

SPRING 2019 | VOL. 12 NO. 1

Solutions

Journal

**TRANSFORMING
ENERGY,
SECURING
COMMUNITIES**



**Power Systems That Stand
Up to Natural Disasters**

**The Fierce Determination of
Next-Gen Climate Leaders**

**Meet, Sway, Lovins:
Globetrotting with Amory**



And more...



SPRING 2019

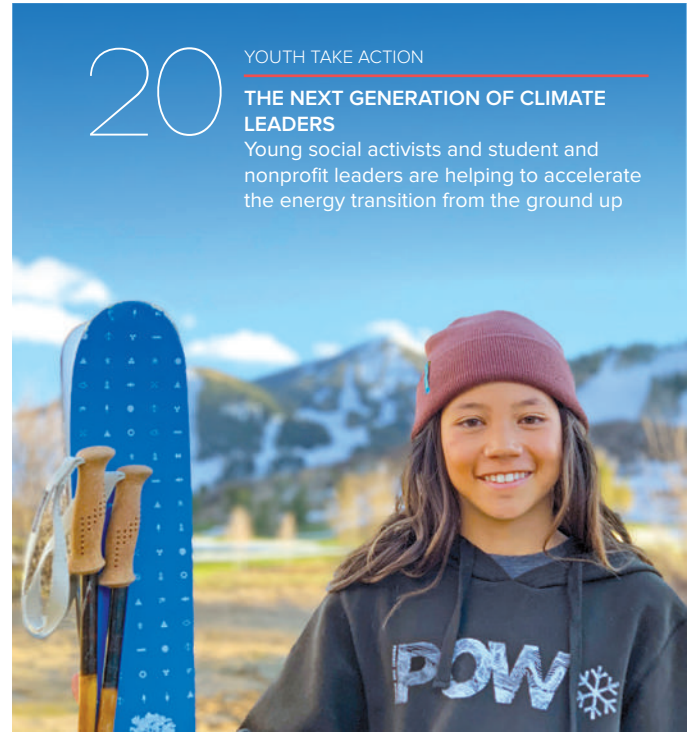
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Our Printing and Paper

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NOW MORE THAN EVER

As the energy transition becomes unstoppable, we must make sure it gains enough speed to avert catastrophic warming

By Jules Kortenhorst

This past July, we at Rocky Mountain Institute were struck in a very personal way by the urgency of the threat of climate change as an out-of-control forest fire raced down the mountainsides surrounding the RMI Innovation Center in Basalt, Colorado. Brave firefighters were able to halt the fire a quarter-mile from our office, but three of our neighbors' homes were lost. It was a stark reminder that we all face the challenges of a warming world, including more frequent and intense droughts and more devastating fires, like the tragedy in Paradise, California, this past fall. This means that we must use new energy technologies to be better prepared (see "Seeking Resilience in the 'New Climate Normal,'" p. 14), but above all it means that we must do everything in our power to speed up the energy transition and slow down climate change. While there is much progress to take heart from, there is far more to be done, and the need for RMI's work is more urgent than ever.

At the World Economic Forum Annual Meeting in Davos, Switzerland, in January, I heard from business leaders that addressing climate is now the most critical challenge we all must face, but I also heard uncertainty about how to proceed. What is the pace and the general direction of the energy transition? What are the right technologies and business models to pursue? How do business, government, and civil society leaders work together to accelerate change? This is where RMI's contribution is so crucial—in bringing clarity to inspire confidence on the best pathways toward a clean, prosperous, and secure low-carbon future. In these pages, you'll see that we are leading global thought and action on the energy revolution.

One area where we've made remarkable progress is energy efficiency—saved energy cut global costs by \$2.2 trillion in 2016 alone. In fact, as you'll read in Amory Lovins's article (see "The

A panel at Davos on realizing the energy transition.

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Invisible Energy Bonanza,” p. 4), efficiency gains are starting to push out investments in inefficient technologies and industries. Another, of course, is the rapidly falling cost of renewable energy technologies like wind, solar, and batteries. We are now starting to see existing coal plants being pushed out by new investments in solar and wind capacity. And in a development that was invented here at RMI, cities in China and India are being designed to harness both renewables and energy efficiency to achieve zero or near-zero carbon emissions while supporting vibrant and growing economies. You can read about RMI’s support of those cities, and the origins of the concept, in “When a Homegrown Idea Goes Global” on p. 32.

But daunting challenges remain. Among them is global air conditioning, which is on track to grow by more than 3 billion units by 2050 as the standard of living rises in hot, humid countries. That’s why RMI is leading the Global Cooling Prize, an innovation competition launched in November to develop a climate-friendly residential cooling solution. The prize, initiated by RMI, Mission Innovation, and the government of India, could mitigate up to 0.5°C of global warming by 2100 (see “RMI in Brief,” p. 9).

Another vast challenge is how to finance the energy transition in developing economies, where capital for renewables and other climate-related investments is not yet readily available. More generally we need to shift global investments away from high-carbon, long-lived assets like coal-burning power plants and prevent existing ones from being run for the decades needed to recoup investments already made. As you’ll read in “Channeling Global Investment for Good” on p. 26, RMI’s leadership is helping global finance flows align with decarbonization pathways.

Another hurdle is reducing climate-forcing carbon emissions from hard-to-abate sectors such as aviation, shipping, trucking, and heavy industry. RMI is hard at work guiding innovation in all of those sectors and, as a recent report by the Energy Transitions Commission shows, decarbonizing them is achievable even with today’s technologies, at a cost far less than that of allowing their effect on climate to remain undiminished. And technologies are improving as more research and development pours in.

That’s why I noted with interest and optimism the rumblings of legislative action in the United States. This country is already achieving much, yet it can achieve more with leadership and R&D investment from the government that developed the Internet and the Global Positioning System. While the Green New Deal proposal got all the press, there is a growing bipartisan consensus that serious climate action must be taken at the federal level. RMI’s *Reinventing Fire* analysis showed that, from 2010 to 2050, the US economy could shift completely away from coal and oil, increase in size 2.6 times, and save \$5 trillion by embracing only the efficiency and renewables available in 2011. Since we published that analysis, costs of the low-carbon technologies have improved even faster than we predicted. We see with growing confidence that the transition to a low-carbon future is profitable, and we can only hope that a consensus will emerge in Washington to put the United States more firmly on that path.

RMI is able to do its part only because of the help that comes from partners and supporters like you, and like Bud Konheim, whose passing we mourn (see “The Konheim Family’s Lasting Impact,” p. 12) while celebrating his continuing contribution to preserving the Earth’s climate. In fact, right now numerous ideas for impact are sitting on my desk waiting until we find the finances to work on them. I ask you to redouble your support, and to encourage others to take part, as well. We must do all we can to scale up the transition to a cleaner and more prosperous future for us all. 🌍



*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



THE INVISIBLE ENERGY BONANZA

Creating Wealth out of Nothing

By Amory B. Lovins

Three guesses: is this article about a new, cheaper renewable technology? a cheaper, safer nuclear fission or fusion technology? a new technology to extract more fossil fuel at lower cost?

None of the above. It's about neither energy supply nor new technology. It's about a more important but far less familiar story: how smarter design can better apply existing technologies to create radical energy efficiency at far lower cost. That game-changing linkup creates a potential new competitor to all forms of energy supply. Every year, it could save the world many trillions of dollars' worth of fossil fuels more than it costs. Indeed, some savings are better than free: they can actually make buildings, vehicles, and factories cheaper to construct.

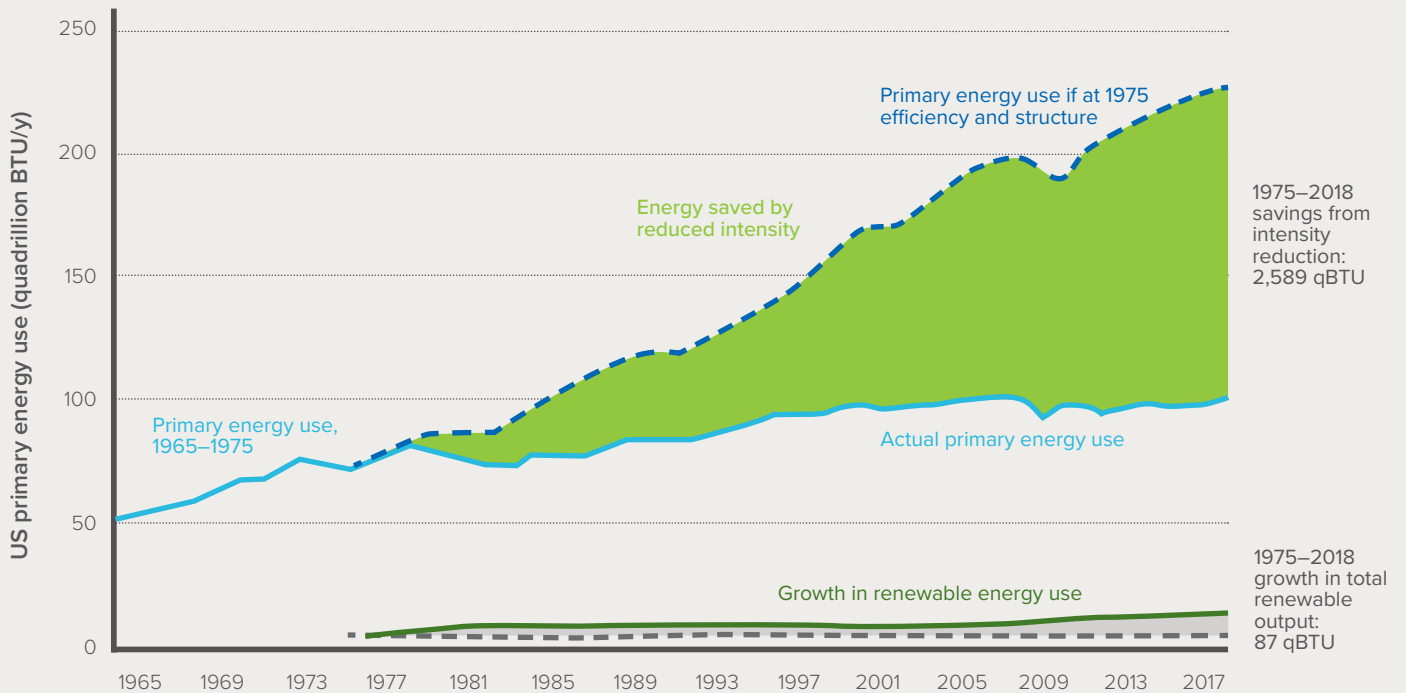
ENERGY EFFICIENCY: BIG IMPACT, LITTLE ATTENTION

Conventional ways to save energy are actually the world's largest energy "source" today. Millions of small improvements over the past few decades—insulation, weather-stripping, better motors and engines, recovering waste heat, more-frugal chemical reactions, all the myriad fruits of careful engineering—add up to efficiency gains that now provide more global energy services than oil or any other fuel. Of the vast energy savings so far in producing each dollar of GDP, roughly two-thirds came from smarter technologies, one-third from shifts in the composition of economic output and in human behavior.

Exhibit 1 shows how since 1975, the United States got about 30 times (or from more-efficient

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Exhibit 1: Reduced Energy Intensity Has Had 30 Times the Impact of Growth in Renewables (United States, 1965–2018, Not Weather-Normalized)



Source: Rocky Mountain Institute analysis of US Energy Information Administration annual data



technologies alone, roughly 20 times) as much energy from savings as from doubling renewable output. US and global energy savings are now reducing energy intensity three times as fast (or efficiency technologies alone roughly twice as fast) as the stunning growth in renewables—which nonetheless get nearly all the headlines. Why? Renewables are conspicuous and easily understood. Efficiency is far bigger but gets no respect. Try this simple thought experiment:

If someone had discovered yesterday that the world has several times more oil than had been thought, and at a cost several times lower, it would be in today's front-page headlines, steeply trending on social media, and all over the evening news. The new oil's owners would suddenly be richer and more powerful, their competitors less so. And, awash in more oil for longer, the world would face more energy disruption, conflict, corruption, pollution, and climate change.

While nobody has discovered such an oil bonanza overnight, a trend I've been nurturing for decades reached an important milestone on September 18, 2018, when my scientific article "How Big Is the Energy Efficiency Resource?" assembled powerful evidence for a previously unnoticed phenomenon. The paper, published by *Environmental Research Letters*, documented a severalfold increase in the size and affordability of a global energy resource with three gratifying properties: it's already bigger than oil, even before it gets severalfold bigger still; it's cheaply available to everyone everywhere; and

its widespread use could profitably decrease conflict, corruption, pollution, and climate change. It's also more fun for the engineers.

BETTER DESIGN PROVIDES A REAL AND HUGE VALUE

This new energy resource went virtually unreported because it's neither a fuel to be burned nor a gadget to be sold, but simply a better way of designing everything that uses energy—buildings, vehicles, factories, appliances, equipment—to do more and better work using less energy, less money, and more brains. This bonanza is invisible because, unlike barrels of

Fatter pipes with less friction make pumps and motors five- to tenfold smaller. The right-hand pump is so small that traditional designers might wonder if someone misplaced a decimal point.

“Millions of small improvements over the past few decades—all the myriad fruits of careful engineering—add up to efficiency gains that now provide more global energy services than oil or any other fuel.”

oil or lumps of coal, energy itself is invisible, and the energy we don't even need or use seems to verge on imaginary. But its value is real and huge: the International Energy Agency says that saved energy cut global costs by \$2.2 trillion in 2016 alone, including \$1.1 trillion in China and \$0.5 trillion in the United States. That global saving was worth twice the GDP of Australia—

An integrative design process helped make Manitoba Hydro Place one of the most energy efficient buildings in the world. Located in Winnipeg, Canada, it uses 70 percent less energy than a comparable office building of conventional design.

yet it's just scratching the surface of the savings that are now available, that are worth buying, and that have recently been greatly enlarged.

