’s revolutions in lightweighting and electrification. (An early example, the 124-mpg carbon-fiber electric car I drive, is already profitable for BMW.) RMI spin-off companies developed, with industry partners, a 67–114-mpg uncompromised midsize SUV design in 2000 and a 100-mpg production-ready utility/delivery van in 2011. Another RMI spin-off developed, and sold into the supply chain, the leading process for making ultralight carbon-fiber structures at automotive cost and speed; making just U.S. autos that way could displace half OPEC’s oil for under \$10 per saved barrel, or about a fifth of the mid-2017 world oil price. We helped change federal policies so lightweighting can save both lives and oil, and so government R&D can rapidly advance ultralighting and batteries. We suggested and tested novel federal, state, and local supporting policies now spreading around the world.

Freight and integrated mobility systems: We showed highly profitable paths to make heavy trucks two to four times more efficient, helped Walmart double its truck-fleet efficiency, spun off

the North American trucking industry’s leading efficiency program, and identified a pathway for China to halve empty truck hauls. We helped lead the military revolution in mobility-platform efficiency and wrote the Pentagon’s roadmap to oil-free security. We helped the aviation industry begin its path off oil. We drove the shift toward efficient marine shipping via market transparency, and introduced radical efficiency into cruise, luxury, and naval vessels. We

“From the start, we envisioned a world thriving, verdant, and secure, for all, for ever. We still do.”

elucidated new electric, autonomous, and connected mobility business models now upending the auto and oil industries; sped electric-vehicle infrastructure deployment; and trialed integrated urban mobility systems. We helped the governments of China and India shape major accelerations in electric mobility and integrate information technology and urban design with mobility, just as we’re piloting in the United States. And we confirmed the practical potential to save \$4 trillion by getting a far more mobile U.S. completely off oil by 2050.

BUILDINGS

Our new Innovation Center, in Basalt, Colorado—the most efficient commercial structure in the coldest climate zone in the U.S.—is just the latest step in more than a third of a century of built-environment leadership. RMI invented the green real estate development concept in 1991, showing how developers could heal natural and human



Staff members from LBNL’s China Energy Group, China’s Energy Research Institute, and RMI met in RMI’s first headquarters and Amory’s home to work on their joint Reinventing Fire: China project.



Most of the world's energy is used by industry, and RMI has proven new paths for dramatically cutting the waste.

communities. We wrote its standard text and basic treatises, helped build its institutions and train its practitioners, discovered and proved its huge non-energy benefits, invented its highly profitable deep-retrofit and right-timing practices, enlisted governments in adopting it, and elucidated its barriers, business opportunities and models, and policy and strategic implications. Today's deep retrofits, building-code reforms, and zero- or positive-net-energy new-builds widely apply our learnings and tools, gained from codesigning more than a thousand diverse superefficient buildings worldwide. Our signature way to cut construction cost—smaller or eliminated mechanicals, such as chillers and boilers, that pay (or more than pay) up front for the efficiency that makes them smaller or unnecessary—is spreading, and we're helping build it into popular design software.

By around 2008, RMI's widely sought-after design skills had helped create a third of the world's LEED Platinum projects. But our iconic deep retrofits of the 21st century, like the Empire State Building and Byron Rogers Center, built on our earlier greening of the White House, the Pentagon, Deutsche Bank's Greentowers, the Sydney Olympic Village, and other projects. Those, in turn, applied our 1986–1992 six-volume encyclopedia of electric efficiency—the basis of a leading spin-off firm—and our \$18 million 1990–1997 “ACT²” integrated energy efficiency experiment with Pacific Gas & Electric Company. Our first headquarters building (1982–1984) helped inspire the European passive-

house movement that's now going global. Such thought leadership continues today in our efforts to take U.S. commercial and residential buildings' efficiency potential to national scale, and to help China implement our collaborative reframing of its building strategy around passive and radically efficient design.

We developed and proved performance-based design fees, zero-energy campus retrofits, right-timing tools for portfolio retrofits, and innovative financing methods. We crafted tools for biomimetic and biophilic design, superefficient building portfolios for firms from Ford to Walmart, and fundamental redesigns for everything from affordable housing to zoos, from refugee camps to corporate campuses and medical facilities. In all, our design support, trainings, and insights helped inspire and evolve what is now a major industry beginning to capture U.S. buildings' potential for \$1.4 trillion in net-present-value energy savings with a 33 percent internal rate of return.

INDUSTRY

Industry uses over half the world's energy, much of it wasted. Our design prowess can help fix that, and has already markedly raised many sectors' efficiency bars. RMI has advised more than 85 *Fortune* 500 firms and more than 10 of the world's top 50 brands—not just on technology and strategy but also on superefficient facilities and technical processes. Our hallmark integrative design

techniques optimize whole systems for multiple benefits. This often makes very large energy savings cost less than small or no savings, turning diminishing returns into expanding returns. Across such diverse sectors as microchips, hydrocarbons, chemicals, mining, manufacturing, data centers, food and beverage, retail, and supermarkets, our \$40-plus billion worth of collaborative industrial redesigns have typically found about 30 to 60 percent energy savings in retrofits with two- to three-year paybacks, and in new facilities, about 40 to 90-plus percent energy savings with generally lower capital cost.

Just optimizing friction by making the world's pipes and ducts fat, short, and straight—rather than thin, long, and crooked—could save roughly half the world's coal-fired electricity, with typical paybacks under one year in retrofits and less than zero in new-builds. Yet this isn't in any textbook, business forecast, or official study, because it's not a technology: it's a design method. We have the opportunity to make such “integrative design” commonplace via a half-dozen scaling vectors from new design pedagogy to installer training and from software development to graphic “how-to” manuals for Chinese factory engineers. Now the durable relationships formed, reputation earned, and skills honed in our industrial work are enabling a new RMI effort to help the hydrocarbon industries profitably eliminate 10 percent of their methane emissions by 2030—the fastest way to dial down the Earth's thermostat.

ELECTRICITY

From scholarly debates to practical fieldwork, from helping utilities and regulators craft least-cost resource plans to enlisting the Department of Defense's leadership in resilience, there are few important electric innovations today that don't show RMI's handiwork, and many of the industry's most basic trends have depended on it. Our wide-ranging and rapidly evolving electricity practice focuses on collaborative industry reinvention, new business and regulatory models (notably New York State's Reforming the Energy Vision proceeding and China's grid reforms), corporate renewables purchasing, clean energy for low-income households, low-cost solar power for communities and mines, widening investor access, and the new economy of flexible loads, batteries, grid and load deflection, distributed assets, mini- and microgrids, balancing costs, and green dispatch.

Besides moving customers toward saving three-fourths of U.S. electricity (now used one-fourth in industry, three-fourths in buildings), RMI is driving profound change in how electricity is made and delivered. RMI has laid most of the conceptual, analytic, and often technical foundations of modern least-cost electricity strategy, melding efficient and timely use with diverse, distributed, resilient, and renewable supply. Our work underpins the vast industry (about \$12 billion a year in the U.S. alone) of selling saved electricity, or negawatts—a term we

“RMI did almost none of this transformation singlehandedly—many other important actors have helped at many critical stages.”

first popularized. It has influenced the language, business models, and offerings of firms whose global market for efficiency and renewables exceeds a half-trillion dollars a year. Our decades of work with more than 100 utilities and scores of regulators worldwide evolved a logic that's transforming the industry, with electricity demand declining in rich and flattening in poor countries, and the majority of global new supply now renewable.

We first showed the enormity of the electric efficiency resource, urged that negawatts be bought whenever they're cheaper than megawatts (nearly always) and that utilities be rewarded for best buys first (as 14 states do and eight are considering), asked that efficient and timely use of electricity be allowed to compete directly against its supply (as two-thirds of the U.S. now does), debunked equity and rebound myths, devised some 20 ways to make markets in saved electricity, predicted how renewables could outcompete thermal power plants, showed how to integrate variable renewables like wind and solar reliably with little or no bulk storage, organized industry efforts (underpinning the U.S. Department of Energy's Sunshot program) to halve photovoltaics' balance-of-system cost and cut solar power's cost by two- to fourfold, showed how to correct grids' frightening vulnerabilities, uncovered the hidden economic value of distributed generators, warned of the utility “death spiral,” predicted and explained the failure

of California's botched 2000–2001 electricity restructuring, analyzed why costly nuclear plants reduce and retard climate protection, showed how natural gas's price volatility undercuts its apparent cheapness, and helped drive and explain the impressive—but widely misrepresented—power revolutions in Germany and Asia.

“So what were those 35 years preparing us for? To achieve exponentially more impact.”

SYNTHESES

Ever since my 1976 *Foreign Affairs* paper and 1977 book *Soft Energy Paths* controversially reframed the energy problem—with uniquely accurate foresight of year-2000 U.S. energy demand—RMI's “grand syntheses” have defined and organized new categories of intellectual capital. These works organized contemporary thought about energy vulnerability and resilience (*Brittle Power*, 1982), profitable climate protection (*Least-Cost Energy: Solving the CO₂ Problem*, 1982), profitable green business (*Natural Capitalism*, 1999), economics of scale (*Small Is Profitable*, 2002), getting profitably off oil (*Winning the Oil Endgame*, 2004) and off coal (*Reinventing Fire*, 2011), and profitably delivering seven times more Chinese GDP per unit of energy and 13 times more per unit of carbon (*Reinventing Fire: China*, 2016).

These and more than 1,000 topical publications by RMI's roughly 170 staff support the institute's global reach—now extending from helping China lead the world in deploying efficiency and renewables and helping India explore new mobility and electricity futures to helping Rwandans gain solar access and Caribbean island nations switch from diesel to renewable power.

WHAT'S NEXT?

So what were those 35 years preparing us for? To achieve exponentially more impact. To sustain our values, improve our quality and effectiveness, evolve our tactics, and keep our culture audacious and tenacious. Past global energy transformations have taken a half-century or more, but historic transformations and modern industrial dynamics now give us hope that this one is on track to go far faster.

China and India added 86 percent of the world's new coal stations in the past decade, but have now halted hundreds of gigawatts ripe for cancellation before they become stranded assets. India's energy minister predicts his country's total capacity will be 60 to 65 percent renewable by 2022 because auctions made renewables cheaper than coal, and he engaged RMI to help launch India's transformation of personal mobility. Renewables, their costs plummeting, are half or more of net electric capacity being added in America, China, India, and the world. In 2016 alone, costs fell 37 percent for Mexican solar power and 43 percent for European offshore wind power. The cheaper renewables get, the more we buy, the cheaper they get, and so on.

Extrapolating our U.S. roadmap—and its *Reinventing Fire: China* counterpart we organized to help China's government reframe its energy strategy—to the rest of the world could about achieve the Paris Agreement's 2C° climate trajectory while delivering the same or better energy services roughly \$18 trillion cheaper. Reinvesting in helping natural systems move carbon from air to soil could then about achieve the aspirational 1.5C° goal and save trillions of dollars while boosting global development, prosperity, and security. These are worthy tasks for our next 35 years.