Even if we can't see energy itself, can't we see the devices that save it? Not easily. You can see an oil refinery, but not the better catalysts and heat-recovery systems inside. You can see solar panels on rooftops, but not the thermal insulation beneath them that keeps people warmer in winter and cooler in summer. You can see wind turbines, but not the advanced materials that make their blades longer, stronger, and more efficient, nor the electronics

and software that make them more productive and valuable. You can see a car, but not its lighter materials, sleek underside to cut air resistance, and better propulsion systems. You may look closely enough to spot new LED lights, but you might not notice if better lighting design has made them more visually effective, or if controls dim or extinguish them whenever daylight suffices. Wherever you look, you won't see energy efficiency—yet it is the foundation of our prosperity and security.

Many people think of energy efficiency as static, as if whether you have an energy-efficient house were a binary question like whether your house has a garage. But in fact, efficiency's untapped potential is highly dynamic. That's not just because technologies improve, but also because we're learning better ways to choose and use them. The best new and old office buildings lately doubled their energy efficiency in five years, not because their technologies got twice as good, but because designers combined and applied those technologies twice as effectively.

THE MORE YOU BUY, THE CHEAPER IT GETS

"How Big Is the Energy Efficiency Resource?" is a rigorous compilation of empirical evidence drawn from across all sectors of the economy. It shows that the scope for technological energy savings has long been underestimated, and that its cost has been overestimated by at least two- or threefold, often more. Moreover, exploiting this invisible bonanza can often yield the same increasing returns that drive renewable energy's stunning pace: the more you buy, the cheaper it gets, so you buy more, so it gets cheaper. Just as almost nobody expected the cost of solar and wind to nose-dive, speeding adoption so their cost drops further, almost nobody has realized that the cost of modern energy efficiency can do the same thing. This second shoe to drop in the efficiency-and-renewables revolution is the best news in many years for climate, health, prosperity, and national security.

I published the findings in the peer-reviewed journal *Environmental Research Letters* rather than a mainstream publication, and the mainstream still hasn't picked up on its full import. It's the most important stage-setter for energy in 2019 and the years to come.





Completed in 1984 and upgraded continually since then, Amory's 4,000-square-foot home remains a showcase of efficiency ideas.

The ability to save more energy at lower cost is most obvious in buildings. In the early 1980s, my own house (where we just harvested our 75th passive-solar banana crop high in the Rockies despite outdoor temperatures that used to dip below -40°) showed how superinsulation and superwindows add less construction cost than they subtract by eliminating the heating system, so net construction cost falls slightly (and fuel cost vanishes). The key to a cheap-to-construct building turned out to be costly windows, insulating as well as 16 or even 22 sheets of glass—and from optimizing the whole building as a system, not each part singly.

The *Financial Times* reports 1.8 million square meters of such passive buildings were certified in Europe during 2011–2018 (two-thirds of the German ones from fixing up old buildings). Experienced European practitioners have cut the extra construction cost to about zero, plus or minus a few percent. In fact, extensive European data marshalled by the Intergovernmental Panel on Climate Change's *Fifth Assessment Report* proved that in diverse buildings—big and small, new and old, hot- and cold-climate—energy savings around 80 to 90+ percent needn't cost materially more than small or no savings.

So buildings, which use two-fifths of America's energy and nearly three-fourths of its electricity, don't follow the freshman-economics theory that saving more energy must cost more (diminishing returns). Neither do other energy-using systems.

My *Environmental Research Letters* article shows that similarly big and cheap savings are also proven and available in vehicles, factories, and equipment, spanning all sectors and nearly all uses.

How? Not by adding more or fancier equipment, but by using less and simpler equipment—by taking stuff out and optimizing system sizing and design. Fatter pipes with less friction make pumps and motors five- to tenfold smaller, more than paying up-front for the fatter pipes.

“This second shoe to drop in the efficiency-and-renewables revolution is the best news in many years for climate, health, prosperity, and national security.”

Lighter, more streamlined cars need smaller engines, and if electric, they save costly batteries, partly paying (or, in my carbon-fiber car, entirely paying) for the lightweighting. Redesigning energy-using devices as whole systems, not as a pile of isolated parts, can offset efficiency's costs not just with avoided energy costs over time but also with lower capital costs up-front. Integrative design thus creates a new normal: bigger savings at lower capital costs. That's called increasing returns. It makes traditional economic models blow up. It deeply disrupts energy markets.

MARKETS ARE MISSING OUT

News of this design-driven energy-efficiency revolution hasn't been fully digested by the markets. Energy suppliers, though, will discover it the hard way as customers get radically more efficient, energy sales and revenues dwindle, forecasts and business models collapse, and these unforeseen outcomes seem mysterious. Business innovators preferring foresight to mystery can simply read "How Big Is the Energy Efficiency Resource?," which is available for free.

“Market actors who first master and scale such integrative design will win. Those who ignore its power will lose. Competition between megawatts and negawatts will work inexorably, whether we foresee it or not.”

If my 1976 *Foreign Affairs* paper “Energy Strategy: The Road Not Taken?” reframing the whole energy problem (later independently assessed as the only accurate foresight into energy demand in 2000) was a Richter 8 earthquake that knocked things down, my 2018 *Environmental Research Letters* paper feels like a Richter 7 that shakes things up. Four decades’ experience confirms that energy efficiency is the least visible but most potent driver of supply/demand balance. Now the unheralded news is that energy-saving technologies can become far more powerful and affordable when combined using whole-system design. As Aristotle taught, the whole is more than the sum of the parts: well-integrated efficiency technologies can save far more energy, at far lower cost, together than separately.

Thus integrative design that optimally chooses, combines, times, and sequences an artful bundle of efficiency technologies can greatly speed and enlarge their savings of energy and money. Market actors who first master and scale such integrative design will win. Those who ignore its power will lose. Competition between megawatts and negawatts will work inexorably, whether we foresee it or not. Integrative design can be a formidable competitor to supply growth—and an asymmetrical one, because once designers master and refine integrative techniques, they’re

not likely to forget them and return to old dis-integrated design methods. And the pervasively emerging mashup of energy with ubiquitous sensors and information technology, enabling device-to-device transactions secured by block-chain, makes integrative design even more versatile and effective.

As an energy observer and author with a half-century track record, I feel obliged to warn when important news is spreading slowly at investors’ peril, creating systemic risk of vaporizing vast energy supply investments and asset valuations by overlooking new demand-side competitors. Energy investors need to pay attention before painful history repeats itself. Integrative design makes the already large overhang of unbought energy efficiency much bigger than we thought—and such simple design ideas can spread at the speed not of infrastructure but of Twitter.

Supply-side investments traditionally seemed low-risk: regulators often set prices while energy users’ efficiency rose at a modest and measured pace, typically slower than economic growth. But today’s customers are figuring out how to buy less energy, use it far more productively, and even make their own. Now this bypassing of traditional suppliers will accelerate. The solid bedrock of durable energy sales by incumbent vendors is starting to crack and shift. Queasiness is appropriate. Alertness is essential. Reallocation is wise. Energy efficiency is transforming itself and the entire energy sector. Demand will be just as dynamic as supply, and the future will belong to the superefficient. 🌐

This article is updated and adapted from first publication by Forbes on January 21, 2019, at <https://www.forbes.com/sites/amorylovins/2019/01/21/the-invisible-energy-bonanza/>. Visit the online version for hyperlinks to the sources referenced in the article.

A four-minute video abstract narrated by Amory shows simple practical examples. It is posted at the same site as his scientific paper, both freely downloadable: <https://doi.org/10.1088/1748-9326/aad965>.

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

RMI IN BRIEF

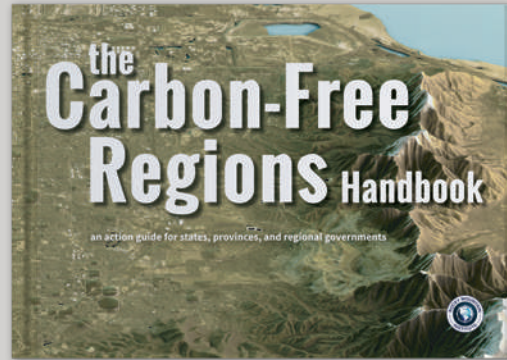
News From Around the Institute



Members of the Global Cooling Prize team and RMI's China team launch the international competition in Beijing.

COOLING PEOPLE WITHOUT WARMING THE PLANET

The Global Cooling Prize is an international competition that calls on innovators to develop a breakthrough residential cooling technology that will provide people around the world access to cooling without warming the planet. The competition was launched in November 2018 by RMI, Mission Innovation, and the Government of India. In February 2019, the coalition hosted an event in Beijing to engage policymakers and leading AC manufacturers, as China is both the largest manufacturer of room air conditioners in the world today and the largest market for room air conditioners sold annually. The winning technology is expected to prevent up to 75 gigatons of carbon dioxide-equivalent emissions by 2050 and put the world on a pathway to mitigate up to 0.5°C warming by the turn of the next century.



The Carbon-Free Regions Handbook helps regional governments place their communities on an aggressive path toward sustainable, low-carbon economies.

BROWNFIELD MINES AS SOLAR ENERGY PRODUCERS

RMI's Sunshine for Mines Initiative partnered with land conservationists and mining companies in Nevada to begin repurposing brownfield mine sites with utility-scale renewable systems. In cooperation with the Nature Conservancy and the Nevada Mining Association, we are supporting the development of solar projects on some of the almost 3 million acres of closed mine sites in Nevada, helping the state meet its 50 percent renewable energy portfolio standard.

THE CARBON-FREE REGIONS HANDBOOK IS A HIT

RMI recently published *The Carbon-Free Regions Handbook*, a companion guide to the popular *Carbon-Free Cities Handbook*, released in 2017. US Senator Martin Heinrich, from New Mexico, was so impressed with the *Carbon-Free Cities Handbook* that his staff met with RMI to discuss our supporting their efforts to drive city and state actions on climate. Senator Heinrich is also handing out copies of *The Carbon-Free Regions Handbook* and a personal letter to 50 other US senators.



Members of the Sustainable Energy for Economic Development team celebrate RMI's award from the National Postcode Lottery.



A NEW ELECTRIFICATION MODEL FOR SUB-SAHARAN AFRICA

The Dutch National Postcode Lottery awarded RMI \$3.2 million for our Sharing the Power project—to bring affordable, efficient, and clean energy to sub-Saharan Africa. The project tackles rural electrification with an innovative bottom-up approach, supporting communities' efforts to implement affordable electricity and helping communities use the availability of new power for economic development. The Lottery also awarded RMI \$1.58 in general support. In all, the Lottery has donated more than €5.8 billion since 1989 to hundreds of charities and social initiatives around the world.

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HELPING CORPORATIONS GO RENEWABLE...

In March 2019, RMI spun out its Business Renewables Center (BRC) to become part of the Renewable Energy Buyers Alliance (REBA), a membership association for businesses and organizations seeking to procure renewable energy across the United States. This transition comes on the heels of a record-breaking 6.53 gigawatts of total nonutility renewable energy deals in the United States in 2018. RMI is continuing to support

the BRC with the launch of BRC China. Over 50 multinational companies connected with renewable developers and assessed opportunities to meet their sustainability goals in RMI's BRC China 2018 Annual Workshop. And REBA is also leveraging the BRC to create even more impact with BRC Canada and BRC Australia, helping accelerate corporate purchasing of renewable energy in those respective countries.

...AND HELPING CITIES GO RENEWABLE

To support the more than 100 US cities that have made ambitious renewable energy commitments, RMI, Bloomberg Philanthropies, World Resources Institute, and Urban Sustainability Directors Network launched the American Cities Climate Challenge Renewables Accelerator. The initiative will work with municipalities to access off-site renewable energy, deploy renewables locally, and navigate regulatory and policy barriers. Our work will directly benefit the populations of the 125 US cities with which we are partnering, providing their city leaders with access to the tools they need to move quickly on their renewable energy commitments. The goal is to help cities procure more than 2.8 gigawatts of renewable capacity.

NACFE TURNS 10

This year, the North American Council for Freight Efficiency (NACFE) is celebrating its 10th anniversary of providing unbiased information to help trucking fleets double freight efficiency. Data is critical and NACFE is providing the industry with real-world information that fleets can use to take action. Launched by RMI in 2009, NACFE has produced 16 Confidence Reports covering more than 85 technologies that help improve fuel efficiency, giving fleets confidence to invest in these technologies. NACFE is now producing Guidance Reports on future technologies; the latest three analyze the challenges and benefits of electric trucks.

ACCELERATING THE FUTURE OF MOBILITY

In October, RMI's Mobility Transformation team successfully launched the first Mobility Project Accelerator Workshop, in partnership with the Midcontinent Transportation Electrification Collaboration. Teams of stakeholders from the midcontinent region tackled specific local challenges to electrifying the transportation sector, focusing on electric school buses, electric vehicle charging at multi-dwelling units, and corridor fast charging. In a separate project, the RMI team worked with Seattle's public utility, Seattle City Light, to develop its transportation electrification strategy, evaluating the impacts of electric cars, trucks, and buses on the grid and drafting recommended actions for the utility to take that will enable transportation electrification while minimizing the risk of premature investment.



Kaitlyn Bunker (left) and Ana Sophia Mifsud at the Society of Women Engineers national conference.

RECOGNITION FOR AN OUTSTANDING RMI ENGINEER

RMI's own Kaitlyn Bunker and Ana Sophia Mifsud attended the Society of Women Engineers (SWE) annual conference, WE18, in Minneapolis, where they gave a presentation together titled, "Don't Be Caught With Your Power Lines Down: How Renewable Energy Can Support Resiliency." Bunker, a manager with RMI's Islands Energy Program, received the SWE Distinguished New Engineer award, which honors women who have demonstrated outstanding technical performance, as well as leadership in professional organizations and the community, in the first 10 years of their career. Two years ago, Bunker was recognized by her regional SWE group for the same award, and has now earned national recognition. Congratulations, Kaitlyn!

INDIA MOVES AHEAD ON CLEAN MOBILITY

India, with some of the most polluted cities in the world, is getting serious about transforming its mobility sector. In September 2018, the government of India hosted a global

mobility summit where RMI served as a knowledge partner. In October, Pune was selected as the first Lighthouse City for an urban mobility lab, a platform to transform the way goods and people move in Indian cities through pilot projects. The idea was first conceived of in a joint report issued by NITI Aayog—India's premier national policy think tank—and RMI titled *India Leaps Ahead*. RMI is administering the Urban Mobility Lab with the support of central, state, and city governments.

ZERO-ENERGY HOMES BECOME COST-EFFECTIVE

Zero-energy homes—efficient homes that produce or procure as much renewable energy as they consume over the course of a year—have quietly passed cost thresholds that make them not only good for the environment but also cost-effective. These homes, often more comfortable and healthier than conventional homes, are often marketed as luxury homes. But RMI showed that in most markets, when using solar leasing, they are either at cost parity or within 1–3 percent of the cost of a conventional home. Meanwhile, federal mortgage lender Freddie Mac launched new services to help low-income families make their homes more energy efficient, which RMI had input on through our strategic alliance with the mortgage giant.

MORE OIL AND GAS COMPANIES PLEDGE TO REDUCE METHANE EMISSIONS

Methane's climate impact is 84 times greater than CO₂'s over a 20-year period and 25 times greater over a century, so it's critical that we control it. RMI, together with several leading climate and energy NGOs, released a set of guiding principles aimed at reducing methane emissions from the oil and gas industry at the end of 2017, and a group of eight international oil and gas companies—BP, Eni, ExxonMobil, Repsol, Shell, Statoil, Total, and Wintershall—signed on. Interest grew last year and Russia's Gazprom—which holds the world's largest natural gas reserves—and Qatar Petroleum also signed on to the commitment.

DECARBONIZING LOW- AND MODERATE-INCOME BUILDINGS

The New Energy Model Organization (NEMO), dedicated to reducing greenhouse gas emissions from residential and commercial buildings in low- and moderate-income communities, recently became a part of RMI's REALIZE Initiative. The REALIZE Initiative is leading the effort to bring the Dutch zero-energy manufactured building component retrofit method called *Energiesprong* to North America. We are now launching pilots in Boston and Chicago, working with affordable multifamily portfolio owners and managers, project developers, builders, financiers, and other stakeholders.

THE KONHEIM FAMILY'S LASTING IMPACT

What began as a memorial to one young person is touching the lives of many—and changing the world

By Kelly Vaughn and
Laurie Stone



This past April, the Rocky Mountain Institute community mourned the loss of longtime friend, supporter, and partner, Bud Konheim (pictured left). Bud, who was the chief executive officer of Nicole Miller Inc., worked with RMI to establish the Eric Konheim Memorial Fund to celebrate the memory of his son, who died in a kayaking accident in 1991 at age 28. At the time, the Konheim family discovered tens of thousands of dollars hidden in Eric's pillow. Those funds, he had written in a will, were to be bequeathed to Rocky Mountain Institute.

Bud realized how strongly Eric felt about the environment and the work RMI was doing. "Eric was very passionate about the environment," according to Bud. "He would come up to my office and argue with me about why I was using so many plastic bags for our clothing." One day in the late 1980s, Eric told Bud about RMI, expressing that he found an environmental organization that was not fighting business, but works with businesses to make them greener and more profitable.

After Eric's death, Bud worked with RMI to create the Eric Konheim Memorial Fund as a memorial to Eric and everything he was passionate about. For 23 years, Bud, along with Nicole Miller, carried on Eric's support for RMI, spreading the Institute's work throughout their networks in the fashion industry and the world.

Nicole and Bud's commitment to sustainability is also evident through Nicole Miller's clothing and operations. On Earth Day, Nicole Miller created an exclusive pair of denim jeans with Eco Made technology, in which the fabric is derived from recycled water bottles and plant-based materials. The recent fall-winter 2019 runway collections were centered on being sustainable, reusing existing garments to create something new and fresh. Nicole Miller is generously donating 10 percent of the sales of its anti-plastic T-shirts and eco-friendly denim to RMI.

The Eric Konheim Memorial Fund is more than a way to memorialize Eric. It's now also a way to celebrate and memorialize Bud, and for their family and friends to keep memories of Eric and Bud, and their deep passion, alive. RMI is honored to be trusted with such an important purpose. It's a responsibility and expectation we strive to live up to every day with the impact we drive in the world—for Eric, for Bud, and for all of us.

"Bud was a wonderful friend and supporter and would be so pleased to know of the direction of gifts in Eric's memory," says Marty Pickett, a managing director at RMI. "Losing his son at such an early age was tragic for Bud, but he was so inspired by and proud of helping other young people with the Konheim internship. Bud's legacy is a wonderful one indeed."

Since 1991, the Eric Konheim Memorial Fund has financed 17 interns at RMI, and most of these individuals have gone on to work in the energy and environmental sector. Greg Hopkins first came to the Institute in 2016 as a Konheim intern and today is a senior associate in the Buildings Program. Here he shares how his internship reshaped his life:

After seven years working in various real estate finance roles in New York City, I started to feel a sense of urgency to "course-correct" and apply my skills in the fight against climate change. I wondered if there was a way for me to integrate my passion for the environment without sacrificing the business career I'd been developing. The more I read about sustainable design and deep energy retrofits, the clearer that path became to me, and I was accepted into Harvard's Graduate School of Design to formalize that education in a master's program.

After my first semester, I submitted my very first internship application to the one organization that seemed to show up again and again in everything I had been reading and learning about—the one organization whose approach of working with (not against) business to accelerate the clean energy revolution really resonated with me: Rocky Mountain Institute. Fortunately, there was a role for me to play on the buildings team at that time, and there was funding support from the Eric Konheim Memorial Fund.

That 12-week internship changed the course of my life. Not long after I got to Boulder that summer and started working at RMI, things clicked into place for me. To be surrounded by incredibly bright, impact-driven people, who were influencing so many different facets of the global economy, was a humbling and inspiring contrast to all of my previous work experiences. This wasn't just a job—this was a mission.

Every day since then, I've been leveraging my background in real estate finance to strengthen the business case for sustainability in the built environment. Every day I get to develop and scale market-based solutions that reduce carbon emissions from our buildings. My career pivot would not have been possible without the support of the Konheim family, and I will be forever grateful for the opportunity to solidify and start fulfilling my purpose in life. 🌱

More information on the Eric Konheim Memorial Fund is available at rmi.org/donate/ways-to-give/eric-konheim-memorial-fund/.

Kelly Vaughn is RMI's marketing director for development. Laurie Stone is a senior writer/editor at Rocky Mountain Institute.

SEEKING RESILIENCE IN THE “NEW CLIMATE NORMAL”

Communities around the world are taking steps to improve their resilience against extreme weather events

By Kelly Vaughn

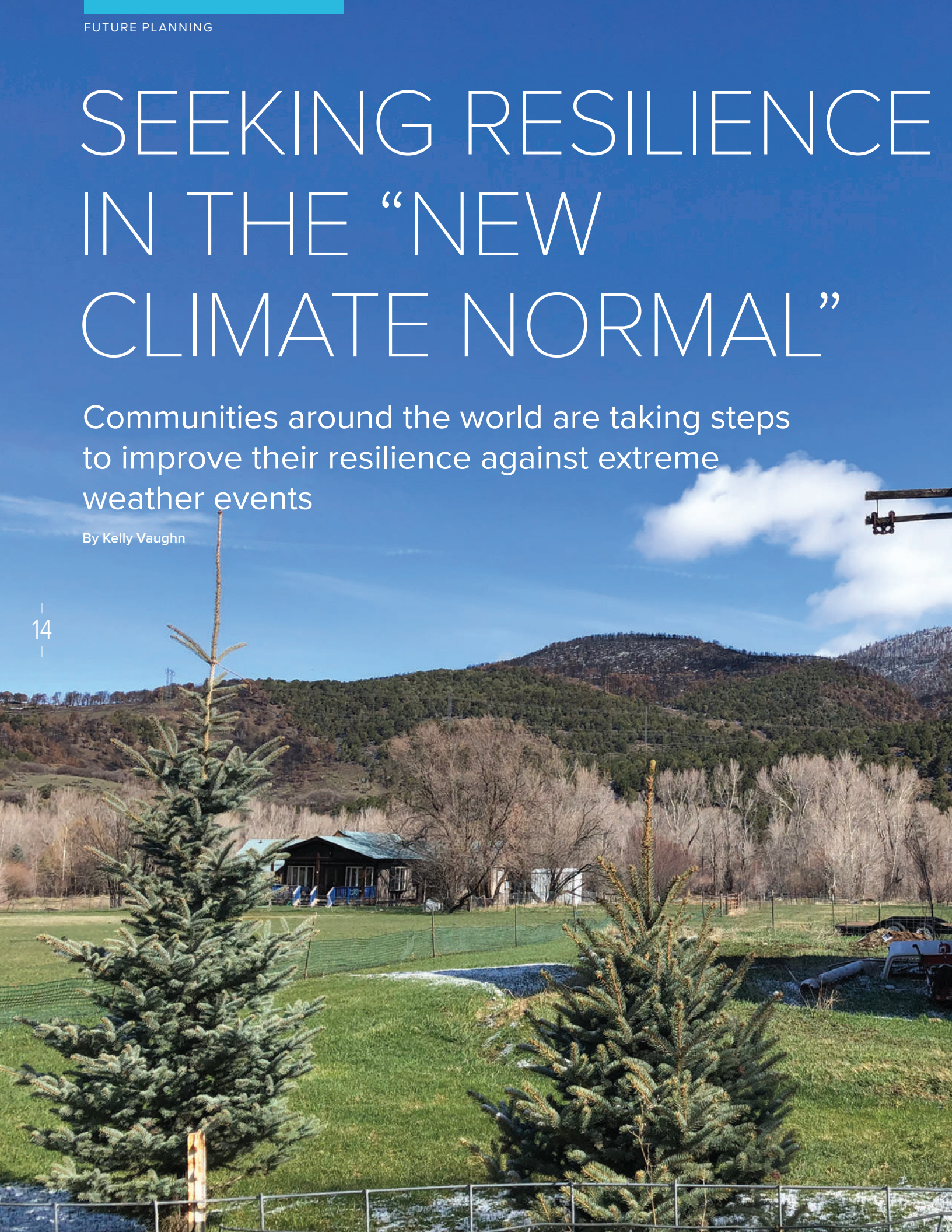




Photo: Kelly Vaughn

At dusk on July 3, 2018, my five-year-old daughter, my husband, and I watched as a wall of flames rose in the place of the sun and advanced ominously over a hill within view of our home in Basalt, Colorado.

We evacuated that night. My husband and I made a quick pact to focus our efforts: if it's irreplaceable, bring it. Otherwise, it stays. Within 15 minutes and with the help of friends we loaded our car with a seemingly random mix of important documents, photos, and hard drives.

We spent the next two weeks evacuated due to the Lake Christine Fire, and we were graciously welcomed by a mix of family, friends, and families of friends. We were glued to our phones following emergency alerts and Twitter updates, listening to streamed community meetings, and constantly checking in with neighbors on the status of our and other homes on Ridge Road, which was ground zero for "holding the line" above the town of Basalt. Many of my colleagues in Rocky Mountain Institute's Basalt office location shared a similar experience, as the fire burned an estimated mere quarter mile from the RMI Innovation Center.

"The Lake Christine Fire spread incredibly quickly," says Mike Palamara, who was part of a three-man crew from Boulder Mountain Fire Protection District that went to Basalt to help battle the fire. "Unfortunately, with changing weather patterns, we've been seeing more of these bigger and fast-moving wildland fires. We need to prepare by making our communities more resilient to natural disasters."

Over the course of the next few months, the wildfire burned a total of 12,588 acres, but by some miracle claimed only three homes, and no human lives were lost. Once the fire was successfully contained in September 2018, our community was faced with a new set of challenges, including smoky air, damaged electricity infrastructure, charred landscapes, and threats of flash floods.

But the challenges also revealed opportunities seized right away by the community to define who we are and how we come together during a time of crisis. Neighbors cheered on firefighters returning to their camp after the fire had been successfully contained. Homemade signs honoring public safety officials hung in homes

This family's property was spared in the Lake Christine Fire, but others were not so lucky.

and local businesses. And local entities came together to ask themselves a fundamental question, “How resilient is our community, and will we be ready when this happens again?”

A NEW CLIMATE NORMAL?

An increasing number of studies have investigated the connection between climate change and severe events such as the deadly floods in the US Midwest, the California drought, Colorado’s severe 2018 fire season, and other events affecting millions of people around the world—evaluating the extent to which rising global temperatures exacerbated these events and/or made them more likely to occur. The Bulletin of the American Meteorological Society now issues a special report each year assessing the impact of climate change on the previous year’s extreme events. And one of the strongest messages coming out of the fall 2018 Intergovernmental Panel on Climate Change report is that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels, and diminishing Arctic sea ice, among other changes.

In light of this evidence, communities and countries as dissimilar as Basalt, Colorado, and Caribbean islands are partnering with RMI in search of processes, tools, and tactics to improve their resilience to extreme weather events in the “new climate normal.”