Despair (said René Dubos) is a sin. Ignorance is not bliss. But RMI brings good news rooted in advanced technology, integrative design, mindful markets, irrepressible innovation, and fearless entrepreneurship. So far, human skill and will have expanded to match the problems humans create. Each of us evolved from ancestors who overcame huge challenges. We must not betray their legacy but apply it.

My early mentor, the inventor Edwin Land, said, “Never undertake a project unless it is manifestly important and nearly impossible.” But Henry Ford reassured us that “Whatever is worthy and right is never impossible.” Ford added: “Whether you think you can, or whether you think you can't, you're right.” We can.

Rocky Mountain Institute has the ability and the duty to help all people, of all views, everywhere, to see what they can do, and to do it. I feel blessed by that privilege, by gifted colleagues, and by your companionship on the journey. 🌱

RMI IN BRIEF

News From Around the Institute



RMI's Kaitlyn Bunker (left) accepting the Distinguished New Engineer award from the Society of Women Engineers.

RECOGNITION FOR AN OUTSTANDING RMI ENGINEER

Congratulations to RMI's own Kaitlyn Bunker, Ph.D., who was awarded Distinguished New Engineer by the Society of Women Engineers (SWE) Region i (the square root of -1). Kaitlyn, a manager at RMI, won the award for demonstrating outstanding technical performance as well as leadership in professional organizations and the community in the first 10 years of her career. We applaud Kaitlyn's achievement, as well as the mission of SWE, which includes stimulating women to achieve their full potential in careers as engineers and leaders.

NEWSMAKER: PEAK CAR OWNERSHIP CAPTURES HEADLINES

“A truly sweeping report on the future of vehicles” is how the *Washington Post* described *Peak Car Ownership: The Market Opportunity of Electric Automated Mobility Services*, RMI's recently published report about what to expect as the United States moves away from the traditional model of car ownership, to one where mobility is provided as a service by electric autonomous vehicles. The research describes how the deployment of electric mobility services, and their gradual takeover of the market, will disrupt oil companies, carmakers, and other auto industry incumbents. The widely cited report was also referenced in the *Huffington Post*, Europe's *Energy Post*, *Renew Economy*, *Slate.com*, *Curbed.com*, and other outlets.

A MINING-INDUSTRY LEADER IN RENEWABLE ENERGY

The Sunshine for Mines team was in Toronto at the end of 2016 for the Energy & Mines World Congress on renewables in mining. During the congress, RMI presented a best-in-class award to mining group Gold Fields, for the work we have done together to serve the energy load of its South Deep gold mine in South Africa by integrating 40 MW of solar photovoltaics and 7.5 MWh of battery storage. Gold Fields is an industry leader, producing about 2 million ounces of gold per year, and an important validator for renewable energy in the mining sector, which represents 1.25 percent of the world's total energy consumption.

RMI INNOVATION CENTER EARNS TWO PRESTIGIOUS CERTIFICATIONS

We are excited to announce that the RMI Innovation Center—our beyond net-zero energy office and convening center in Basalt, Colorado—became Petal Certified and Net-Zero Energy Certified through the Living Building Challenge (LBC). All Living Building Challenge projects have a 12-month performance period, and are audited by a third party before they can receive certification. “RMI is thrilled to achieve LBC Petal certification. It validates our efforts to create a model for design, construction, contracting, and operation for net-zero energy buildings,” said Cara Carmichael, RMI project manager.

ENERGY WEB FOUNDATION LAUNCH

RMI has officially launched an exciting project we've been working on for a while, the Energy Web Foundation (EWF). A joint venture between RMI and Grid Singularity, EWF aims to unleash the potential of blockchain technology in the energy sector. Blockchain technology—the technology underpinning the bitcoin virtual currency—has the potential to play a significant, potentially game-changing role in the global electricity system's transition to a more secure, resilient, cost-effective, and low-carbon grid. To achieve this goal, EWF focuses on defining blockchain use cases, building a blockchain platform for the energy sector, incubating an ecosystem of stakeholders, and educating the public. EWF is supported by 10 industry-leading affiliates located in nine countries, including Royal Dutch Shell, Statoil, Tokyo Electric Power, and Sempra Energy. We're also continuing to hold advanced discussions with other companies interested in joining, so we expect the EWF family to grow over time.

Amory B. Lovins is
cofounder, chief
scientist, and chairman
emeritus of Rocky
Mountain Institute.

WEB EXTRA

For more
information on this
topic visit:
[https://rmi.org/
about/history/](https://rmi.org/about/history/)

AMPLIFIED IMPACT

Sir Richard Branson on RMI's evolution and clean energy

Interviewed by Cindie Baker

One of the world's most famous entrepreneurs and philanthropists, Sir Richard Branson hardly needs an introduction. But you might need an introduction to his relationship with Rocky Mountain Institute. In 2009, Branson and a team of like-minded entrepreneurs cofounded the nonprofit Carbon War Room (CWR), with a mission to stimulate business-led market interventions that advance a low-carbon economy. From 2009 to 2014, CWR made significant progress in improving the efficiency of cargo ships and North American trucking fleets and integrating renewables into the grids on Caribbean islands, among other accomplishments. In 2014, CWR merged with RMI to magnify the impact of both. Two and a half years since the merger, we asked Branson about his perspective on the combined organization's successes and future.

Solutions Journal: The rationale for the 2014 merger of CWR and RMI was simple: two nonprofits tackling very similar challenges became one, making better use of their combined approaches and philanthropic dollars. How has that played out?

Sir Richard Branson: The challenge of tackling climate change is so critical to all of our futures, we felt we needed to work together to go further, faster. Carbon War Room has always had a strong entrepreneurial approach, while RMI is renowned for its strong technical depth. Working together and combining our unique strengths has helped us broaden and speed up the energy revolution.

I'm proud of the impact CWR has had on RMI in helping its growth. RMI has adopted the best of CWR's characteristics—entrepreneurialism, quick interventions, bold innovation. We are

growing our portfolio of programs around the world and ensuring we can generate more impact with every program. We must do this if we are to succeed in creating a clean, prosperous, and secure low-carbon future.

When people see "Rocky Mountain Institute"—which we're using as the organization's name—we want them to think about an organization that is audacious, collaborative, optimistic, and smart. We want them to think of essentially the most impactful NGO in the energy space. Carbon War Room's infusion into RMI is helping make that happen.

SJ: What do you think is the most promising technology for a clean energy future?

SRB: I am actually very excited about graphene, which is a new material developed at the University of Manchester. It is very light and very strong, and I think, when blended with carbon fiber, it will play a big part in creating more fuel-efficient planes in the future. At the same time, I am encouraged by the improving efficiency of solar and wind power, which should make it easier to build up capacity so we can create much more cost-effective sources of energy that are sustainable for the long term.

SJ: RMI regularly expands into new areas, such as combating methane emissions. What do you think about RMI's ongoing evolution?

SRB: I think such new work is vital if we are going to succeed, not just as an organization, but also as a community in winning the struggle for our climate. We need to constantly push the boundaries of what is considered possible. Helping industry profitably stop methane leaks is a big challenge, but we must find a way to do it, and RMI's entrepreneurial spirit will help find a new paradigm.

Just as exciting is RMI's work on blockchain technology via the Energy Web Foundation. The idea of taking the technology behind bitcoin and applying it to the electric system may sound crazy, but it is actually revolutionary. Tackling the carbon emissions of sea freight sounded crazy when Carbon War Room started doing it, and now it's spreading. It's only by exploring the limits of the possible that we evolve past business as usual.

SJ: What's your view of RMI's international work?
SRB: It's essential to broaden the base beyond the

USA. I learned through building global businesses in many sectors that having strong local partners is critical to success in international markets. It's no good just having them—listening to them is crucial. That's what's so pleasing about the approach that RMI is taking in sub-Saharan Africa and in China. Working closely with local governments and business leaders, and truly learning from the local communities, is the only way to be effective. RMI's work with mining companies also follows this path.

SJ: Some people see policy as the key to stopping climate change. Do you agree?

SRB: Look, policy is important, but it is not nimble enough or powerful enough to succeed on its own. Business has an important part to play with government and the consumer. When I cofounded Carbon War Room, it was with the idea that business is faster and stronger at making real change. If someone has an audacious idea and an opportunity is revealed, people in business move fast to seize it right away before their competition beats them to it. Entire industries can shift before policymakers have a chance to catch up. That's why we believe in working directly with industries to reveal the disruptive technologies that make our world cleaner and their businesses more profitable.

SJ: You've made Necker Island, in the Caribbean, your home for many years. How does that inform your view of our work with the Clinton Climate Initiative to transition island nations to renewables?

SRB: Islands are special places. Their isolation can make it tough to create quick change. However, it's critical to free islands from importing expensive diesel fuel to run dirty turbines. It will save them money, release them from dependence on distant suppliers, and improve the quality of life for the people who live there. Even more important, we want these islands to be examples to the world of what a clean energy system can look like.

SJ: Do you have a favorite quote about change that would inspire our readers to join us in the change we're enabling to transform energy systems?

SRB: Buckminster Fuller said, "You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete." I've taken this approach in business and philanthropy and it has kept me moving forward, and RMI is doing the same. 🌱

Cindie Baker is editorial director at Rocky Mountain Institute.

WEB EXTRA

For more information on this topic visit: <https://rmi.org/carbon-war-room/>

35 AUDACIOUS IDEAS

A selection of projects and concepts from around the institute destined to change the future of energy

By the Staff of RMI

Thirty-five years ago, when Amory Lovins cofounded a small nonprofit in the mountains of Colorado, little did he know that the organization would grow 170 strong, have five offices, and be working on the ground around the world. The past 35 years have proven that Rocky Mountain Institute's market-based approach works. With your help and the help of many other important partners, we have driven transformative change in some of the biggest and most complex systems in the world, from China's economy to the Empire State Building. We're still pushing the boundaries of what's possible today. Here, 35 years after RMI was born, we give you 35 of the coolest things we're working on now and how they will change the future.



Dreaming up big ideas is serious business.



Ending the Methane Threat Before It's Too Late ▲

Methane emissions are an urgent threat to the climate—methane emissions from the oil and gas industry alone will equal 40 percent of total CO₂ emissions from global coal combustion over the next 20 years. RMI is using its expertise in private-sector engagement to end methane emissions from oil and gas, beginning with putting out flares around the globe. Utilizing a project-based strategy, we are convening industry, governments, multilateral finance actors, and third-party entrepreneurs to capture methane leaks at the source in major oil- and gas-producing nations like Oman, Kazakhstan, Nigeria, and others. Leveraging partnerships with the World Bank and the European Bank for Reconstruction and Development, RMI is catalyzing innovative project development and opening an entirely new industry to drive methane flares to zero and avoid billions of tons of carbon emissions. In the near term, we are driving exponential progress in the effort to put flares out by catalyzing a number of projects and speeding expansion across the 30 top flaring countries.