ACTING LOCALLY, THINKING GLOBALLY

One of the biggest threats posed by the Lake Christine Fire was to the electricity infrastructure managed by Holy Cross Energy, a rural cooperative utility that provides service to more than 12,000 customers in the Roaring Fork Valley where Basalt is located. “Because of our mountainous geography, all electricity transmission lines serving the Upper Roaring Fork Valley pass through a constricted area around the substation in Basalt. And even though Holy Cross does have a few redundant transmission lines, we came very close to having power knocked out for an extended time to the entire Upper Roaring Fork Valley during the busiest time of the year,” says Kevin Brehm, a manager with RMI’s electricity team. “We came extremely close to a very serious power outage.”



Almost immediately, the utility took action, calling upon local stakeholders in policy, energy, and climate to consider how to prepare for the next fire. Today, Holy Cross is partnering with RMI in a sweeping effort to evaluate how to improve the resilience of the region’s electricity system in preparation for future disasters, ensuring—at the very least—that reliable access to critical services like hospitals and wastewater treatment could be maintained, and doing so in a way that meets other community needs and goals.

“Holy Cross is partnering with RMI in a sweeping effort to evaluate how to improve the resilience of the region’s electricity system in preparation for future disasters.”

The team designed a process to evaluate the current state of affairs (surveying people in charge of critical facilities and services in the area to assess energy requirements and what solutions they already have in place), engaging with the community to evaluate which solutions could work, and assessing current and emerging solutions (along with associated costs and business models) to recommend strategies to improve energy resilience in the short and long terms.

“Our town and Holy Cross Energy have already made very aggressive and voluntary commitments to clean energy. Goals such as these are important to consider in designing a solution that is appropriate for the customers and community that Holy Cross serves, because it signals what is important to them,” says Joseph Goodman, a principal with RMI. “For our team at RMI, the project provides a unique opportunity to have a positive impact in the community in which we reside, and to

share insights about what a community-based approach to resilience can look like.”

Early interviews revealed that while many agree that resilience is a top priority, entities differ in how they approach resilience and many have yet to explore the interdependencies that exist among facilities or agencies that need to work together in the event of a disaster. Harnessing these interdependencies can open up new ways for technologies like renewable energy plus battery storage to provide resilient and sustainable energy solutions to more parties, more cost-effectively than everyone “going at it alone” with a solution like a diesel generator.

“The process is as important to our community as the recommendation,” adds Brehm. “Discussions and dialogue will help people gain awareness of and trust in emerging solutions, identify the assets that carry the most benefit to the greatest number of people, and ultimately allow Holy Cross Energy to successfully invest in and manage these assets.”

In the coming months, the team expects a set of projects that can be put in place by the next fire season, along with a set of case studies,



Photo: Top left, courtesy Holy Cross Energy; right, Luis Soto

recommendations, and lessons that can help other communities and electric utilities facing similar opportunities and challenges.

SHAPING A RESILIENT FUTURE FOR ISLAND NATIONS

Nobody is on the frontlines of climate more than Caribbean island nations, many of which suffered the devastating effects of Hurricanes Irma and Maria in 2017. In Puerto Rico, for example, Hurricane Maria virtually wiped out electricity infrastructure. It took a full 130 days to restore power to seven out of 10 people, which still left thousands in the dark.

Now, as island nations and communities look to rebuild, they are doing so in a way that is more resilient to future storms and that sends a powerful message to the rest of the world: instead of being victims of climate change, we are leaders in clean energy solutions.

With the help of RMI and partners like the International Renewable Energy Agency and Caribbean Electric Utilities Services Corporation, 14 island nations have made big strides on long-term energy planning and implementation of renewable energy projects that boost resilience and energy affordability.

“When we first started the Islands Energy Program, we didn’t have the resilience buzzword front and center. Our goal was to make islands more sustainable, but the two are fundamentally interwoven,” says Chris Burgess, a principal with RMI. “Relying on diesel shipped every week from other countries and central fossil fuel plants to deliver power is not sustainable—nor is it resilient. For an energy system to be sustainable and resilient, it must be affordable, local, and distributed.”

The citizens of island nations pay some of the highest electricity rates in the world, and in the Caribbean, the average household spends one-quarter to one-third of its income on energy. Historically, islands have relied on one energy

Opposite page: Power lines in the Roaring Fork Valley were being repaired before the fire was out.

Left: In Puerto Rico, the Resilient Schools Microgrid Project is bringing solar energy to 12 schools.



RMI is helping to increase the ability of solar systems to withstand hurricane winds.

STRONGER SOLAR SYSTEMS

Resilience solutions can be worked into renewable technologies themselves. RMI's 2018 report *Solar Under Storm* is another resource for technology providers to use to advance and improve the design of solar installations that stand up to extreme weather. "The report was a direct response to devastation we saw to PV systems after the 2017 hurricane season," says RMI's Chris Burgess. "We dug into the engineering as to why some systems failed and others survived."

Specifically, the team examined and compared systems that were damaged by hurricanes or failed in extreme weather against those that survived to understand common root causes and best practices.

"We're not replacing structural standards, but helping people make decisions as they rebuild," continues Burgess. "We want to send the message loud and clear that you can and should rebuild with solar, and solar can survive a category five storm."

Solar Under Storm is available at rmi.org/solar-under-storm

source: imported diesel. Rising costs and intermittent supply (especially during emergency events), plus an abundance of local renewable energy resources (like wind, solar, and tidal power) mean that islands have a unique and strong business case to make the clean energy shift. The hurricanes simply underscored the critical need.

"For an energy system to be sustainable and resilient, it must be affordable, local, and distributed."

Burgess points out that RMI is uniquely positioned to support and accelerate islands energy transitions because, even though we are a foreign entity, we can help establish homegrown solutions. "Islands are inundated with consultants, but none that are partners. We bring the right people to the table—government, the utility, and service providers—to create an enduring national energy transition strategy based on the shared goals of securing their energy future," says Burgess. "Interestingly, people's objectives are usually aligned: everyone wants cheaper, more reliable power. The nuances are in how to get there. RMI serves as an independent fact-based broker in the process."

This independent approach is making an impact by allowing islands not only to plan for more renewable energy, but also to install projects and advance shared learning. So far, the team has helped facilitate the installation of 17 projects totaling over 70 megawatts of renewable energy spread across eight island nations. And, there is an online knowledge exchange community for island energy practitioners, which has grown to over 1,000 members. In March, the team attended a ribbon cutting for a new 925-kilowatt solar park in the Bahamas, which is expected to replace the equivalent of 310,000 gallons of diesel fuel annually.

But perhaps most ambitious on its path to energy resilience is the poster child for Hurricane Maria devastation: Puerto Rico. This spring, Puerto Rico's legislature passed a bill that calls for all electricity to be generated from renewable sources by 2050, with benchmarks of 20 percent by 2022 and 40 percent by 2025. RMI has been helping Puerto Rico since 2017 with post-hurricane energy planning efforts, and with on-the-ground programs that demonstrate how renewable energy-powered microgrids can provide increased resilience while also moving the country toward its ambitious energy target.

Together with partners Resilient Power Puerto Rico, Save the Children, and the Kinesis Foundation, RMI is helping to make sure the tools and resources for microgrid development are available for the benefit of communities across Puerto Rico through two distinct but related efforts: the Renewable Microgrids Program and the Resilient Schools Microgrid Project. The Resilient Schools Microgrid work is supporting approximately 3,600 students at 12 schools and up to 100 critical community facilities with upgraded energy infrastructure like solar energy and battery storage. The systems on the 12 schools, which will also serve as emergency preparedness locations, will total about 300 kilowatts and the community facilities' systems will total about 1,500 kilowatts of solar energy installed.

SOFT SOLUTIONS TO HARD WEATHER

Interestingly, as more and more communities, cities, countries, government agencies, and corporations plan for the future, the best solutions for resilience have a common thread and are very much rooted in the past.

In Amory Lovins's 1970s landmark article for *Foreign Affairs*, "Energy Strategy: The Road Not Taken?" an alternative for the world's energy future was laid out: one that combined energy efficiency and renewable energy, and carried myriad economic, security, and environmental benefits.

"In the face of today's climate challenge, both despair and complacency are equally unwarranted."

"For years, Amory Lovins has talked about the benefits of the soft and distributed energy path, and he founded RMI to accelerate the adoption of the soft energy path. These projections have turned out to be somewhat prophetic," says Brehm. "It is becoming increasingly evident that this path offers a much more resilient future—and the increasing resiliency risk is forcing more and more communities and utilities to reconsider what assets they invest in." It seems that the biggest risk is doing nothing—sitting back and assuming that "this won't happen to me."

In early April, I sat with Amory at lunch in downtown Basalt at a quaint community restaurant with the charred landscape from the Lake Christine Fire visible just outside the window. It seemed so strange that

our community could feel so comfortable a mere six months after the fire was contained, and that it was so easy to forget about what happened and fall back into the comfort of the old ways of doing things. Things have—for the most part—gone back to "normal." But then Amory said something that I will never forget: "In the face of today's climate challenge, both despair and complacency are equally unwarranted."

Thankfully, there are so many of us that agree. 🌱

Kelly Vaughn is RMI's marketing director for development.

RESILIENCE READING

This article only scratched the surface of important resilience efforts underway that carry key lessons for others. Additional resources to check out include:

"Elevating the Priority of Resilience in Our New Climate Reality," RMI Outlet, 2016. rmi.org/blog_2016_06_30_elevating_the_priority_of_resilience_in_new_climate_reality

Customer-Centric Energy Transformation: A Case Study of the Opportunity With Green Mountain Power, RMI, 2018. rmi.org/insight/customer-centric-energy-transformation/

Public Collaborative for Puerto Rico's Energy Transformation, RMI, 2018. rmi.org/insight/public-collaborative-for-puerto-ricos-energy-future/

The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings, RMI, 2018. rmi.org/insight/the-economics-of-electrifying-buildings/

The Economics of Battery Energy Storage: How Multi-Use, Customer-Sited Batteries Deliver the Most Services and Value to Customer and the Grid, RMI, 2015. rmi.org/insight/economics-battery-energy-storage/

"A Resilience Strategy Based on Energy Efficiency Delivers Five Core Values," RMI Outlet, 2018. rmi.org/a-resilience-strategy-based-on-energy-efficiency-delivers-five-core-values/

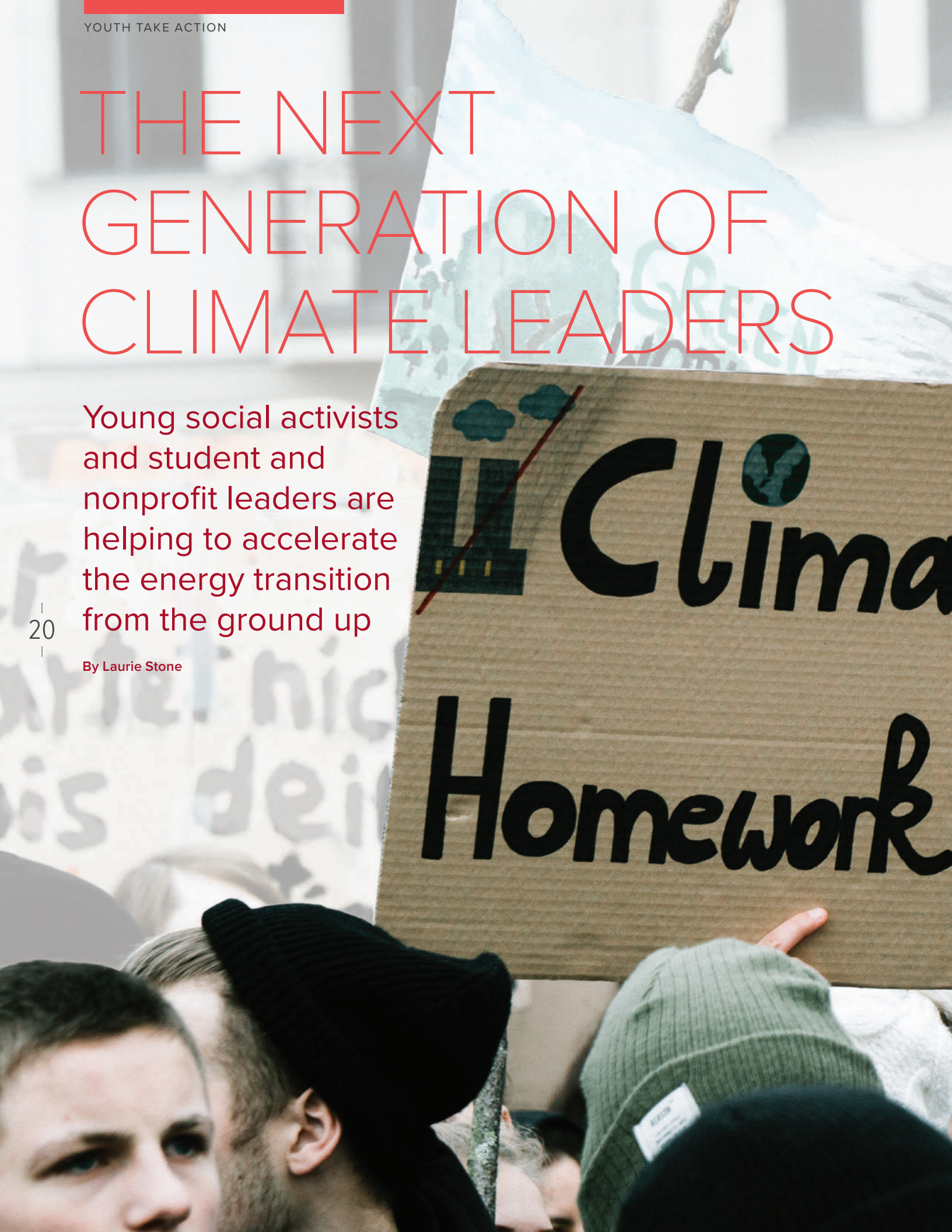
"Rebuilding America and the 'New Normal' of Resilience," RMI Outlet, 2017. rmi.org/rebuilding-america-new-normal-resilience/

THE NEXT GENERATION OF CLIMATE LEADERS

Young social activists and student and nonprofit leaders are helping to accelerate the energy transition from the ground up

20

By Laurie Stone



Climate
Homework

In the face of growing climate change and what is seen by many as insufficient concrete action, young people all over the world are stepping up to take a stand and make a difference. Hundreds of thousands of elementary, middle, and high school students from over 100 countries recently walked out of their classrooms to participate in school strikes against climate change inaction. College students are asking for more renewable energy and sustainability courses and programs. Millennial entrepreneurs are starting businesses to tackle climate change in innovative ways. And more young people are joining Rocky Mountain Institute to help create

the world they want. All of these young folks have one thing in common—they realize their future depends on it.

GEN Z STEPS UP AND OUT

The student strikers are following the lead of 16-year-old Greta Thunberg from Sweden, who delivered a speech to policymakers at COP24 in Poland. “You say you love your children above all else,” Greta said, “and yet you are stealing their future in front of their very eyes.” Every Friday for the past few months she has been on strike from school as an act of protest.



Act NOW,
Later!

JOIN THE
GREEN SIDE



| 22
|

Competitive skier Bodhi Yang, shown here with his sustainable bamboo ski poles, made a movie about climate change and why it's important to protect our winters.

Other students are taking measures such as urging their school administrators to install solar electric systems on their buildings and raising money for environmental organizations. Students from the Severna Park Middle School in Maryland actually raised money for RMI through their Model United Nations (UN) club. Each year the club tackles a global issue, and in 2018 it was the development of environmentally responsible sources of energy. The children, ages 11 to 13, are tasked with promoting the issue and raising funds for an organization through a charity challenge. They decided to make pencil windmills using recycled *National Geographic* covers, and sell them at lunch time and at the school's Earth Day festival.

The Severna Park kids won the award for raising the most money of all the schools in the county. According to the head of the Model UN club, teacher Christine Torelli, "These are intrinsically motivated kids, they have a sense of the bigger picture. And through the process of raising money, they got to see that their actions do matter." Camille, 12, a seventh grader in the club, believes, "We should take care of and be responsible for our environment, or the world and the amazing animals that live in it will disappear. We should work with organizations like Rocky Mountain Institute and

advocate for a clean environment." "Kids should care about the environment since we are the future," added Juliana, 14, an eighth grader in the club. "We need to teach future generations to advocate and properly care for the health of the earth."

Another inspiring young donor to RMI was Eric Konheim. Eric was an avid river runner, recycler, and nonconformist who lived life true to his environmental beliefs. He lived frugally, saving money so he could spend time on the rivers he loved. When he tragically died in a kayaking accident at age 28 in 1991, his family discovered tens of thousands of dollars hidden in his pillow. Those funds, he had written in a will, were to be bequeathed to RMI. After Eric's death, his father, Bud Konheim (see p. 12), created the Eric Konheim Memorial Fund as a memorial to his son. The fund, which carries on today, supports the RMI work that Eric was so passionate about by funding interns.

Children and youth around the world are making a difference in other inspiring ways. Bodhi Yang, the 12-year-old son of RMI's Development Operation Manager Ginny Yang, is a champion skier from Aspen, Colorado, who is passionate about climate change. He recently produced a short film for his sixth-grade project focused on his and his friends'

love of skiing and fear of climate change, and how important it is to take action. “Since I really love our planet and especially snow and skiing, I wanted to make a short ski film with kids talking about how it’s our future that will change and there shouldn’t be adults deciding to just throw it in the trash. We have to try to fight it,” says Bodhi. The film won the overall and audience award at a local short film festival.

MILLENNIALS MAKE A DIFFERENCE

While Bodhi might still be some years off from becoming a member of RMI’s growing staff, many other young people are joining our ranks. Every summer a group of interns from colleges and graduate schools across the country come to RMI to work on projects as varied as vehicle electrification, net-zero energy homes, and African minigrids. We have had hundreds of interns over the past three decades.

One of our more recent interns, Grant Glazer, 24, joined us in 2018 from Stanford where he was pursuing an environmental engineering master’s degree. Grant worked with the electricity team helping to develop a model to create portfolios of clean energy that can replace proposed natural gas plants. Grant’s environmental advocacy started young. “As a kid my parents taught me to always leave a place cleaner than I found it, whether a room or a picnic area,” he says. “Pretty early on in my life I realized that was not what was happening, and that I and others like me who consume a lot of energy have large carbon footprints, almost certainly leaving the world dirtier and worse than we found it.”

Grant applied for the Schneider fellowship at Stanford, which is named in honor of Stephen H. Schneider, one of the first climate scientists

to stress the importance of scientists telling the world about climate change and producing solutions. Becoming a Schneider fellow meant that Grant could intern at a leading US sustainable energy organization. He says, “I chose to spend my time at RMI because it’s a small organization that tackles big problems and takes a detailed-oriented approach to target the exact sticking points to reduce carbon emissions and unlock a clean

“It’s our future that will change and there shouldn’t be adults deciding to just throw it in the trash. We have to try to fight it.”

energy future.” Grant is now an RMI associate working on both decreasing carbon emissions from natural gas plants and helping communities become more resilient to the threat of wildfires. “The opportunity I have to work professionally in a job that tries to leave the world cleaner than it is now is an incredible honor,” he says.

Zihe Meng, 28, was another RMI intern, joining us in the summer of 2014 while she was pursuing her master’s degree in engineering management at Duke University. She had always been interested in cars, and did two internships in the automotive industry while getting her undergraduate degree in China. She jumped at the chance to work on transportation issues in China at RMI. During her internship with RMI, Zihe worked on our Reinventing Fire: China initiative, helping China adopt more stringent fuels standards for vehicles. “I really admire RMI’s holistic approach,” Zihe says, describing how she learned a lot about other energy

Below left: From left to right, Juliana, teacher Christine Torelli, and Camille selling homemade windmills at the Severna Park Middle School Earth Day celebration to raise money for RMI.
Below right: Former RMI intern Zihe Meng is now a senior associate working on RMI’s SEED team promoting microgrids in Africa.



Photos: Previous page, Jonathan Kemper; top left, Carly Rebeiz; near right, courtesy Christine Torelli; far right, courtesy Zhe Meng

issues during her internship. “Even though I was on the transportation team, I worked with people from other teams looking at energy efficiency and renewables from multiple angles.” She joined the RMI staff in 2015, and now works on the Sustainable

Under 30 list, which chronicles what *Forbes* calls “the brashest entrepreneurs across the United States and Canada.” Just this year, Ryan Laemel, 27, a manager in RMI’s India Program, made the list. Ryan leads RMI’s Urban Mobility Lab and is focused on partnering with the Indian city of Pune to implement solutions for traffic management, public transit, and electric mobility. (See Ryan’s story about his travels with Amory on page 38.) Before joining RMI, Ryan was at Yale, where he created the first university-based internal carbon pricing program. He believes that “as the inheritors of our society and natural world, young people have a responsibility to play a central role in energy and climate action.” Ryan also believes that young people have something unique to bring to the challenge. “Having grown up in an era of rapid advancements in policy, technology, and business models, young people can bring a fresh perspective to today’s energy and climate action,” he says.

“We may be avocado-toast eating, big-box-retail destroying, college-indebted millennials, but we also are the most connected and globally conscious generation in history.”

Energy for Economic Development team, helping to promote minigrids in Africa. Zihe says she loves working on the implementation and pilot project side of things. “We’re really changing people’s lives and improving their living conditions. We’re also helping countries start things in the right way by adopting renewables from the beginning, instead of having to retire coal plants,” she says. “It’s important for my generation to be involved,” she adds, “because the earlier we fully realize and understand the consequences of climate change and start taking action, the more effective we can be.”

And in 2016, Mark Silberg, 27, RMI’s first e-Lab Network Manager and current associate made the *Forbes* 30 Under 30 list. Besides leading external engagement for e-Lab, Mark was the lead associate on long-term energy system planning and regulatory support for key decision makers in Puerto Rico after Hurricanes Irma and Maria. He is currently working on RMI initiatives related to building electrification and energy resilience and is also the founder of Spark Clean Energy, a nonprofit that received Department of Energy funding to support university cleantech start-ups. According to Mark, “Climate change is a rare breed of complex problem—it requires technological, economic, political, and policy approaches, alongside an

Those who believe the stereotypes of millennials as being lazy and self-centered have obviously not met RMI’s interns and other young staffers, who are making a big impact on the world. In fact, two RMI staff members have been listed in the Energy category of the annual *Forbes* 30

Avocado-toast eating millennial Mark Silberg facilitating an e-Lab Accelerator meeting and making a difference in the world.



awareness of societal, business, and moral matters. We may be avocado-toast eating, big-box-retail destroying, college-indebted millennials, but we also are the most connected and globally conscious generation in history, and there's no better problem to solve than one that requires changing the entire global energy system and world economy."

ACADEMIA GETS ACTIVE

RMI is also helping other young people learn about the issues and make change. Since 2011, RMI has been helping run an annual National Environmental Summit for high school students from around the United States. Held at Catawba College in North Carolina each summer, the summit helps students explore how they can use their interests and talents to address today's environmental challenges and make a difference in the world. According to RMI Manager Robert McIntosh, 34, who presented in the summit for three years, the students are super engaged. "Climate change is going to be the critical issue of the next 50 years, of their productive lifetime. They could rearrange the deck chairs on the *Titanic*, or they could prevent it from going down," says Robert. "Fortunately, they want to be engaged, they want to know how we addressed these problems in past generations. They want to know what we're doing out there practically in the world and how they can make a career out of helping to fix this problem."

We have also been working with Stanford University holding a yearly weeklong class on integrative design and extreme energy efficiency. The 30 to 40 students come to RMI's Innovation Center in Basalt, Colorado, over their spring break to learn and practice how to increase efficiency through whole-systems design within the buildings, mobility, industrial, and electricity sectors. The students are a mix of graduate and undergraduate students, and they're not all studying engineering, they come from varying disciplines. Avery McEvoy, 24, took the class in 2018 as a master's student in atmosphere/energy engineering. She returned in 2019 as a teaching assistant for the course. "When I first got to Stanford, I hadn't heard of RMI because I wasn't in the energy space yet," says Avery. "But my first energy course cited a lot of RMI's and Amory's work. So when the opportunity came up to learn a lot about energy in a very intensive way, I thought it would be a great way to spend spring break."

While not the classic spring break, learning experiences like these are becoming more popular. In fact, the Stanford class was so popular this year the university had to turn students away. "There's been an increased rhetoric and understanding that climate change is real and happening, so I think more people of my generation want to do something about it," says Avery. "Classes like these are important because knowing the kind of future we're going into, everyone needs to have some sort of energy literacy."

"Knowing the kind of future we're going into, everyone needs to have some sort of energy literacy."

Vivan Malkani, 21, another Stanford student, grew up in Mumbai and saw a lot of social inequity as a child. He became a political science major because he saw politics as the best way to make change. He is now pursuing a graduate degree in management science and engineering, and joined the RMI course because he believes integrated system design has a lot to offer in approaches to problem solving that go beyond engineering. "I started out working on social issues from a policy side. But I recognized the incredible impact climate change was going to have, and how we were careening toward disaster," Vivan says. "So I started working on energy issues, because I realized people from across several disciplines have to work together on this. Integrated design makes you question how our system got here and what we need to change in order to move forward."

THE CLIMATE GENERATION

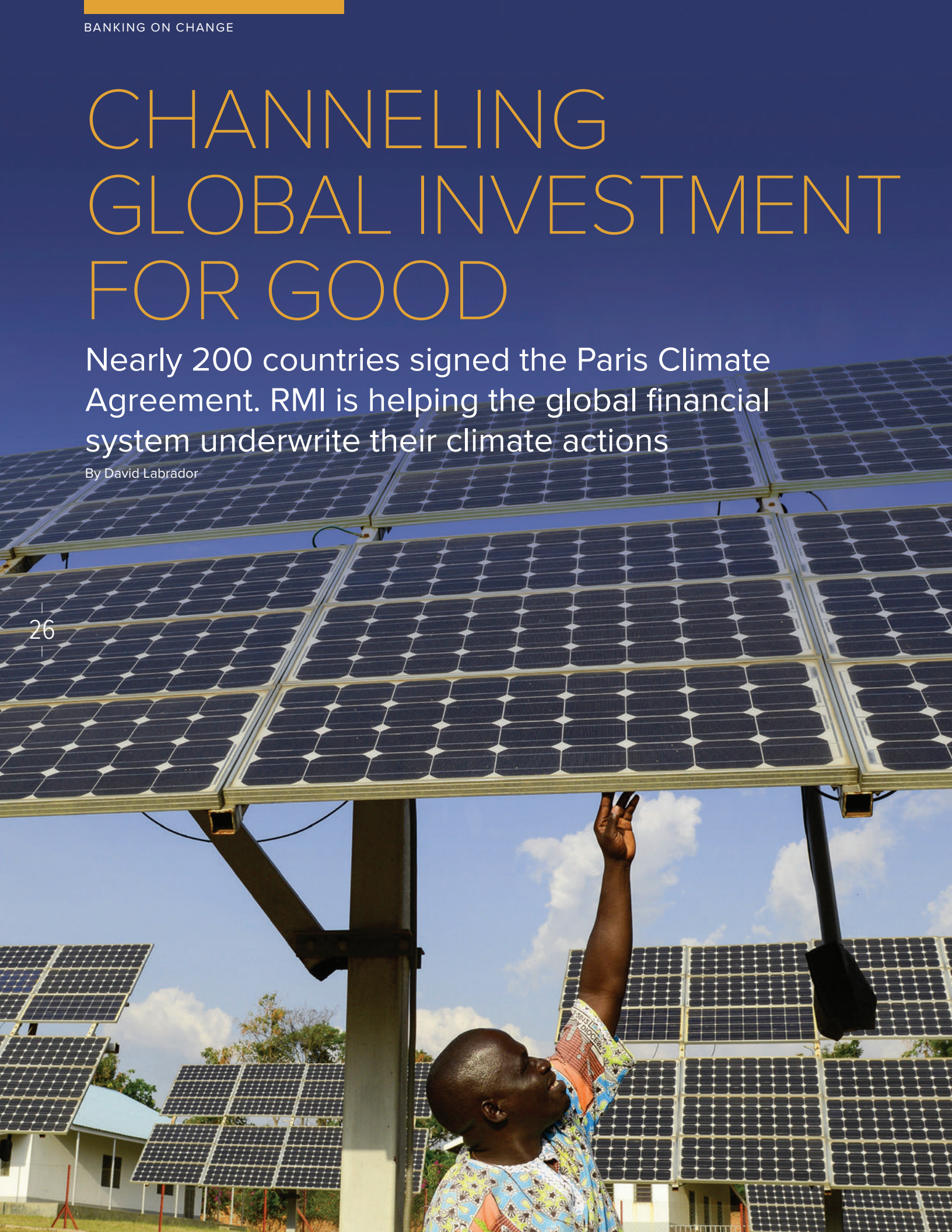
From school strikes to innovative start-ups, young people are leading the way on climate change. Greta Thunberg may have started a movement, but she is not alone. Grade-schoolers, teenagers, and millennials around the world are challenging the current decision makers to take action, and when that action isn't sufficient, they are educating themselves and taking bold steps on their own. They realize that the future is in their hands, and they're not going to just rearrange the deck chairs, they're going to keep the ship from going down. 🌱

Laurie Stone is a senior writer/editor at Rocky Mountain Institute.