Factoring Energy Costs into the Home-Buying Process ►

The market crash of 2008 devastated the real estate and lending industries, leading to a new system of checks and balances to ensure that American homeowners could buy only what they could afford. But, the second biggest cost of home ownership—energy use—is still not a major factor in the home-buying or mortgage-underwriting process. RMI's Residential Energy+ initiative aims to change that. We're working with the country's biggest lending institutions, real estate professionals, customers, government agencies, and major real estate platforms to make home energy performance a key consideration in the home-buying process. This will drive widespread improvements in home energy use and in financing.



Making a Market for Utility-Scale Wind and Solar

As corporate giants shift to 100 percent renewable energy, or close to it, RMI's Business Renewables Center (BRC) is helping them to procure utility-scale wind and solar from utility-scale projects. In our "bag of tools" is the BRC Marketplace, an online platform that brings together corporate buyers, project developers, and intermediaries. Corporate buyers and intermediaries can either search our database of projects or post requests to project developers. Corporate buyers use our Marketplace to sense the market, identify opportunities, and get direct access to developers. Developers use our Marketplace to provide visibility to their projects to a broad audience with minimum investment in time. The Marketplace is fast proving a valuable companion to the BRC's other resources, including its education and analysis platforms.

Busting Legal Barriers for Net-Zero Buildings ▼

Thanks to a pioneering approach to contracts in our two Colorado offices, we are helping bust industry barriers to achieving net-zero energy in both owner-occupied and leased multitenant buildings. At RMI's new offices in Boulder Commons, we partnered with others to develop a first-of-its-kind lease structure that built a strong business case for both tenants and landlords to achieve net-zero energy, and established new ways of billing tenants for operating their leased space. At the RMI Innovation Center in Basalt, we pioneered a new contracting structure that shared the risks and rewards of achieving net-zero energy. These contracts are publicly available so that they can provide a resource for others to successfully pursue cost-effective net-zero energy buildings or developments—regardless of their ownership structure.

Autonomous Electric Vehicle Fleets for a Major U.S. City

RMI is helping Austin, Texas, move boldly toward a mobility system of the future that is starting to take shape. With RMI's support and facilitation, the Austin City Council passed a resolution in early 2017 to help shift the city's transportation system to one that enables "shared, electric, and autonomous mobility services, in a city designed for it." Austin is getting down to brass tacks and charting a cleaner, safer, healthier, more accessible, and more affordable future. Austin is poised to be a nexus for the commercialization and consumer adoption of the most exciting new mobility services and technologies. Fielding fleets of self-driving cars, powered by electricity, that cruise the streets to provide mobility to whomever needs it is no small feat. As Austin succeeds in demonstrating a viable path, we will also share and scale the model for other cities to emulate.

Eastbound and Down: A Truck Rally to Prove We Can "Run on Less"

RMI, the North American Council for Freight Efficiency, Shell, and PepsiCo are putting on a cross-country fuel-efficiency roadshow called Run on Less to showcase advances in fuel economy for Class 8 trucks. In September 2017, six to 10 trucks will set off from multiple locations around the U.S., using commercially available technologies and hauling real freight. These trucks will show fleets just how much fuel they can save. Driver progress, as well as the dollars and carbon emissions saved, will be tracked and reported in real time via a website. The run will culminate at the North American Commercial Vehicle show in Atlanta, where final results will be announced.

Helping Sustainable Aviation Take Flight

Biofuel is not yet cost-effective for airlines, even though it is a proven technology. RMI's approach relies on airports taking the lead in accelerating the deployment of biofuels. We've begun a groundbreaking partnership with the Port of Seattle and SkyNRG to investigate financing mechanisms that could supply sustainable aviation fuels to all airlines at Seattle-Tacoma International Airport—the first airport in North America to pursue this goal long term. Our partnership aims to help sustainable aviation fuel go from an alternative product used by a few select airlines to a standard product that is used by all airlines at the airport, proving the feasibility for other airports to follow.



Methane flaring (top left) releases a potent greenhouse gas. Home energy upgrades (bottom left) make financial sense for homeowners. RMI's innovative new Boulder offices (right).

PHOTOS: previous page, iStock.com; top left, iStock.com; bottom left, © Green Energy Futures, courtesy of Dave Spencer and Debbie Whitshire; right, courtesy of Boulder Commons



When Is a Ship a White Elephant? ◀

It is expected that the onset of climate policies in coming years will require ships to run cleaner, with fewer emissions. Ships that can't do so risk becoming stranded assets, unable to operate profitably and repay the loans for which they are collateral—and ships secure \$400 billion of loans worldwide. RMI works to decarbonize shipping, and also to ensure that decarbonization is profitable. Our groundbreaking work is the first to demonstrate these risks as well as steps that can be taken by financiers, shipowners, and shareholders to help ensure investments deliver long-term value and contribute to successful decarbonization.

Transformative Mobility Solutions for India

As India has rapidly ascended the ladder of economic development, its mobility system has been shifting from the use of nonmotorized and public transportation to private ownership of vehicles. This change has brought with it the familiar problems of urban congestion, worsening air quality, increasing traffic fatalities, and increasing reliance on imported fuel. In February 2017, RMI partnered with NITI Aayog, a government think tank, to cohost a charrette to identify transformative mobility solutions for India. India's public and private sectors have already begun to move toward implementation of some of the participants' ideas. Read more in "Modernizing Mobility in India," page 30.

Going Green in the Blue Ridge Mountains

Government, community, and utility stakeholders within the Western Carolinas are exploring alternatives to a new natural gas plant and associated transmission line for meeting the growth in electricity demand in the region. One approach combines demand management resources, including energy efficiency and demand response, and distributed energy resources, including solar power and energy storage. This effort, which RMI is supporting, has already avoided the imminent construction of a new natural gas power plant. The utility involved in this effort is Duke Energy, one of the largest utilities in the country, so this work could provide lessons that can be applied across the country.

Superefficient propellers (left) save fuel. Solar farms (below) power corporations, cities, and universities. CAREC keeps island energy practitioners in touch (bottom).

Standardizing Megawatt-Scale Solar Farms ▶

RMI has developed a breakthrough design for a standardized solar photovoltaic (PV) solution for the distribution grid. The RMI Power Block Solution provides a pathway to a standardized 1 megawatt solar power plant that makes possible dramatically lower labor costs, reduced cycle time, and improved customer adoption rates, which will allow solar PV to compete without subsidies with wholesale electricity. The turnkey 1 megawatt system can be scaled as needed to create larger plant sizes and flexibly meet siting requirements. The design ensures maximized PV performance and efficient installation with a minimally skilled labor force under a wide variety of conditions. Widespread adoption of the Power Block Solution will also create a new, unsubsidized market segment with revenues of about \$1.5 billion per year, and can be deployed around the world.



Mining for Big Cuts in Global Carbon Emissions

Transitioning mining sites from diesel-heavy energy to renewables-based energy has the potential to cut global carbon emissions by billions of tons per year. But most mining companies have never considered moving to renewables and wouldn't know where to begin. A new planning tool from RMI's Sunshine for Mines program enables mines to explore the advantages of renewables. The program's unique, multistep approach starts with a low-cost screening phase to quickly and affordably engage mining firms that may have only a cursory interest in renewables, and takes them through to implementation. For the first time, the value proposition of renewables can be presented to mining companies on a low-cost, bespoke basis.

Planes, Trains, and Automobiles: Better Data for Seamless Travel

Imagine seeing all of your transportation options in real time, in the palm of your hand: where the subway is, if the bike-share is available, how far the rideshare driver is from where you're standing—along with the costs and arrival times of each choice. And envision being able to choose and pay for your transportation choice with the touch of a button on your phone. RMI is working to make that a reality. Interoperable transit data allows transportation modes like public transit, bike-shares, ridehailing companies, and others to communicate with each other and with users, allowing phone-based intermodal travel to be seamless, trustworthy, and efficient.

All-Electric Vehicle Fleets in Hawaii

When in 2015 Hawaii passed its first-in-the-nation law requiring all utilities in the state to transition to selling 100 percent renewable electricity, the state created an incredible hotbed for innovation. We are supporting a push to electrify 100 percent of the Hawaiian light-duty-vehicle and mass-transit fleets. This will have impact beyond the cleanliness of the energy used; this transition is a way to develop and scale up solutions with worldwide application. Adding such a large number of electric vehicles to the grid entails new business models and rate structures for the utilities that serve them, and also provides a huge new customer base. And when electric vehicles are connected to their chargers, they can help manage the grid in ways that Hawaii is poised to pioneer.

An Island-Hopping Knowledge Exchange ▶

The people leading the charge in transitioning island nations to clean energy and away from imported diesel fuel are, by definition, isolated from each other. That's why we helped create a thriving online community that is connecting renewable energy professionals from more than 40 countries to each other and the knowledge they need, and helping them to solve their local energy challenges. The CARILEC Renewable Energy Community (called CAREC) provides members with the information, support, and tools required to facilitate the transition to clean energy and enables them to exchange expertise and good practices. Islands can demonstrate system-wide, sustainable solutions across an entire economy, and collectively show that the clean-energy transition is both replicable and scalable.



PHOTOS: left, right, © Rocky Mountain Institute; middle, iStock.com

Greening Islands in the World's Oceans

RMI has long been working with partners to guide Caribbean island nations' transitions to clean energy. We've helped put steel in the ground and demonstrated the feasibility of integrating high shares of renewables into island electric grids and economies. Now we are looking wider and seeing oceans of opportunity. Island nations in all the seven seas are ripe for similar work. In the Caribbean, we've worked with partners to develop a playbook for transforming island economies, and our expertise in providing capacity building, peer-to-peer collaboration, and regional market development should be applicable to virtually all small-island developing states worldwide. These are some of the countries most vulnerable to the impacts of climate change, and we are looking to expand our work to as many as we can.

All Energy Revolutions Are Local ▼

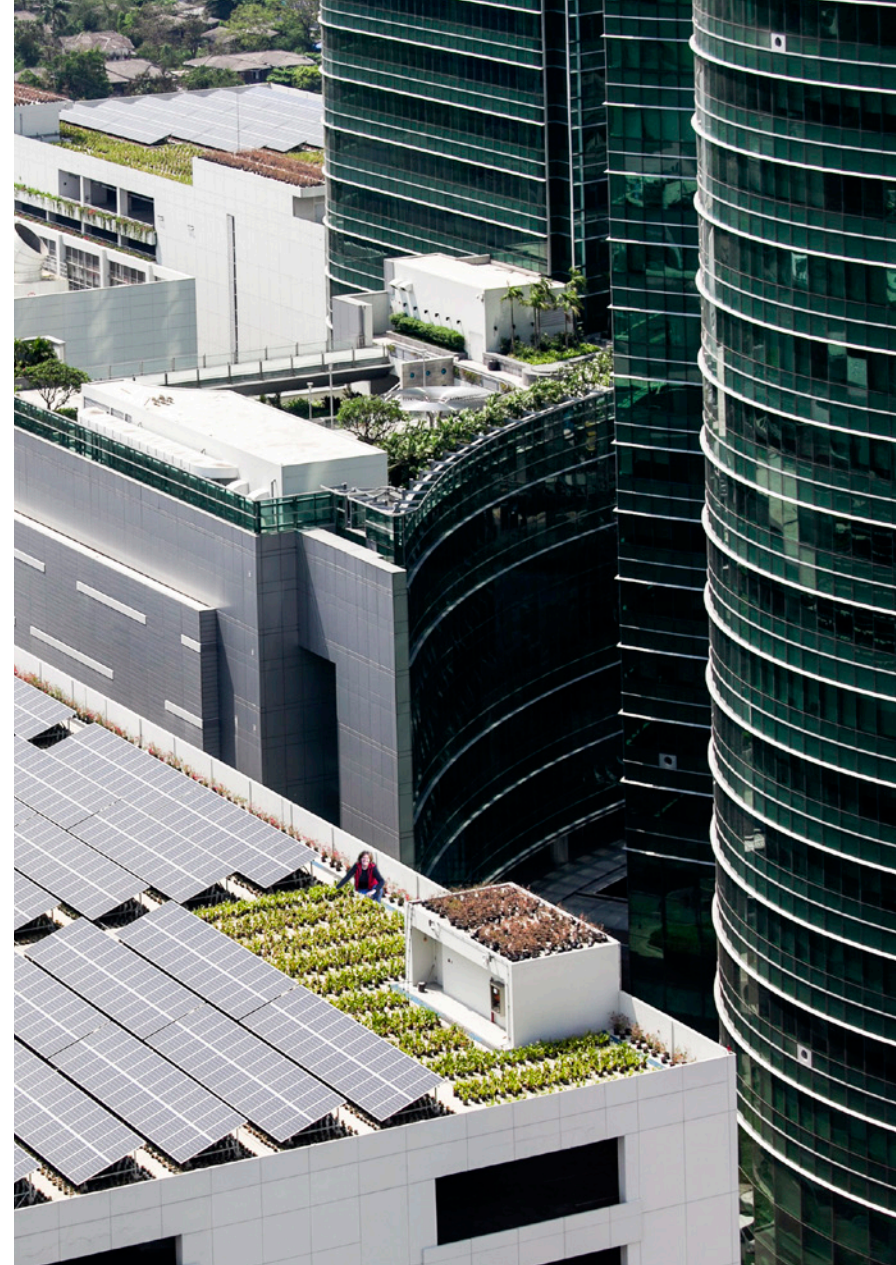
In sub-Saharan Africa, RMI's Sustainable Energy for Economic Development (SEED) program has been collaborating with governments and stakeholders to develop clean energy plans and establish the relationships and mechanisms needed to implement them. A distinguishing characteristic of our approach is that we equip local stakeholders with the tools and skills they need to develop, own, and update an integrated resource plan to guide energy procurement, demand management, and rural electrification decisions on their own—commonly called capacity building. We did just that with the national utility of Rwanda, our first partner country. We designed an integrated resource planning tool that runs on computer programs in use in Rwanda, and then trained staff to use it. Our Rwandan partners are using the tool to evaluate future resource options for their electricity grid, and have asked us to train an even larger group of staff in its use.

Buildings That Make People and Grids Healthier

Our state-of-the-art, beyond-net-zero office and convening center, the RMI Innovation Center in Basalt, Colorado, pushes the boundaries of what's possible with passive, integrative design. After one year of occupancy, the building is performing even better than expected. The Innovation Center's instrumentation, automation, and controls have set a new paradigm for the industry, inspiring numerous companies and academic institutions to seek out our data and better understand our systems to develop scalable pilots on advanced measurement and verification, or to build high-performance buildings of their own.

Reaching a Peak with Cities in China

Recognizing that China's cities are responsible for more than 60 percent of national carbon emissions—a number that will only increase as China urbanizes—RMI supported the creation of, and is now a leading partner supporting, China's Alliance of Peaking Pioneer Cities (APPC). This group of bold cities and provinces is committed to making the groundbreaking changes required to peak their emissions ahead of China's national goal to peak emissions in 2030. APPC cities are implementing best practices from around the world and developing innovative policies and strategies that will in turn be global models, especially for the developing world.



When Buildings Work Cleaner ◀

Commercial buildings consume more than 35 percent of the generated electricity in the U.S. and are underperforming at every level. But retrofits don't happen fast enough when they're customized building by building. Our Portfolio Energy Optimization initiative is bringing building efficiency into the age of the building portfolio owner with an innovative, hands-on, and mass-customized approach. We are developing software tools, working with portfolio owners, and directly testing and evaluating new technologies that can dramatically increase the efficiency of portfolios of operating buildings. Meanwhile, we're also working to establish third-party financing solutions for high-tech upgrades like LEDs and building controls.

Net-Zero Energy Districts in the U.S. and China

Net-zero energy buildings are critical to cutting emissions, but they have not yet achieved market penetration due, in large part, to the perception that a net-zero development comes at a higher upfront cost than business as usual—when, in fact, it is lower. RMI's groundbreaking business model for developing net-zero energy districts can also create new income streams for developers, tenants, investors, and communities. This model has proven to be attractive in China, where the government is strongly supportive of net- or near-zero carbon development but is increasingly reliant on private investment and market forces to deliver. The size of the prize in China is tremendous, with roughly 10 billion square feet of floor space under construction annually.



Location, Location, Location

Corporate buyers of clean energy face a difficult problem: how to assess the value of a renewable energy project? Like for real estate, it is all about location: electricity prices, prices of environmental attributes, and production costs all vary from place to place and state to state. And without that information—which most corporate buyers do not have—it is difficult for buyers to select the right projects. RMI's Business Renewables Center (BRC) has collected more than 70 GB of data from across the country and made it available to corporate buyers on the BRC's software platform. Future versions of the interactive online tool will include more precise estimates of network congestion and pricing of credit risk. The tool provides a unique and much-needed service to increase the quality of decision-making on the buyer's side—and also to guide project developers.

A Game-Changing Technology for the Electric Grid

The blockchain technology supporting bitcoin's virtual currency replaces central clearinghouses with a combination of software, governance principles, and cryptography, making it possible to conduct transactions without trusting a third party for monitoring and control. We believe this technology is capable of facilitating low-cost, secure, and fast integration of rapidly evolving distributed energy resources (e.g., energy efficiency, solar photovoltaics, demand response, and battery energy storage) to the electricity grid in support of our vision for the electricity future. Recognizing blockchain's potential, RMI and Grid Singularity—an Austria-based blockchain technology developer—formed the Energy Web Foundation with one goal in mind: accelerate deployment of blockchain-based solutions in the electricity sector. With 10 affiliates so far, it's off to an auspicious start.

Solar-powered microgrids light up the night in Africa (left). Standardized energy retrofits can quickly make portfolios of commercial buildings (above) energy efficient.



Energy-efficient, energy-producing schools can transform the lives of children—and communities.

Bettering Communities with Net-Zero Carbon Schools ▲

Two-thirds of all people on Earth will live in cities by 2050. Securing a more sustainable and resilient future for our communities is crucial for the generation of children worldwide that will live with the consequences of the decisions we make today. RMI and partners have developed an approach called Generation Z Schools, which can make schools net-zero carbon, slashing their emissions and unlocking additional investment in these schools. The energy retrofits would be just the start, as connected curricula would activate today's students to be champions of an equitable and sustainable climate future. It is hoped that these projects would then scale these improvements to other buildings in each city and beyond, creating centers of resiliency.

Priority for Chinese Renewable Energy

Despite extraordinary growth in China's renewable capacity, China still experiences challenges fully utilizing this energy. The first half of 2016 saw as much renewable energy curtailed as was produced by the entire U.S. solar industry in 2015. To support China's ongoing efforts to address this curtailment, RMI is helping China implement "green dispatch," shifting the way that power from different electricity sources is used and paid for on the country's grid. Green dispatch gives priority to renewable power and the most efficient fossil-fueled power plants, reducing the amount of curtailment of variable renewable energy and maximizing the efficient use of resources. Changing the way the grid utilizes China's diverse energy supply makes it possible for the country's electricity system to save billions of dollars and reduce emissions by up to 10 percent annually—about 1 percent of global emissions.

Reducing Emissions with Automatic Time-Shifting

Until now, there hasn't been a way to measure emissions from electricity use at an exact time and place. RMI has partnered with WattTime, a new technology provider that accurately measures moment-to-moment carbon emissions from electricity systems, allowing users to time their electricity loads to manage emissions creatively and with less effort. With the ability to track the actual emissions impacts associated with specific actions, both in real time and ahead of time, people can now use appliances, for example, at times when electricity is the cleanest. Just shifting the times water heaters and air conditioners are used could reduce CO₂ emissions by over 6 million metric tons of CO₂ per year—that's like taking more than 1 million cars off the road. Harnessing the flexibility of end-use devices equipped with WattTime technology can make them run, on average, 15 percent cleaner than other devices, with no cost or quality impacts for the end user. RMI is partnering with WattTime to integrate this technology in devices coming to a store near you.

Building for Jobs, Revenue, and Carbon Neutrality

With national leadership on climate in question, states are ramping up their goals and commitments to achieve carbon savings on their own. For one major state, we have identified a strategy to economically achieve an 80x50 (80 percent by 2050) emissions-reduction target in the building sector. The strategy focuses on using the sale of a building as a retrofit trigger to increase its value while also curbing its carbon emissions. This strategy can yield \$1 billion per year in energy cost savings, create 50,000 new jobs, and generate hundreds of millions in tax revenue—all without negatively impacting the real estate market. Plus, it can serve as a replicable model for other states seeking an economically advantageous path to a more sustainable and competitive future.

Zero-Cost, Net-Zero Carbon Home Retrofits

Existing residential buildings account for 20 percent of U.S. primary energy consumption, but only a tiny fraction of homes have been retrofitted because both the supply side and demand side of retrofits operate piecemeal, meaning greater time, complexity, and cost for each retrofit. But it doesn't have to be this way. In the Netherlands, Energiesprong created a new approach to residential energy retrofits: retrofitting housing units in large numbers to zero-carbon performance levels with no upfront capital cost to owners. RMI's REALIZE project aims to bring this clean industrial revolution to America's homes. We're convening major players in manufacturing to streamline supply, while also partnering with leading cities to aggregate demand—starting with San Francisco and New York—and with the finance industry.