CHANNELING GLOBAL INVESTMENT FOR GOOD

Nearly 200 countries signed the Paris Climate Agreement. RMI is helping the global financial system underwrite their climate actions

By David Labrador



In total, 197 countries made commitments in the Paris Agreement to contribute to the fight against climate change, and now it's all got to be paid for. Suddenly, the whole globe is in the market for clean energy and energy efficiency, and Rocky Mountain Institute's expertise in market-based solutions that shift away from fossil fuels is needed on a global scale. A young RMI program called Global Climate Finance (GCF) is emerging as a catalyst for the changes to the worldwide financial system needed to meet the challenge and enable the low-carbon transition globally.

"Now that we have the Paris Agreement and the rulebook has been agreed, it is critical we dedicate our efforts on implementation and ensuring countries have access to climate finance for adaptation and mitigation," says Professor Prajapati Trivedi, the senior director of the Economic, Youth, and Sustainable Directorate of the Commonwealth Secretariat, who has worked closely with RMI's GCF team. "Without RMI, the counterfactual is there for all to see—a lot of uncoordinated partners, with limited potential for a global program to assist countries with the financial structuring of climate change programs," says Trivedi.

RMI's GCF Program was founded by Paul Bodnar, a key architect of the Obama Administration's international climate policies who served in various capacities, including at the National Security Council and as part of the US negotiating team for the Paris Agreement. Soon after the agreement was in place, Bodnar left the White House and joined RMI as managing director. "I see RMI as the ideal catalyst for global action because it's built to translate breakthrough ideas into concrete action," Bodnar says.

Angela Whitney, one of the early recruits to the GCF Program, says RMI's fledgling climate finance team was focused in the early days on the urgent questions swirling around the Paris climate targets: "Are the systems in place to allow for finance to flow? Do countries have access to the finance they need? And are private investors sufficiently engaged to supply investment into countries?" The team set to work answering them.

CLEANING UP THE CLIMATE BALANCE SHEET

Within days of the GCF Program's formal launch in May 2017, RMI convened three-dozen leading climate finance experts and diplomats with partners World Resources Institute and Climate Analytics. They posed the fundamental question of whether the world was paying sufficient attention to tracking both "clean" and "dirty" financial flows, or what Bodnar termed "net climate finance."

What most people think of as climate finance—boosting clean energy and efficiency investments—is only half of the story. Shutting off investments in dirty fossil-fueled assets and shutting down existing dirty assets are just as important if we're going to transform the world economy from one that runs on dirty power plants, steel mills, vehicles, and the like to a clean, low-carbon economy. "Globally, we're still funding much more fossil energy and high-carbon technology than we are low-carbon technology," explains Whitney. "Net climate

finance is about making sure we are not touting the exemplary cases while ignoring the messy and harmful projects being developed."

Six months after the program's launch, the net climate finance concept had gained enough currency that an event was held on the topic on the sidelines of COP23 in Bonn, Germany, without RMI. "This, in our view, was the optimal outcome," says Caroline Ott, a manager in the GCF Program. "We got the idea out there and others began to pick it up."

The global climate finance system needs to function faster, better, and at larger scale on both the clean and dirty sides of the energy ledger, and RMI is already having a marked impact on the whole system. In developing countries, most of the GCF Program's successes are related to boosting clean finance flows by building more powerful climate finance institutions to harness the flood of available dollars (more on that below). In advanced economies, the program has had an impact on speeding the retirement of fossil-fueled assets by helping asset owners and regulators manage their exit.

RMI's Angela Whitney (below) speaks at the Green Bank Design Summit.



CASH FOR CLUNKERS

No fossil fuel releases as much climate-forcing carbon as coal, and coal plants are still supplying nearly 40 percent of the global power mix. But even though coal power increasingly can't compete economically as the price of power from wind and solar falls, coal plants aren't closing as fast as you'd expect because they are often insulated from market forces. In the regulated US states, for example, electricity ratepayers keep paying for them. Regulatory structures and political considerations are keeping coal-fired plants burning around the world, including in China where the average age of its 1,000 gigawatt coal fleet is 10 years. It's not a simple thing to lay off workers, zero out the equity of investors, and write off project debt. Workers can be retrained, but there's a lot of capital tied up in coal plants and the owners and lenders of that capital don't want to lose it.

"When we talk about the coal transition, we talk about layoffs but not so much about write-offs," says Jeff Waller, a principal with RMI's Global Climate Finance Program. It's vital to manage the exit of capital from coal plants so that capital destruction—the loss of investments because a plant's useful life has just begun, or before full depreciation—is minimized. It's not just that capital should be preserved in its own right; the threat of capital destruction drives opposition

to climate action. "At heart, it's not so much a climate issue for them as it is a business issue," says Waller. "Most of the anti-climate policy push from energy companies is not so much about whether or not they believe in climate change but about what they stand to lose in terms of their investments."

"Most of the anti-climate policy push from energy companies is not so much about whether or not they believe in climate change but about what they stand to lose in terms of their investments."

Like it or not, the coal transition is happening all over the planet, and if policymakers and owners don't get ahead of it, the risk of stranded assets will be realized. The GCF Program is working to give global stakeholders the right financial and policy tools to manage the accelerated exit of capital from coal plants. In September 2018, RMI published *Managing the Coal Capital Transition*, the first global survey of strategies that can help ease capital destruction for asset owners and their shareholders while offering policymakers a clearer path toward transitioning the power sector to clean energy.

Waller says that, "It's really about pulling together the right mix of tools and approaches for a particular context. What are alternative energy sources and what are their costs? Are there funds available from carbon





taxes or other sources that would help offset some of the losses? Is the coal local or imported?" If the coal is local, then the solution must help miners and the part of the economy that depends on the mines.

The same issues arise all over the world about the impact on ratepayers and on the local investment environment, or about how much cost should be

borne by the government versus the owners. "There is a moral hazard of payment for the full value of an early closing coal plant, because what if other industries want the same?" explains Waller.

While there is no one-size-fits-all solution, ways to find the right balance have been found, and *Managing the Coal Capital Transition* provides a playbook for stakeholders. It's based on the hard-earned experience of first movers. These include the Canadian province of Alberta, which is implementing a coal phase-out through a negotiated settlement, and Chile, which announced a coal phase-out date and mapped out the issues it must navigate in the coming years. In Colorado, the utility Xcel shut down two coal plants in a process that brought together 13 stakeholders in an unlikely alliance, including utilities, regulators, and climate advocates.

"The playbook outlines the 10 different policy and financial tools that we've seen used around the world and creates a framework to help policymakers think through different ways to deal with those issues," says Waller. "If you manage the exit of capital from these coal plants, then the owners would be basically indifferent to whether you close them early or not," he says. "That would be a way to get these coal plants to close earlier than their scheduled retirement dates in order to meet the climate goals of the Paris Agreement."

THE DOUBLE BOTTOM LINE

Getting money to drain out of dirty assets like coal plants is one half of the task RMI's GCF Program is tackling. The clean half of the task—getting money flowing to investments in clean energy, energy efficiency, and sustainable transport throughout the global economy—is better known and better funded, but it's even more difficult.

Estimates of the total finance available in 2016 for climate mitigation and adaptation projects range as high as \$681 billion. That money can be invested efficiently in only a relative handful of places because only a portion of the 197 countries that signed the Paris Agreement have functioning markets for carbon-reducing projects like wind farms or electric vehicle fleets. In Tajikistan, for example, you can invest confidently in a bicycle factory but not in a large solar array on the factory's roof, because no one is certain of the costs or risks or revenues of such a project in that context.

The higher risk of doing business in emerging markets has made it harder to get private capital flowing at scale into low-carbon investments. This has meant that international public funders (bilateral, like USAID, or multilateral, like the World Bank or the Green Climate Fund) are usually the early investors in climate-related projects in developing countries. But, given the scale of the investments needed, public money and international institutions can't handle the task.

"Combining the current raft of multilateral frameworks with local ownership and that local ability to drive decisions is going to be much more efficient in reducing carbon emissions than relying on the frameworks alone," says Gavin Templeton, head of sustainable



A panel of existing green bank practitioners reflect on how green banks operate in practice during day one of the Green Bank Design Summit in Paris, March 2019.



RMI and the Commonwealth Secretariat convened 25 climate finance experts at Marlborough House in London to discuss implementation of the Climate Finance Access Service in March 2019.

finance at the Green Investment Group (GIG). The problem is that local investors in most geographies have no experience in climate-related markets, and foreign investors who do are hamstrung by their ignorance of local markets. “The private sector can be quite a cautious beast,” says Templeton.

“The whole Paris Agreement architecture passes the locus of responsibility to national processes, and we need public financial institutions capable of helping deliver a low-carbon economy at the national level. We don’t have that kind of institutional framework across all different kinds of countries,” says Ilmi Granoff, the director of ClimateWorks Foundation’s Sustainable Finance Program.

“Local ownership and that local ability to drive decisions are going to be much more efficient in reducing carbon emissions than relying on the current multilateral frameworks.”

RMI’s GCF Program, like Granoff and Templeton, has identified green investment banks as an important answer. A green investment bank is a public or quasi-public institution specifically designed to lower risk and attract private investment to support domestic low-carbon infrastructure. Green banks can make two critical contributions. They create country-level ownership over climate finance in place of project development by foreign donors, while proving in-country viability of technologies and financial innovations to make investment there more attractive to private investment. Whitney says, “Green banks don’t just fund one-off projects that are good from a climate standpoint, they build

the capacity of a country to do more projects, and get new investors interested and engaged within a country.”

Green banks have been successful in developed economies. Before it was privatized, Templeton’s GIG began its existence as the United Kingdom’s national green investment bank with £3.8 billion of taxpayer money and a double bottom line of profit and positive environmental impact. Among other successes, its investments in UK offshore wind drove down costs in that sector and turned a tidy profit. Now the group, a part of investment banking giant Macquarie, the world’s largest infrastructure investor, is keen to see green banks do the same in other countries to create new investment opportunities. “If there’s a way to de-risk that market sooner, that for us presents opportunity,” says Templeton. “If there’s a deployment of capital from a green bank, if it is able to take a different slice of the capital risk and take a different position, that can unlock new markets.”

Until quite recently, the problem was that countries interested in the green bank model had very little communication with each other and didn’t know where to find technical assistance or funding. These were the problems RMI set out to solve in March 2019, when the GCF team convened the Green Bank Design Summit in Paris, which brought together representatives from 23 interested countries, representing over 70 percent of global GDP and greenhouse

gas emissions, with donors and green bank experts. “We saw a lot of nonprofits and others doing work in-country, but cross-collaboration wasn’t happening. We really wanted to bring the community together for the first time to learn from one another and to share ideas,” says Whitney. The summit has the global network off to a great start. Representatives of 13 donor institutions made commitments of support to green investment banks, and one-on-one clinics between experts and country representatives drew high praise, with one calling it the best hour he’d ever spent. Now a global network of national green banks is on its way to being built out.

“We need to generate a community of practice and scale it up and foster a real global discussion around the establishment of these national and subnational new public financial institutions that can deliver market catalysis for the low-carbon economy around the world,” says Granoff, who was one of the earliest supporters of green investment banks in emerging markets and the lead sponsor of the Green Bank Summit. “It is really transformative, and we needed an RMI to step in to do it,” he says.

A CLIMATE INVESTMENT BANKER IN EVERY PORT

Green investment banks may be a natural solution for larger and more advanced emerging economies, but the RMI team also saw that scores of smaller countries needed a different solution.

In 2016, developed countries offered \$55.7 billion in climate-related finance to developing countries, and have pledged to mobilize \$100 billion per year by 2020, but this Niagara Falls of money is actually a myriad of smaller streams channeling through about 500 funds and facilities. This poses a special challenge for low-income countries and island nations with limited capacity. “It’s a really daunting prospect,” says RMI’s Ott. “There are endless online portals and websites and databases, but many countries simply do not have someone whose job focuses on navigating the complex climate finance system.”