Solar Power for Low-Income Customers ◀

Not everyone can have solar on their rooftop—high-rise apartments have many homes under one roof, and many businesses and families rent the roofs they live under. What's more, high prices and financing constraints can make individual solar photovoltaics unattainable. To bring solar to everyone, RMI is hard at work developing community-scale solar—large shared solar arrays of 0.5 to 5 megawatts. These solar facilities are much smaller than utility-scale solar plants and can be sited close to end users. They also allow for innovative business models and financing that bring solar within reach for homeowners, tenants, and businesses that wouldn't otherwise be able to access it. Our community-scale solar work, through our Shine team, is making solar power more affordable and more accessible.

Community-scale solar like this fits anywhere and is ideal for serving low-income communities.



PHOTOS: top, courtesy of Hood River Middle School; OR, right, courtesy of Quest Renewables, Inc. - QuadPod™ Solar Canopy

Showing the Value of Island Clean Energy

At the Paris conference on climate change, COP21, many small-island developing states made commitments to transition their own economies away from fossil fuels. But most of the nations lack the internal resources to decarbonize quickly. What's more, the true long-term cost of moving island nations away from imported fossil fuels toward a highly renewable electricity system was unknown, discouraging investment. Now, we have shown that the cost is actually a net gain, at least for the island nations of the Eastern Caribbean. While the upfront cost to transition to 70 percent renewable energy will be \$1.8 billion, almost \$1 billion in total net present value will be gained from reduced fossil fuel imports over 20 years. This encouraging work will provide a roadmap for other island nations and isolated economies to follow.

Making the Invisible, Visible (and Bankable)

The Nest thermostat helped to mainstream the concept of a smarter home. Now, high-resolution smart electricity consumption meters, communicating smart thermostats, nonintrusive load-submetering devices, and new cloud-based software are transforming the concept of smarter buildings. Emerging measurement and verification technologies are one of many disruptive forces changing the built environment's relationship with the electricity grid, and creating a new normal for energy efficiency. But for all of their promise, they remain under-delivered, under-explored, and dispersed. That's where RMI and partners come in—we're providing thought leadership to set a shared language and common standards and methodologies for such technologies, and seeking opportunities for disruptive market offerings and pilot projects.

Looking for a Ship? Choose Green, Clean, and Cheap

It has long been difficult for shipping stakeholders to look at opportunities for operational savings over an extended period of time, and compare operational data with peers. But now, RMI and University Maritime Advisory Service have created BetterFleet, an online, free-to-access ship operational efficiency portal. BetterFleet shows how efficiently an individual vessel has operated over the past year and compares it against its peer vessels. BetterFleet will help stakeholders throughout the shipping and logistics value chain better understand the impact of their decisions, create change that lowers costs and reduces emissions, and ultimately enable them to commit to science-based targets.

WEB EXTRA

For more information on this topic visit: <https://rmi.org/impact/>

“Rebuilding an Aircraft in Mid-Flight” ▼

Today's electricity system was designed over 100 years ago and needs to be reconfigured to incorporate clean distributed energy resources like rooftop solar and energy efficiency, and to also become smarter, more resilient, and more efficient. To help accomplish this feat, which is akin to rebuilding an aircraft in mid-flight, RMI's Electricity Innovation Lab (e-Lab) organized the e-Lab Accelerator, which brings together teams from across North America that are working on projects that promise to revolutionize the electricity system's distribution edge. e-Lab Accelerator is a four-day working meeting helping to unlock opportunities to drive projects forward more effectively and collaboratively by including stakeholders from government and incumbent utilities as well as newer entrants to the energy industry. Some of the most exciting advances in clean energy get their start, or a big boost, at Accelerator.

Building Clean Energy Infrastructure in Africa

Providing energy access to the hundreds of millions of unelectrified households and businesses in sub-Saharan Africa quickly, cost-effectively, and sustainably is a daunting challenge. But the opportunity exists to fundamentally reimagine what a power system can be, and RMI is collaborating closely with partners on the ground in several sub-Saharan African countries to design, finance, and build the kind of energy system needed to drive human and economic development. This is critical because thoughtfully designed and built energy systems will provide energy access to the more than 600 million people in sub-Saharan Africa who currently lack it, and drive sustainable GDP growth in the region—without saddling countries with debt. RMI serves as an impartial, trusted advisor and government champion in navigating the ever-increasing array of clean-energy solutions and in securing funding to move from vision to action.

PHOTO: © Rocky Mountain Institute

Creating a Market for LED Energy Savings

The “as a service” model has transformed the way we look at personal mobility (think Uber) and rooftop solar, driving widespread adoption. Now RMI has put forth a new way to unlock the market potential of LED lighting retrofits with “Lumens as a Service.” This approach transforms the delivery of commercial building lighting by combining LED lighting with smart controls and measurement that enable a third-party service model. LED retrofits paired with intelligent controls can maintain comfortable lighting levels where you need them, provide demand response as a benefit to the electric grid, and massively reduce energy costs when deployed at a commercial scale, all while creating more comfortable and productive spaces. With the Lumens as a Service model, LED retrofits become a win-win-win in buildings, allowing owners, investors, and tenants to capitalize on the people-planet-profit benefits of LED lighting. 🌱

RMI's Electricity Innovation Lab brings together stakeholders from every corner of the electricity system.



PAYING IT FORWARD

Alumni amplify RMI's mission as they advance their careers

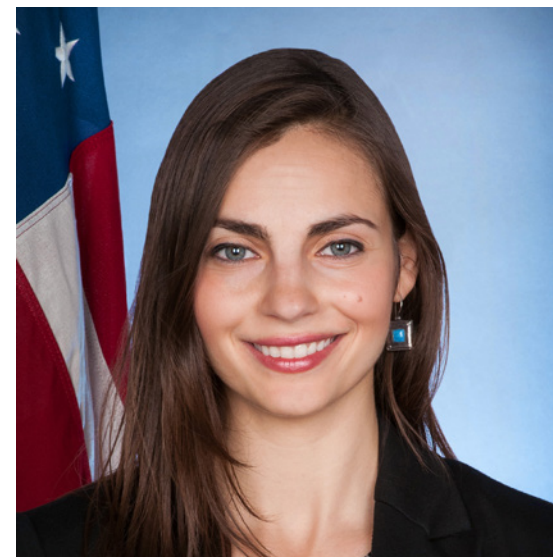
By David Labrador

Hundreds of people who worked at Rocky Mountain Institute over the past 35 years have moved on in their careers, taking the institute's goal of transforming global energy with them. RMI alumni have espoused the ethos of whole-systems thinking; abundance by design; and the pursuit of a cleaner, smarter, healthier energy system, and carried that ethos into the world in some surprising ways, and to some high heights.

Joe Romm held different assistant secretary positions at the U.S. Department of Energy and is a senior fellow at the Center for American Progress. Jigar Shah, the first CEO of Carbon War Room, is the cofounder of Silicon Valley's Generate Capital. Hal Harvey cofounded and led ClimateWorks Foundation and the Energy Foundation, and introduced RMI to

his cofounder, Eric Heitz, who said, "Decades ago, I heard Amory Lovins give a lecture that changed the direction of my career. It led me to found the Energy Foundation with Hal Harvey and to believe in and work toward an affluent, low-carbon economy generally." Under Heitz's leadership, Energy Foundation partnered with RMI on *Reinventing Fire: China*. "It's been great collaborating with RMI in China, and I know we are making the future we want to see," he said.

Our alumni take what they built together at RMI and extend it into the world, creating an ever-widening circle of impact. Here we celebrate the positive change they continue to make by profiling a few of our distinguished alumni. (The interviews have been lightly edited for clarity and length.)



ANNA SHPITSBERG

Global Power Sector Program Manager, Bureau of Energy Resources, U.S. Department of State

Anna was an RMI Stanback Fellow in 2010, while getting her graduate degree at Duke University's Nicholas School of the Environment.

Solutions Journal: What do you do now?

Anna Shpitsberg: I support energy security objectives by initiating and managing global projects on power market reform, grid reliability, electrical interconnections, utility and sector solvency, and energy resource optimization and planning.

SJ: How do you use your RMI experiences in your current position?

AS: RMI is always looking for the latest advancements in technology to drive down costs. While at RMI, I utilized my finance background to design energy-saving programs for the transportation and power sectors. Everyone I worked with understood that financing was a key component to diversifying the energy mix. Now, as I design programs abroad, I pull from this experience to ensure prospective projects account for technological innovation and look toward the future.

SJ: How does your current work advance RMI's vision?

AS: The Power Sector Program, which I had the privilege to help establish and now manage, focuses on partnering with countries to improve power-sector reliability and solvency. In order to attain a reliable and solvent sector, it's critical

to diversify the energy mix so there isn't an overdependence on any one resource. As a result, a lot of my job entails working with countries to conduct energy optimization analysis, which incorporates cleaner solutions.

SJ: What was your most memorable RMI moment?

AS: There were many great moments at RMI, but I particularly enjoyed the time the entire RMI family visited the Snowmass office to run murder boards on active projects. Murder boards are an opportunity to have everyone critically review projects as preparation for external briefings. If a project passes the murder board, then it's ready for the outside world. Watching Amory Lovins participate in these briefings was a unique experience.

SJ: What makes RMI a great place to launch a career?

AS: Personally, I believe launching a career is about figuring out what one enjoys doing day to day, what type of environment makes getting up in the morning enjoyable, and which people can teach one the most. RMI is full of intelligent, curious, and energetic staff. The organization encourages curiosity and diverse backgrounds, which in turn stimulates new ideas.

Alumni spread RMI approaches and ideas like integrative design.





KARL RÁBAGO

Executive Director, Pace Energy and Climate Center, at the Pace University Elisabeth Haub School of Law

Karl was an RMI managing director and principal from 1999 to 2002, and coauthored *Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size* with Amory Lovins and five others.

Solutions Journal: What do you do now?

Karl Rábago: I lead the Pace Energy and Climate Center, which is home to a cross-disciplinary team of lawyers, economists, engineers, and policy experts focused on advancing clean energy in New York, in the Northeast, across the U.S., and around the world.

The center is known for its work in researching and publishing the first comprehensive assessment of the environmental costs of electricity, in coleading a coalition of clean energy NGOs engaged in New York utility policy, and in championing combined heat and power, microgrids, energy efficiency, and distributed solar generation.

SJ: How do you use your RMI experiences in your current position?

KR: RMI was a good fit for my personality: inquisitive, a little bit skeptical, informal, and focused on the big picture—why people and organizations do things, not just what they are doing—analytical, not just descriptive. I learned that there is power in the collection of people who think that way. RMI taught me that I would

be happier working with folks who appreciate (in the sense of understanding) the big picture, the system as a whole, the pressure points, and latent inclinations to change.

At the same time, my RMI experiences instilled in me an expectation, even a demand, for high-quality work, comprehensive analysis, and an appreciation of critical review. A half-baked idea wouldn't fly with Amory or any of the other members of the senior staff at RMI, and it wasn't going to fly with me.

To answer your question: I always asked good questions; my RMI experiences taught me to ask even better ones.

SJ: How does your current work advance RMI's vision?

KR: RMI's mission is compelling, necessary, and right. Over the 27-plus years that I have been involved in the environmental and energy fields, I have come to appreciate that the solutions to our clean energy challenges will come through a focus on change at the community level.

That means that while individual action is necessary, and state and federal policy matters, the changes that are happening—and the greater changes we seek—will happen at and through community-level engagement and initiative. So, we are working on the vision from the community up.

SJ: What was your proudest accomplishment at RMI?

KR: Writing and publishing *Small Is Profitable*.

SJ: What profile does RMI have in your field?

KR: It's seen as a thought leader and innovator.

SJ: What brought you to RMI?

KR: A desire to work on sustainability and not just the clean energy/electric utility regulatory reform agenda. I joined to help costart the Natural Capitalism practice—creating a consulting-oriented mission that worked inside RMI.

SJ: Name one thing readers can do to help create a low-carbon energy future.

KR: Refuse to accept the status quo as inevitable or optimal. Be open to change in your life, your work, and your community. And do your homework before you initiate action.



CHRISTINA PAGE

Founder of Page Sustainability Consulting; Director, Energy & Environment, at Amazon until December 2016; Global Director, Energy & Sustainability Strategy, at Yahoo Inc. for eight years before moving to Amazon

Christina was a senior consultant at RMI from 2001 to 2007, and helped start RMI's Natural Capitalism practice, the backbone of RMI's present consulting practice.

Solutions Journal: What do you do now?

Christina Page: I run an independent consulting firm on business sustainability and systems thinking, and I'm raising two little boys.

SJ: How have you used your RMI experiences in your recent positions?

CP: I learned a lot about the importance of systems thinking while I was with RMI, and also a mind-set of optimism and being solutions oriented, which is partially RMI and partially trademark Amory. It's easy to get discouraged given the seriousness of climate change. Focusing on solutions and maintaining an optimistic mind-set is crucial. At Yahoo, in 2009, we made one of the first corporate commitments to reducing our carbon footprint. In 2010, as part of that, we won a \$9.9 million green IT grant from the U.S. Department of Energy for the famous Yahoo Compute Coop, a chillerless data center—no centralized chilling system, just direct evaporative cooling. Amory had been talking about the concept of chillerless data centers since 2002 as a way of tunneling through the cost barrier. Eight years later, some really smart engineers at Yahoo managed to pull it off.

During my time at Amazon, there were some exciting opportunities to bring sustainable business to scale—it's one of the fastest-growing companies in the world. I had the chance to apply ideas to everything from buying large-scale utility wind to on-site solar installations.

SJ: What was your most memorable RMI moment?

CP: The "Sustainable Settlements" charrette we did in 2002. We tackled the problem of making



Yahoo's Compute Coop data center takes advantage of direct evaporative cooling.

refugee camps and communities more livable. It was incredibly inspiring and seems even more relevant today.

I also just attended the eLab Accelerator event this past April, which was packed with new memorable and inspiring RMI moments!

SJ: What was your proudest accomplishment at RMI?

CP: Being part of the team that built the Natural Capitalism consulting practice for businesses, utilities, and government. The team at RMI took the great ideas in the *Natural Capitalism* book and operationalized them.

SJ: What profile does RMI have in your field?

CP: When I was working at RMI, sometimes I underestimated the respect and authority that RMI as an organization affords the rest of the sustainability community. It's an incubator for some really creative thinking, and people recognize that.

SJ: What's your favorite book, blog, or resource for learning about transforming energy use or addressing climate change?

CP: Donella Meadows's book *Thinking in Systems: A Primer*. It's not specifically about energy systems, but about systems thinking.

I think that right now, the biggest energy challenges involve the whole system—supply, demand, and aging infrastructure—more than a specific technology. The challenge is understanding how the system behaves when technology is transforming really quickly but the institutions that are set up to deliver the power are pretty antiquated. Meadows's book is about how to look at and understand systems.

SJ: Name one thing readers can do to help create a low-carbon energy future.

CP: We need to be mindful of our choices without becoming paralyzed. Changing the mind-set and the paradigm that creates a system is where we really need to focus our attention. The least effective point for changing a system is just messing around with the numbers. The most effective is challenging deeply held beliefs. There's still a belief in this country that business and the environment are inherently at odds. It's crucial that we continue to challenge that notion in our decisions and daily actions.



BENNETT COHEN

Senior Associate, Shell Technology Ventures, and Board Chair and Cofounder, Empower Generation

Bennett was special aide to Amory Lovins from 2008 to 2010.

Solutions Journal: What do you do now?

Bennett Cohen: Since 2010 I've been a board member of a nonprofit that my wife and I cofounded with a Nepali economist called Empower Generation. It takes a market-based approach to both gender equality and sustainable energy by empowering women to become clean energy entrepreneurs in Nepal and other countries. Empower Generation seeds and supports women-led clean energy enterprises serving the energy poor, and gives clean energy technology suppliers access to remote markets where their products are in high demand.

Since 2012 I have worked for Shell, starting in Amsterdam as a member of the Future Energy Technology group, responsible for informing Shell's strategy and developing business options in "new energies"—low-carbon and digital energy solutions. Since then, the energy transition and digitization have become pillars of Shell's long-term strategy, and New Energies is now a division that encompasses renewables, integrated energy solutions, low-carbon transportation, and digital businesses.

In 2015 I joined Shell Technology Ventures, the venture capital arm of Shell. I've spent the last two years developing Shell's network within

the Bay Area community of entrepreneurs and venture capitalists, and working on investments in startups and venture capital funds with strategic relevance to Shell. We just officially opened our San Francisco office in the Transamerica Pyramid, where I am joined by several colleagues from the New Energies group.

SJ: How do you use your RMI experiences in your current position?

BC: There are many similarities in how RMI and Shell look at the energy system. In fact, Amory and RMI have collaborated with Shell on energy-scenario thinking since the 1970s, and I've had the opportunity to engage with RMI several times since joining Shell. Both organizations place a premium on very high quality analysis and arguments, thinking in systems, and a global view of energy as a pillar of modern society. As part of an "intrapreneurial" team within Shell, I always remember Amory's metaphor of institutional acupuncture, and within the venture capital team, I am looking at opportunities that recall projects and thought pieces from my time at RMI. And of course, my passion for the widespread adoption of clean energy, which I honed at RMI, is a big part of what guides my work on the board of Empower Generation.

SJ: How does your current work advance RMI's vision?

BC: I joined Shell in the spirit of RMI's philosophy, which puts for-profit business at the heart of solutions that lead to resource efficiency and sustainability. While many organizations with similar missions take a confrontational approach to business, RMI engages the biggest players to punch above its weight in terms of impact. After my time at RMI and a stint in graduate school, I saw no bigger platform for impact than Shell. I'm optimistic about where Shell and its New Energies business are headed.

SJ: What was your most memorable RMI moment?

BC: My most memorable moment at RMI was the screening of a spoof film that my roommate and coworker, Tripp Hyde, and I made for the institute's annual retreat, which included a film festival. In our film, all the stuffed orangutans in Amory's house came to life and got into some serious mischief.

SJ: What profile does RMI have in your field?

BC: RMI is known for being at the leading edge of innovation within energy, and it has an impeccable reputation among industry stakeholders.

“In our film, all the stuffed orangutans in Amory's house came to life and got into some serious mischief.”

SJ: What's your favorite book, blog, or resource for learning about transforming energy use or addressing climate change?

BC: My favorite classic is *Natural Capitalism*, which set my career path. My favorite recent book is *Clean Disruption of Energy and Transportation*, by Tony Seba. And my favorite website is greentechmedia.com.

SJ: Name one thing readers can do to help create a low-carbon energy future.

BC: Put your money where your mouth is. Drive the consumer energy revolution through installing solar on your roof, buying an alternative energy vehicle or a Nest thermostat, etc. Be an early adopter where you can. 🌱



Amory with a real orangutan, a member of a species that he has done much to protect.

David Labrador is a writer/editor at Rocky Mountain Institute.

WEB EXTRA

For more information on this topic visit: <https://rmi.org/about/meet-our-team/>

MODERNIZING MOBILITY IN INDIA

A recent charrette jump-starts the move toward a 100 percent electric mobility future

By James Newcomb and Clay Stranger



30

Our senses were overloaded as we wound through the labyrinthine streets of Old Delhi. Tangled webs of jury-rigged electric wires hung overhead, while thick smoke billowed from the cooking fires of street vendors. Along the streets, businesses selling recycled mechanical parts and brightly colored fruit; places of worship; and people's homes were woven together in a vibrant tapestry of humanity.

We visited Old Delhi in January 2017 in advance of a charrette that Rocky Mountain Institute would be facilitating about the future of mobility in India to get a firsthand view of the country's diverse mobility system. As we made our way through the city in an auto-rickshaw, the experience was both nerve-racking and intriguing. We shared the road with seemingly every mode of transport under the sun. In an unusual balance of order and chaos, water buffalo pulled carts loaded with bricks, bicycle rickshaws hauled goods to market, and scooters and motorbikes slid through gaps in the traffic ranks, all while three-wheeled auto-rickshaws pulled over to pick up families. And yet, cars were conspicuously absent from the streets of Old Delhi.

INDIA'S UNIQUE OPPORTUNITY

The myriad ways we saw people and goods being moved on the streets hint at the set of advantageous conditions that make India uniquely positioned to take advantage of new developments in mobility services. Rapidly evolving technologies and business models for delivering mobility services have the potential to dramatically transform the global transportation sector. New and fundamentally different pathways are emerging to provide clean, cost-effective mobility services that will also create new jobs, reduce dependence on imported oil, and achieve more efficient land use in cities.

India has an opportunity to “leapfrog” the personal vehicle ownership model of developed countries and move directly to a shared, connected, and electric passenger mobility system—the mobility system of the future. Three especially promising enabling conditions exist: the high share of nonmotorized transport, the low level of private vehicle ownership, and the prevalence of mobility services.

1. Currently, nonmotorized transportation (i.e., walking and biking) and public transportation meet nearly 70 percent of the mobility demand in India. This stands in stark contrast to the

proportion in the United States, less than 10 percent. Preserving this share of transportation modes while improving urban design can make walking, biking, and public transport safer and more desirable in India.

2. Despite having expanded 472-fold since 1950, auto ownership in India remains low, with only 18 cars per 1,000 citizens (whereas the U.S. has nearly 800 cars per 1,000 people!). The paucity of privately owned four-wheeled vehicles creates an opportunity for India to deploy emerging technologies and business models to make mobility services more convenient and cost-effective than personally owned cars.
3. Shared mobility is already familiar and highly utilized in India. Bicycle and auto-rickshaws flexibly carry commuters along routes not served by other modes of transportation, and ridehailing services are experiencing enormous growth. Using interoperable transportation data and user interfaces that aggregate modes, options, and payments to enhance the current mobility services system, while connecting it to emerging offerings, could establish India as a global leader in shared mobility.