That’s why RMI is helping stand up the Climate Finance Access Service (CFAS), a network of trained, independent climate finance investment professionals who could substantially improve the capacity of low-income countries to unlock

funding for green investment. For climate finance to be efficiently and impactfully invested in all the countries party to the Paris Agreement, says Ott, “there is a need for dedicated and unbiased finance professionals. We often refer to them as climate investment bankers.”

“CFAS has been developed based on input from those already working in this space,” says Ott, “and we’re building directly on existing initiatives.” One is the Climate Finance Access Hub (CFAH) of the Commonwealth of Nations, the 53-member group of developed and developing nations, including 31 small states. Their pilot program has run for two years in nine small-island developing states. CFAS is based on that example and a yearlong scoping effort in which RMI’s GCF team talked with more than 100 stakeholders in more than two-dozen developing countries, at climate funds and initiatives, and at related organizations.

“While inspired by the Commonwealth Finance Access Hub, CFAS is a truly innovative concept that has the distinct potential to dramatically scale up the benefits delivered to small states and other climatically vulnerable least-developed countries,” says Trivedi of the Commonwealth Secretariat. “We now have a strong partner in RMI that will significantly enhance the probability of meeting climate finance needs.”

In March 2019, RMI and the Commonwealth Secretariat convened a conference of the first Consortium Planning Meeting for CFAS, a two-day meeting of donors, international organizations, nonprofits, and developing country governments. CFAS is no longer a project of RMI. “This is very much a joint initiative that is being codeveloped with a number of external partners,” says Ott. The consortium’s goal is to place the first cohort of intensively trained climate finance facilitators in 30 countries by 2020.

“CFAS goes beyond the traditional fly in–fly out consultant,” says Ott. “You have a real community in this group that will together enroll in training before working directly in-country. These climate investment bankers will really hustle to accelerate investment in low-income countries.”

RMI’s Global Climate Finance Program is really hustling, too. RMI is working with the World Bank to advance a radical innovation in climate finance—climate auctions—described in a recent joint publication, *Climate Auctions: A Market-Based Approach to National Climate Action*. The team was invited to author sections of the 2018 *Biennial Assessment and Overview of Climate Finance Flows*, the flagship climate finance report of the United Nations, and is also continuing to help flesh out the implementation of the Paris Agreement’s finance mandates. Around the world, RMI’s GCF Program is taking action based on RMI’s whole-systems view that is revolutionizing the capacity of climate finance to actually flow to where it will do the most good, and helping finance realize its full potential as a critical enabler of the low-carbon transition. 🌱

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

WHEN A HOME-GROWN IDEA GOES GLOBAL

RMI is showing the world how working with hundreds of buildings at once has sustainability impacts greater than the sum of their parts

By David Labrador



Rocky Mountain Institute wants to coordinate your entire neighborhood to save you money, and save the climate. For years we built or renovated single buildings—like New York’s iconic Empire State Building—to show how energy efficiency improvements can save energy and costs. But then we widened our focus to whole districts of buildings, and discovered new ways to harness advances in clean energy to create an entirely new business model that allows for sustainability benefits that go far beyond economies of scale. This is the story of how that work unfolded and spread to radically low-carbon districts in China, India, and around the globe.

RMI first switched to working with an entire district in 2014, when we helped Arizona State University’s 1,550-acre campus work toward climate neutrality and save money doing it. The key to achieving such success profitably is that “It doesn’t have to be in one fell swoop,” says Victor Olgyay, a principal with RMI’s Buildings Program. “If you incrementally improve buildings when pieces of equipment are failing and it’s cost-effective to replace them, you can get to deep energy savings, very low energy, even zero energy, over time.” That concept, which underlies RMI’s Zero Over Time Initiative, is helping make existing buildings and districts cleaner and more profitable.

Next, RMI’s Buildings Program found itself creating a new zero-energy district from the ground up. The site is Hazelwood Green, a proposed 180-acre, 6-million-square-foot, mixed-use development on a former industrial site in Pittsburgh. A net-zero energy building or district offsets its annual energy consumption with on-site renewable energy production. The RMI team began with a technical analysis, using whole-building energy modeling and district-level modeling of the electricity systems, including renewable energy, and of the heating and cooling systems.

BUSINESS MODEL BREAKTHROUGH

The breakthrough came when the team did an economic analysis to find the most cost-effective way to get to net zero energy. “At that point, a lot of people thought that, even if net zero energy was achievable technically, it would be difficult to pay for,” says Matt Jungclaus, a manager in RMI’s Buildings Program. But the team found that planning an entire district presented a unique opportunity to make net zero energy profitable



for everyone, including tenants. RMI’s buildings team invented a business model using an integrated energy services provider (IESP) to act as a multipurpose developer, financier, operator, and administrator of the district’s energy systems.

“In its most basic form, an IESP can be thought of as an on-site utility that covers on-site renewable electricity generation,” says Jungclaus. “But it’s also responsible for energy efficiency, district-wide heating and cooling, maintaining all those systems, and billing the customers.” The large upfront investments by the IESP are repaid over time on utility bills, generating a steady return that gives the IESP excellent credit for financing because of the utility-customer relationship. Because the IESP finances all those systems, the cost of construction for developers is lowered, all while keeping costs for tenants and for the district as a whole below business-as-usual costs.

The RMI team designed the IESP business model at the same time as they designed Hazelwood Green, and in one sense they got lucky: location. “Pennsylvania is a deregulated electricity market, so the IESP can be set up to be a retail electricity supplier, which cleared the way,” says Jungclaus. “The United States has so many different regulatory landscapes that one solution won’t necessarily work everywhere else.” There are equally daunting challenges with the electricity-regulation landscape in China and India.

RMI published *An Integrative Business Model for Net-Zero Energy Districts* in August 2016. Now

Left: Arizona State University is working to be climate neutral by 2025.

Above: Hazelwood Green will be a net-zero energy development.

district developments using the IESP business model are under development in Denver, with the 250-acre National Western Center campus, which is based on RMI's Hazelwood Green work, and in Texas, where the Whisper Valley residential

“We continue to evolve for bigger impact. We’re starting to integrate more things into the idea of what makes a net zero city.”

project is doing something very similar. But RMI is already thinking bigger. “We’re not doing what we did back at ASU and we’re not doing what we did at Hazelwood Green. We continue to evolve for bigger impact,” says Olgyay. “We’re starting to integrate more things into the idea of what makes a net zero city.”

“We’re not just saying ‘we want a green district.’ We’re defining everything—water, mobility, green infrastructure, energy storage, resiliency—in the clearest form,” says Jungclaus. “We’re already seeing that this structure has the potential to make a difference around the world, and a lot of those projects’ concepts have really outpaced the development of this one district in Pittsburgh.”

SETTING THE PACE FOR GREEN CITIES IN CHINA

In China, RMI is working closely on a 330-square-kilometer near-zero carbon district centered around Meishan Island (Meishan means “plum hill” in English) in the large port city of Ningbo, just south of Shanghai. The Ningbo project is one of 50 near-zero carbon pilot candidates that China’s central government set in motion with its 13th Five-Year Plan. Net zero carbon is a closely related metric to net zero energy. RMI’s China team traveled to about a dozen cities to find the perfect near-zero carbon district partner in Ningbo, which was both effective and willing to work closely with a foreign NGO. RMI benefits from a good relationship with the central government’s National Development and Reform Commission (NDRC), which plays a significant role in creating the five-year plans. That “allows a really close relationship with local government on different levels,” explains Yihan



Hao, a manager with RMI’s Buildings Program in China. “It allows us to have access to closed-door meetings, which is unusual for an international NGO.” In the end, says Hao, “They took us seriously.”

RMI assisted with a thorough survey and technical and economic analysis and an ambitious design that makes Ningbo’s one of the most advanced of the 50 pilot candidates. The design has the potential to reduce carbon emissions in the district to less than one ton per person by 2030. For reference, emissions in the United States were 16.5 tons per person in 2014. Also by 2030, the design will allow for the district’s gross domestic product to quadruple and population to triple, while saving \$3.4 billion on energy compared to business as usual.

But Ningbo also had to contend with regulations governing the connection with the local electric grid. The Ningbo district generates power from wind turbines, and the development ran into difficulties with State Grid, the national electricity grid operator that supplies its own power to Ningbo, as to every city in China, under business as usual. State Grid was initially reluctant to distribute growing amounts of Ningbo’s wind power. But the concept RMI developed in Pittsburgh also applied on the coast of China. “When we proposed the solution of an integrated energy service provider business model, they finally smiled and started taking photos of our projects,” says Hao. State



Grid and the local government jointly operate the IESP. “So now State Grid has asked the local design institute and energy planners to follow our targets and they have started the construction of a smart control center for the zone,” says Hao.

RMI’s next step in China will be upgrading the near-zero carbon district concept. This will include not just carbon emissions reductions, but waste control and pollution mitigation, with the goal of getting them all to zero. RMI is exploring this concept with other jurisdictions in China that are less built up than Ningbo. “We are proposing a new concept very much based on learnings from the Palava project [see below],” says Hao. “In less-developed areas, they not only want carbon emissions to be low, they also want it to be sustainable and livable and green.”

A GREEN CITY RISES IN INDIA

Since February 2018, RMI has been collaborating on the design of a net-zero energy, 4,500-acre city on the outskirts of Mumbai, India, that will house 2 million and employ 500,000 when it is fully built out. The city, Palava, is being built by the Lodha Group, India’s largest real estate developer. Phase 1 was largely completed before RMI joined, and had 16,500 housing units occupied as of March 2019. RMI is collaborating on the design of Phase 2, which will add 80,000 units, and Phase 3, which will be bigger still.

Palava has the potential to reduce annual CO₂ emissions by 290,000 tons. Much of its energy, for both buildings and electric vehicles, will come from rooftop solar, which will cover practically all rooftop space. But deep efficiency is really the key to making Palava net zero energy. Overall, the buildings will use 60 percent of the energy of an average building in India. Almost all water in the city will be treated and reused to reduce water intensity and energy costs. And mobility, which is the single largest energy draw in the Mumbai suburb, will be transformed.

Lodha is a developer that means to be a leader, especially in sustainability. “Mumbai has some real challenges with traffic, with air pollution, and with water pollution, and this is a solution to that. They are responding to the challenges of India,” says Seth Coan, an RMI manager with the Buildings Program. “They’re evolving constantly, picking up on what we give them and not only running but sprinting with it. It’s been exciting to see how they’re integrating our recommendations into their business practices and into this actual city,” says Coan. Olgay says, “By making a good business case for them to pursue zero-carbon development, we think Lodha will influence developments throughout India.”

Coan says that, “They saw us as a partner because we weren’t working on one element of the smart city, we were, like them, looking at the whole

Ningbo, China, is the center of a 330-square-kilometer near-zero carbon district.

system holistically.” One of the most striking things about Palava is how deeply holistic design can cut carbon produced through mobility. “We’re starting to understand how good design of these projects can reduce mobility needs, and that’s especially true of Palava,” Olgyay says.

“They’re picking up on what we give them and not only running but sprinting with it. It’s been exciting to see how they’re integrating our recommendation into their business practices and into this actual city.”

Mobility was projected to consume 64 percent of the total energy footprint of Palava, and the new design has the potential to reduce that by 90 percent, in part by colocating employers and residences. “By reducing commuting distance, you have the largest impact,” explains Coan. The design also encourages people to walk, bike, and use shared and electric transport. Olgyay says, “That’s a huge thing, it turns out. It’s design: it’s essentially free. You’re not paying for a lot of infrastructure.” Palava’s design was developed with the help of the RMI team working with the Indian government on that country’s mobility transformation, which could save India as much as 1 billion tons of CO₂ emissions by 2030.

But just as in the United States, electricity regulations were a challenge in Palava. “They’re grappling with the regulatory environment around renewables. Fitting into the current

regulatory framework for solar is challenging,” says Coan. Selling excess electricity back to the grid was the main obstacle. It is possible under current regulations, but only a portion of electricity delivered is compensated and that is only paid on an annual basis. This complicated the business case by reducing much of the revenue that on-site solar can produce. This interface of electricity-producing districts with the electric grid is a challenge everywhere.

HOW GREEN DISTRICTS CAN SAVE THE WORLD

As RMI helps develop net-zero districts around the world, our ambitions are growing for not just what they can be, but for what they can do. “What we’ve really started to think about is the grid integration of districts with the utility,” says Olgyay. Jungclaus explains that, “These districts, given the amount of load they have, could collaborate with utilities and with grid operators to drive benefits for both the district and the greater grid, and those two entities could share the revenue or the costs savings.”

Olgyay says that, “The RMI Buildings practice and Electricity practice are starting to have a lot of overlap, because buildings can be distributed energy resources, especially when they’re generating electricity, or when they’re able to consume and store excess electricity from the grid.” RMI is on the cutting edge of optimizing buildings to provide these benefits to the grid, a concept called grid-integrated efficient buildings, or GEBs (see “Grid-Interactive Efficient Buildings”).

But while individual GEBs can do a lot to help level out demand for grid electricity, lowering the peak demand that drives so much spending and carbon-emissions by utilities, “You can do even more than that when you’ve got a whole district, because when you’ve got aggregation of hundreds of buildings they can help balance out some of the issues on the electrical grid,” says Olgyay. A large, controllable power source like a fleet of hundreds of GEBs can provide essential services to an electric grid that previously only a billion-dollar power plant could provide. “We can actually have buildings integrated with the grid in such a way that they can do black start [recovering from grid outages] and voltage regulation and all kinds of cool things. That actually allows for the utility to avoid capital costs by having buildings provide some of those services,” Olgyay says.

Traffic in the Mumbai metropolitan region is heavy and growing heavier; Palava will help.