Despite these supportive conditions, India faces challenges that signal the gravitational pull of privately owned vehicles and reinforce the importance of pursuing a different mobility future. Every day, 50,000 new motor vehicles (two-, three-, and four-wheelers) hit the roads; India has seen a 10 percent annual increase in vehicle registration for the past decade. Despite the country's very small per capita automobile fleet, traffic congestion and pollution are already serious issues. According to a 2016 World Health Organization study, 10 of the world's 20 most polluted cities are in India. India imported more than 80 percent of its oil in 2015, at a cost of US\$112 billion. Traffic fatalities cause around 150,000 deaths annually on India's roads, and it is estimated that losses related to traffic congestion cost the city of Bangalore nearly US\$1 billion per year.

Given the country's population of more than 1.3 billion, representing approximately 17 percent of the world's population, India's pursuit of different pathways to clean growth and prosperity—in mobility and beyond—not only would benefit its citizens but could also serve as a model for other developing nations.

Two- and three-wheeled vehicles are a large part of India's traffic.



RMI IN INDIA

In March 2016, RMI's cofounder and chief scientist, Amory Lovins, traveled to New Delhi to meet with senior leaders from the Government of India. During the visit, Piyush Goyal, the minister of coal, mines, power, and new and renewable energy, described his ambition to realize 100 percent electrified passenger mobility in India by 2030. This goal, which was made public in the weeks following Lovins's meeting, would represent the most ambitious and largest-scale national electric vehicle (EV) usage target to date.

Minister Goyal also made it explicit that the transition to EVs should not rely heavily on subsidies or other public funds, and that the majority of the technology should not be imported. Achieving such a momentous goal necessitates coordinated action by government and the private sector, and it became clear to Lovins that a systemic approach to the challenge would be required.

COLLABORATION AMONG DIVERSE STAKEHOLDERS

Aiming to develop an integrative solution, RMI and NITI Aayog—the premier think tank of the Government of India—partnered to cohost a charrette titled “Transformative Mobility Solutions for India” in February 2017. One goal was to identify specific near-term actions that could jump-start India's move toward a 100 percent electric mobility future. The charrette provided a unique forum in which participants could engage in focused dialogue on issues that have historically been pursued in silos, but that will require extensive collaboration if new opportunities to address them are to be unlocked.

More than 75 individuals gathered at the event, including government officials from the joint secretary level to the cabinet minister level, private-sector participants from the chief of strategy level to the CEO level, and leading academic and subject matter experts. During the charrette, Dr. Ashok Jhunjhunwala, who leads the Government of India's Electric Vehicle Task Force, relayed the strength of India's commitment, saying, “The government is determined to make EVs happen. Challenges are always there. But there are huge compulsions, too.”

NITI Aayog's CEO, Amitabh Kant, and its transportation sector advisor, Dr. Manoj Singh, ensured that the charrette was a high-profile

call to action at the ministerial level. Five cabinet ministers, who govern much of India's mobility system, keynoted the inaugural dinner. Many participants, including the ministers themselves, remarked that the occasion to discuss the opportunity with stakeholders representing the entire passenger mobility system was critical and had not happened previously.

Speaking at the charrette's inaugural dinner, India's minister of heavy industries and public enterprises, Shri Anant Gangaram Geete, described the importance of the event: “In the last many years we have seen that coordination that was required among the various ministers of the government was not to be seen. But now, for the first time, it is seen that we have all got together and are working towards a collective responsibility to face the challenges and come out of it with a solution.”

THE STANDARDIZED SWAPPABLE BATTERY SOLUTION

CONTEXT



Two- and three-wheelers make up about 80 percent of India's domestic automobile sales, and two-wheelers dominate India's urban transportation mode share (24 to 29 percent of the mode share in cities of between 500,000 and 8 million people).



EV capital cost premiums, for which EV batteries are largely responsible, are hindering market adoption.

OPPORTUNITY



Standardized swappable batteries for two- and three-wheelers, with an extensive swapping facility network and robust tracking and payment systems, could rapidly electrify a dominant segment of India's transportation sector.



Removing the battery from the sticker price of an electric two- or three-wheeler would make the vehicle cost competitive with fossil fuel-powered alternatives.



The *India Leaps Ahead* report launch, held in New Delhi on May 12, 2017, was widely covered in India. At right, NITI Aayog's Dr. Manoj Singh and Amitabh Kant and RMI's James Newcomb and Jerurd Weiland (l-r) present the report.

In an effort to represent the entire mobility system, we structured the charrette around three foundations: the systems by which people move, the vehicles and technologies they use to move, and the mobility environments that they move through. A balance of Indian leadership and international experts ensured that practical solutions were developed and that stakeholders with influence over policy and business decisions were present to create implementation strategies.

Chetan Maini, an entrepreneur, investor, and leader in EV technology, and president of the Maini Group, described the whole-systems approach: "The workshop looked at a range of issues from energy security to a thrust on renewable energy and brought together multiple stakeholders. This hasn't happened before. I see everything coming together." Maini launched India's first electric car in 2001, the Reva, which is now driven in more than 25 countries.

"The workshop looked at a range of issues from energy security to a thrust on renewable energy and brought together multiple stakeholders. This hasn't happened before. I see everything coming together."

Sohinder Gil, CEO of Hero Electric and director of the Society of Manufacturers of Electric Vehicles, described the importance of the multi-stakeholder approach this way: "All these years, it would be mostly us manufacturers who would lock ourselves in a room to discuss issues, with nothing concrete emerging. This workshop was refreshingly different."

ACTIONABLE IDEAS

The charrette concluded with representatives from six working groups presenting detailed action plans designed to capture the opportunities identified. Solutions fell into five broad categories: governance, infrastructure, policies and incentives, business models, and data access and availability.

At the behest of the Indian Government, the charrette focused on creating actionable and specific solutions. One exciting solution explored at the charrette was a business model that would standardize batteries for electric two- and three-wheeled vehicles so that they could be swapped at a network of charging stations (see "The Standardized Swappable Battery Solution," p. 33).

LOOKING FORWARD

During the charrette, RMI and NITI Aayog signed a memorandum of understanding extending the partnership between RMI and the Government of India. NITI Aayog and RMI coauthored a report that summarizes the key insights from the charrette, describes the vision for mobility transformation in India, and provides recommended actions that can be initiated immediately to capture long-term value and reach India's ambitious 2030 targets. The recommendations address city, state, and central government actors; the private sector; and civil society. RMI and NITI Aayog will conduct an outreach and engagement campaign to syndicate the findings and recommendations to stakeholders and decision makers across the government and private sector.

In the days and weeks following the NITI Aayog and RMI event, stakeholders made encouraging progress. Several days after the charrette, Nitin Gadkari, India's minister of roads, highways, and transportation, announced that he was devising a scheme to remove the permitting requirements and fees for commercial electric vehicles. This promising announcement aligns with a conclusion from charrette participants that bolstering currently economic segments of the electric vehicle market can develop economies of scale and lay the foundation for market-wide transformation. The reduced operating costs of high-mileage electric vehicles outweigh their higher capital costs, making them cost competitive with other internal combustion engine alternatives today.



Commitments from the private sector are also targeting the commercial electric vehicle opportunity. One month after the charrette, Bhavish Aggarwal, CEO of Ola (India's largest ridehailing service) announced that the company would deploy electric cabs. "There is a lot of focus on electric vehicles. We shall be rolling out electric cabs in top cities in three months," said Aggarwal.

The compelling economics of commercial electric vehicles are taking hold, and supportive and coordinated policy interventions can rapidly scale electric mobility. Many challenges remain, including the need to provide reliable fast-charging infrastructure to service commercial fleets, but market forces are already favoring electric vehicles in selected segments. Strategies such as aggregated procurement that have proven effective in India for other technologies can further reduce costs and expand the market for electric vehicles.

India has proven itself highly proficient in driving down costs and deploying clean technology at scale in other sectors. India's nationwide mission to rapidly deploy LEDs has been a huge success, and in 2014 aggregated demand and procurement of LED lights lowered costs by 76 percent. It is estimated that the program will have saved 85 metric tons of CO₂ per year by 2019. India's reverse solar auctions have driven down costs by 73 percent since 2010, and India has already realized solar tariffs that are among the cheapest in the world.

A CONVERGENT OPPORTUNITY

The mobility sector represents an opportunity to expand system boundaries and create value not just for passengers, but also for the electricity sector. India has set a target of installing 175 gigawatts of renewable energy generation by 2022, and a draft government target aims to generate 57 percent of India's electricity from nonfossil sources by 2027.

These ambitious targets and India's electric mobility mission can create more value and be more readily achieved when pursued together rather than separately. For example, smart charging of electric vehicles can help smooth electricity loads and provide valuable flexibility to the grid, and enhanced payment and data systems can improve customer experiences while also supporting better system planning and greater efficiency.

India is poised for success. Shared vision among India's top leadership, a dynamic and thriving entrepreneurial culture, and the opportunity to avoid the private vehicle ownership model can mitigate worsening traffic congestion and air quality and can reduce dependence on imported oil. Such a transformation could position India as the global leader in clean, shared, and connected passenger mobility, while establishing a model of low-carbon solutions for other developing nations to follow.

James Newcomb is a managing director at Rocky Mountain Institute. He leads the institute's electricity practice.

Clay Stranger is a principal at Rocky Mountain Institute. As director of the Office of the Chief Scientist, he oversees projects in China, India, and the United States.

WEB EXTRA

For more information on this topic visit: rmi.org/https://rmi.org/insights/reports/transformative_mobility_solutions_india/

SPEAKING UP FOR OUR FUTURE

A digital native expands the online conversation about the energy transformation

By Lindsey Chew

36



Last summer, I graduated from Boston University where I studied business and public health, but outside the classroom I always circled back to tackling the global climate challenge with words—by writing articles, opening up dialogue with peers, and leveraging social media as a powerful tool to bring people together to make a lasting impact. When I learned about Rocky Mountain Institute's work, and found that the organization had been championing practical, profitable business solutions for a clean, prosperous, secure low-carbon future since its very beginning, I was immediately interested in joining the team. It was exciting that RMI was ramping up its efforts internationally in China, Africa, and island nations, and I liked the entrepreneurial edge that the recent merger with Carbon War Room brought. All this seemed to set RMI apart as fast-paced and effective.

By the time I applied to work at RMI, I was hooked on using digital media to fight climate change. My grassroots efforts to confront climate change as a student grew to a much more influential scale than I ever expected—including representing the social media voice of a high-profile global event called Climate Week NYC, and launching a Twitter campaign, #CleanEnergyU, that connected students on dozens of college campuses with more than 40 inspiring change makers from business, government, and NGOs who together identified promising new clean energy solutions.

These social media movements gained major impact and recognition, and I found myself invited to a climate action roundtable at the Obama White House. This ultimately contributed to bold new commitments by Boston University to reduce its carbon emissions by 35 percent in 4 million square feet of building space by 2020, and reduce its energy consumption by 10 percent between 2012 and 2017.

Through all of these conversations with thought leaders, the resounding takeaway was simple: My generation is the first to feel the impacts of climate change from our youth, and the very last to be able to do something about it. The dialogue is no longer centered on a vague outlook for future generations because right now, emerging economies and low-income populations around the world are facing the harshest consequences of a warming world, including impacts from sea level rise, superstorms, droughts, crop shortages,

and more. Today, we must rise to the occasion and take on the greatest global challenge of our time. For me, the best way to do that is working at Rocky Mountain Institute.

My first eight months on RMI's communications team have been a fast-moving, thought-provoking, and exciting time of rapid growth. I learned very quickly that working at RMI meant being on the leading edge of transforming the way that the world uses energy. But even with 35 years of progress under our belt, we have a lot of ground to cover.

What's most exciting about digital is that it is so new—exploring this uncharted territory and the evolving way that people are communicating means that the job is frequently self-taught and entrepreneurial in a way that few are. Social media gives us a global opportunity to speak up for our future; we can connect with thousands of people each day to swiftly develop a more collective worldwide voice and influence.

As digital marketing associate, I now manage the vision and long-term strategy for RMI's online presence. I craft and present new content—articles, blog posts, reports, photos, videos, infographics, media mentions, and more—on multiple platforms. On the social media side, I develop our Twitter, Facebook, LinkedIn, YouTube, and Google+ channels (our Instagram channel is launching soon!).

Beyond managing our public-facing sites, I build collateral that gets sent directly to you, our partners and supporters—things like newsletters, event invitations, confidence reports, and press releases. Timing and relevance are critically important. Every morning we selectively share industry-relevant energy and climate articles with a particular focus on international policy, groundbreaking technologies, and progress by states, cities, and regions.

And in the new digital environment, information flows both ways. It's inspiring to listen to and learn from our audience's Facebook comments and tweets, and bring those shared insights to our staff. It is rewarding to see constructive comments and debates pop up, and to see that our supporters are motivated to share our important messages far and wide. Social media also opens new doors for partnership opportunities with other NGOs

and businesses. We have developed collaborative campaigns with other organizations to copromote ride-sharing programs, Earth Day events, book launches, reports, and more.

We've also started using video to engage with our supporters using Facebook Live Q&As. They've gone well, and we are working to develop and produce two new Facebook Live Q&A series, one called #AskRMI and one for RMI's Business Renewables Center called Corporate Renewables Today. #AskRMI is an interview-style series in which our experts explore the most important clean energy business, technology, finance, and policy topics of the 21st century through questions from our audience. Corporate Renewables Today is a timely market update and response to the latest renewable energy deals and company commitments. If you miss them live, you can always find them on our YouTube channel, and the most insightful sound bites will be reshared on Twitter.

“My generation is the first to feel the impacts of climate change from our youth, and the very last to be able to do something about it.”

Because RMI's research and collaboration teams churn out such a large volume of projects each week, we strive to present complex concepts in a succinct, creative, and positive way. Our work influences the lives of people in societies around the world, so our digital marketing seeks to clearly articulate these human and economic impacts. For example, we recently launched a report on the potential of electric minigrids in Africa to unlock a multibillion-dollar market opportunity and bring access to electric light and power for millions.

I hope that you and others will come to rely on our channels as an educational, insightful resource for energy facts and timely expertise—that our posts will be a seed of inspiration for your daily actions, conversations with family and friends, votes, long-term investments, classroom discussions, and business decisions. All of our social channels are accessible from our newly launched website's home page, www.rmi.org. I hope that you'll provide feedback and comments, and connect with us! 🌱

Lindsey Chew is RMI's digital marketing associate.

⊕ WEB EXTRA

For more information on this topic visit: <https://twitter.com/RockyMtnInst>

FROM THE ARCHIVES

Some artifacts from RMI's rich history

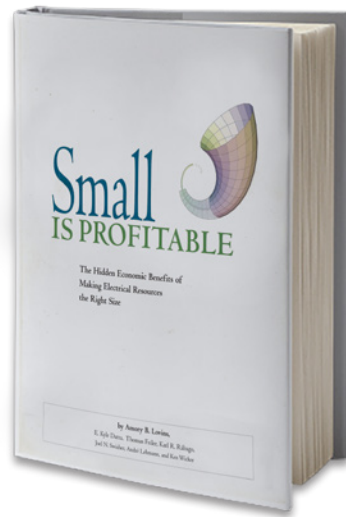
By Laurie Guevara-Stone

A lot has happened over the past 35 years to make Rocky Mountain Institute what it is today. From our humble beginnings in the Lovins's home to writing thought-provoking solution-oriented books, to creating new words and influencing policy, we have a lot to be proud of. We combed through our archives to pick out a few of the interesting projects and moments from RMI's past.



Rocky Mountain Bananas

Who knew you could grow bananas in the mountains of Colorado? RMI's first office was based in a wing of Amory Lovins's passive solar home, built in 1984 at an elevation of 8,000 feet. The home includes a 900-square-foot interior garden, which houses a tropical jungle including a banana tree that has produced 69 banana crops to date, leading the house to be affectionately known as the Banana Farm.



Smaller Can Be Better

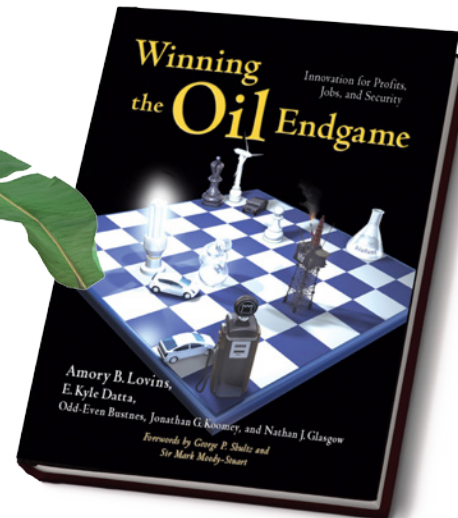
RMI's book *Small Is Profitable: The Hidden Economic Benefits of Making Electric Resources the Right Size*, published in 2002, explains how the size of electrical resources affects their economic value. This *Economist* book of the year shows how distributed and decentralized electric resources can be up to 10 times more economically feasible than large power plants.



Mr. Lovins Goes to Washington

In 1977, President Jimmy Carter invited Amory Lovins into the Oval Office to discuss Amory's recent *Foreign Affairs* article, "Energy Strategy: The Road Not Taken?" which discussed combining energy efficiency with a shift to renewable supply. In 2014, they met again, and President Carter said he found the article very helpful in forming his energy policy, the most coherently pro-efficiency-and-renewables policy to date at that time.

PHOTOS: Banana tree, iStock.com; recent Carter and Lovins image courtesy of Chip Commins; Amory carbon hat



Getting Off Oil

Want to know how the U.S. can completely phase out oil? In 2004, RMI published *Winning the Oil Endgame*, cosponsored by the Pentagon, which detailed the first strategy for ending U.S. oil dependence, led by business for profit.



The Bucky Dome Lives On

In 1982, inventor and visionary Buckminster Fuller offered to build one of his geodesic domes on the Windstar estate in Old Snowmass, Colorado, where RMI was soon to be headquartered. In the summer of 1983, weeks before construction was scheduled to start, Fuller died of a heart attack. In his spirit, a group of young architects and engineers, including RMI staff, built the Windstar biodome, which stood next to RMI's offices until the 2015 move to the new RMI Innovation Center.



Getting Ready for EVs

In 2008, RMI formed Project Get Ready to help prepare for electric vehicle adoption. By 2011, Project Get Ready had partnered with 25 cities and regions throughout the U.S. as a trusted source of information on smart bidirectional charging infrastructure.



Lightweighting with Carbon

Those of you who have seen Amory in his carbon fiber "hat" know that in 1991, RMI invented the ultralight, superefficient Hypercar® concept. Based on lightweighting cars through the use of carbon fiber, often illustrated by Amory with a carbon fiber bowl (that can double as a "carbon cap"), the concept won the Nissan prize and helped launch modern hybrids and lightweighting.



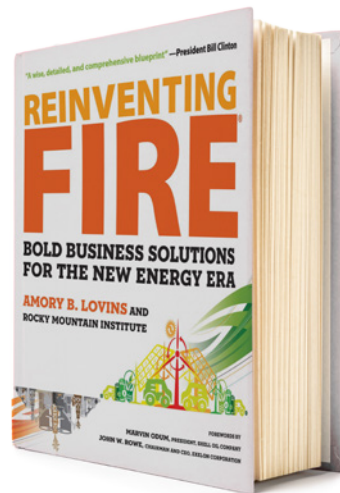
Low-Carbon Trucking

In 2009, RMI brought together a diverse group of people working in the trucking industry to figure out how to make this carbon-intensive industry more efficient. This Transformational Trucking Charrette led to the formation of the North American Council for Freight Efficiency (NACFE), an organization still working today to make truck fleets more fuel efficient.



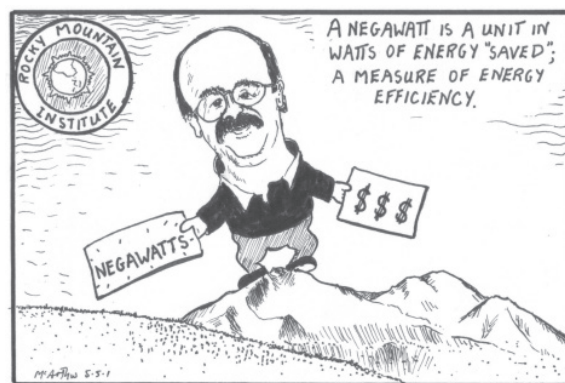
Creating the Next Industrial Revolution

In 1999, RMI coauthored *Natural Capitalism*, which describes a new type of industrialism that is more efficient and profitable while saving the environment and creating jobs. It became a U.S. bestseller, and RMI launched a consulting practice based on its principles.



Reinventing Fire

Imagine no climate change, no oil spills, and no dirty air. In 2012, RMI published *Reinventing Fire: Bold Business Solutions for the New Energy Era*, which shows how a richer, fairer, safer world is not only possible but profitable. Based on RMI's 30 years of research and work in the field, the book maps pathways for running a 158-percent-bigger U.S. economy in 2050 but needing no oil, no coal, and no nuclear energy, while saving \$5 trillion.



The Negawatt

How do you describe something that is not there? Fortunately, Amory Lovins saw a typo in a 1989 Colorado Public Utilities Commission report—negawatt instead of megawatt—and coined the term to describe electricity that is not created (i.e., efficiency). The word soon entered the English lexicon, and in 2003, was officially added to the Oxford English Dictionary.



RMI Retrofits an Icon

In 2008, RMI co-lead the design of a deep energy retrofit of the Empire State Building. The retrofit saved two-fifths of the iconic building's energy use with a three-year payback, and has since been scaled to more than 100 other buildings.



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About Rocky Mountain Institute

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