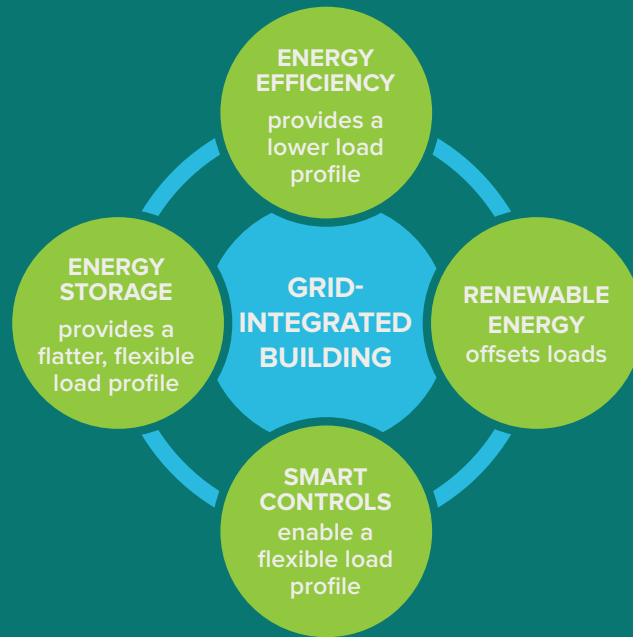
GRID-INTERACTIVE EFFICIENT BUILDINGS

By Cara Carmichael

Buildings can work with the power grid, not against it, and so become the linchpin to decarbonize the electricity sector: responsive and dynamic assets that support solar and wind generation sources, rather than one-way, standalone users of energy. As responsive assets, buildings can communicate with the power grid and ramp their energy use up or down depending on the cost or the carbon intensity of the grid electricity at any given time. This will reduce operating costs for building owners and help utilities integrate more renewable power into the electricity system, resulting in resilient buildings, communities, and regions. Grid-interactive efficient buildings (GEBs) also make electrification (e.g., heating buildings with electricity) not only possible but also potentially profitable.

GEBs have four key attributes: energy efficiency, on-site solar, energy storage, and load flexibility. They can reduce energy use by 40 percent, while reducing peak demand by up to 85 percent. This would enable building owners and occupiers to reduce their energy bills by at least 60 percent.

GEBs can be implemented profitably today using existing technologies. Building owners should



first focus on energy efficiency and on-site solar. Next, improve load flexibility by means of advanced control systems that can shift energy use (e.g., staging electric vehicle charging to reduce peak demand). Then owners should consider on-site energy storage, which is cost-effective in many locations today and becoming more so across the United States. Grid-interactive efficient buildings are most profitable in all-electric buildings, utility territories with demand charges or time-of-use rates, and buildings with a high baseline energy use.

Cara Carmichael is a principal in RMI's Buildings Program.

“This represents an opportunity for the building owners to have a source of income and a source of energy arbitrage, but the policies and so forth are not in place to make that happen right now,” says Olgay. “Regulations have to catch up. We have to make it easier for building and district owners and developers to invest in this sort of thing and to profit from it. There is a block, as indicated in Palava, as indicated in Ningbo, that we need to address,” Olgay says. “Unlocking the relationship between building owners, developers, utilities, and to some extent, policymakers, is going to potentially get many more buildings renovated and much more green energy on the grid.”

Everywhere in the world, whether in Pittsburgh, Ningbo, or Palava, getting building- and district-based renewable energy integrated into and

compensated by the electrical grid is the frontier where deep progress on climate and energy can be made. “It’s technically not that difficult, it’s just difficult in terms of the business model,” says Olgay. And RMI is continuing to scout the cutting edge of what is possible. Junglaus says, “What I think the future has in store is more of a focus on these districts integrating with the greater grid around them. To see successes happening in Ningbo and Palava, or even in other districts across the United States that are moving at a quick pace, I think it’s incredibly promising.”

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

LIFE LESSONS FROM GLOBETROTTING WITH AMORY LOVINS

How RMI's cofounder effects change and inspires energy change-makers around the world

By Ryan Laemel



As the wheels kiss the tarmac goodbye, Aspen, Colorado's snow-capped mountains come into view. I can see Amory Lovins, RMI's cofounder and chief scientist, in the front row of our tiny plane, resting his arms at his sides after the 40th flap of his "wings." Amory enthusiastically flaps his arms during takeoff on every flight. By my rough math, Amory's annual flap count must be well over 10,000. While he knows that he's inside the boundary layer, with a twinkle he says, "It always seems to work!" and considers it an interesting sociological experiment with his cabinmates. It's 7:09 a.m. on March 21, 2018, and we're on our way to Cancun, Mexico, to meet with energy regulators. Amory starts working on his slides for a class we're teaching with Stanford University next week.

I'm the latest person in a long line of RMI staff to have the privilege of globetrotting with Amory. In the past year, we've traveled together to Mexico, India, Japan, Germany, and Finland. Alongside my teammates in the Office of the Chief Scientist, I support Amory's research, writing, projects, and travel. While I'm still learning what makes Amory such an effective and inspirational figure in the energy industry, our journey around the world has given me a glimpse of how we can effect change in our own worlds and inspire those around us. I'd like to share a few of those life lessons, drawing on quotes from Lao Tzu, the author of one of Amory's favorite texts, *Tao Te Ching*.

"A thousand-mile journey starts with one step."

—Lao Tzu

Somewhere over the Gulf of Mexico, on our way to Cancun, I remembered my first trip with Amory. We went to Mexico City for the C40's Climate Leadership Group—90 of the world's greatest cities working to address climate change.

Amory took the stage at the C40 with Chicago's mayor, Rahm Emanuel, to discuss the role of building efficiency in city climate action. Twelve minutes later, lightbulbs were going off as people realized that if superefficient, net-zero energy buildings offer compelling economics and higher performance, what is stopping us from scaling this solution?



Photo: Map, iStock.com; Amory, © Judy Hill Lovitt

Many participants walked away understanding that the process of designing, building, using, and learning from demonstration projects, such as Amory’s passive-solar “banana farm” or RMI’s Innovation Center, represents a discrete action—a first step—in the journey to better buildings around the world.

That first trip to Mexico City was also the first step in Amory’s and my journey together. It ended with a whirlwind of back-to-back meetings with Mexican electricity regulators, where we learned that the country’s regulators are actually ahead of the market. Instead of merely congratulating the regulators on their achievement, Amory provoked them into doing more by asking, “Now, how do you stay ahead?” After he offered a number of pieces of advice throughout that week, which were well received by a range of government officials, we boarded a plane to California to teach a course on resource efficiency at Esalen Institute.



“A good traveler has no fixed plans, and is not intent on arriving.”

—Lao Tzu

The work that we do at RMI involves embracing ambiguity—being open to what emerges and trying not to force outcomes, even when we have a vision of how the future might or should unfold. Amory’s words of wisdom helped me listen to and work with our Indian colleagues to coproduce a number of solutions that ended up in *India Leaps Ahead*, an RMI report that has helped shape India’s national dialogue around electric mobility.

40 | Two months later, we were on a plane to India for a two-week trip that culminated in a design charrette on transforming India’s passenger mobility system. Amory and our colleague Clay Stranger had set up this engagement with the Government of India before I joined RMI. As I took the stage this time, I felt my curry-filled stomach in my throat. “I’m responsible for facilitating a group of CEOs and government officials?” I thought. While walking outside in New Delhi’s hazy air to calm my nerves, I remembered what Amory told me over the phone when I signed up to work with him: “Let’s wade into the ambiguity together!”

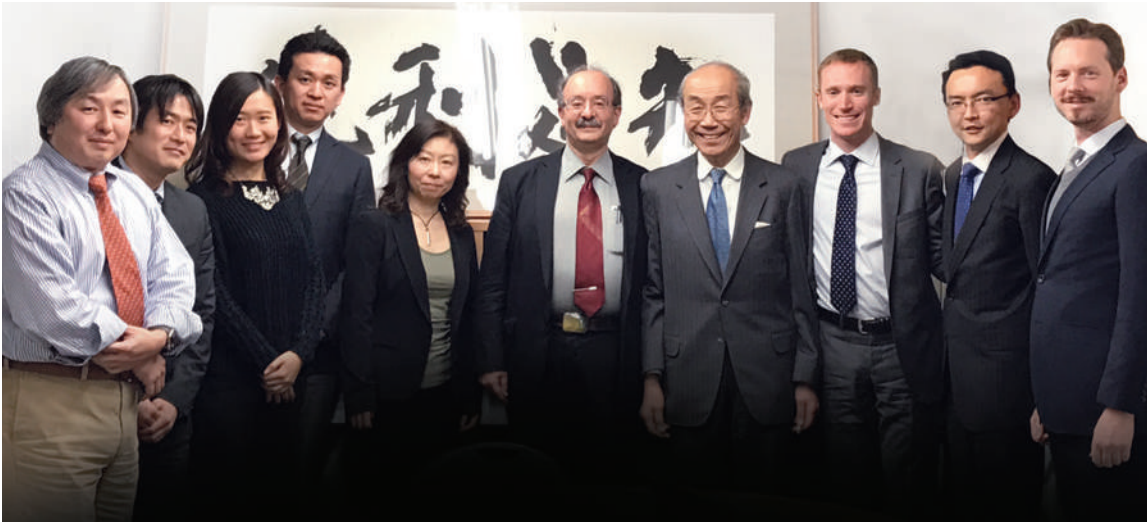
“Water is fluid, soft, and yielding. But water will wear away rock, which is rigid and cannot yield. As a rule, whatever is fluid, soft, and yielding will overcome whatever is rigid and hard. What is soft is strong.”

—Lao Tzu



Left: Author Ryan Laemel (second from right) and others on RMI’s India team at the Urban Mobility Lab workshop in Pune, India.

Above: Amory in Delhi, teaching the sons of one of our former NITI Aayog colleagues about integrative design.



Amory and Ryan (third from right) in Tokyo, meeting with a small group of auto industry players.

A day later, we landed in Tokyo after a 10-hour flight from Delhi. We checked into the conference, hosted by Renewable Energy Institute, and headed to a nearby restaurant for Kaiseki—a traditional multicourse Japanese dinner—with Tachi Kiuchi, former chairman and CEO of Mitsubishi Electric America. At 82 years old, Kiuchi-san still works a full day, keeps up with his running, and does several hundred pushups each day. As plates of cold sashimi, hot miso soup, and sweet fruits appeared and disappeared, the meandering conversation set the stage for the following two days: an expert panel on Japan's electricity sector and a keynote presentation on RMI's work in China.

That morning, Amory sat quietly among a room full of experts, listening carefully to different players describe a long list of formidable obstacles that Japan's government had systematically placed in the way of efficiency and renewables. Toward the end of the session, Amory's microphone turned from red to green, and in typical Amory fashion he laid it out straight for them without beating around the bush. "If the government's goal were to look as if it were favoring efficiency and renewables while actually preventing them from competing fairly in the market, its policies would look very like what we've just been hearing about all day," he said. As the most senior foreign guest, Amory felt that he was best able, and therefore obliged, to say what was necessary. The room fell silent. Then, one after another, heads started shaking in affirmation.

While Japan has taken steps to diversify its electricity supply mix following the Fukushima nuclear disaster in 2011, like many countries, much progress remains to allow efficiency and

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renewables to compete on a level playing field. Amory's message—built on a foundation of persistent research and practice—was powerful because of its accuracy and its conciseness.

Tao Te Ching is full of paradoxes. So are our world's energy system and our own lives. Amory has taught me that when we are rigid, we're unable to see others' points of view; the full range of possibilities isn't on our radar. At any moment in our work and lives, we face a choice: to be hard and rigid, or to be soft and flexible—open to other ideas, beliefs, people, and situations. In my short time with RMI and Amory, I've seen firsthand how the latter approach can drive results on which my generation depends.

Amory closes his keynote in Cancun by saying, “Focusing on outcomes, not motives, can turn gridlock and conflict into a unifying solution to our common energy challenge.” I think that this aphorism rings true in our own worlds, too. After hurrying to a cab to try and make our flight so that we can reach Aspen before a winter storm rolls in, I plop down into my seat and settle in. Amory flaps his arms and goes back to working on his slides. 🌀

Ryan Laemel is a manager in RMI's India Program. Previously, he was a senior associate in the Office of the Chief Scientist supporting RMI's cofounder and chief scientist, Amory Lovins.

MAKING CHANGE IN THE WORLD

An interview with RMI Managing Director Lena Hansen

Interview by Laurie Stone

Lena Hansen started at Rocky Mountain Institute as an intern and is now the managing director of RMI's China Program, based in Beijing. She leads a team of 20 who advise and support China's energy transition in the areas of power market reform, city carbon peaking, near-zero carbon development, and freight electrification. Prior to joining the China Program, Lena led RMI's US Electricity Program and co-founded RMI's Electricity Innovation Lab (e-Lab), a unique multiyear collaboration of leading power sector decision makers who create transformational solutions. Here she talks about what drew her to RMI, the importance of working in China, and making change in the world.

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You started at RMI as an intern in 2004. What first drew you to RMI?

I was in graduate school at Duke, in an environmental master's program. Amory came to speak, and I had actually never heard of RMI or Amory. His talk was really pretty radical for me, because I never thought much about making change from a market-based perspective. I thought of environmentalism more traditionally, and although I have huge respect for environmental organizations, I had been pretty frustrated with their approach and impact. When the opportunity came up to do an internship at RMI, it was a no-brainer for me to try something totally different and find a leverage point and way to make a bigger change.

You have now been at RMI for almost 15 years. Why have you stayed all these years?

There are many reasons. For one, of all the different ways I see people in the world making change, RMI's approach is the most resonant for me. I can understand the impact that we create, and it has always seemed like the place where I can make the highest and best contribution to solving the energy and climate problem.

Another reason is that RMI rarely gets stuck in one line of reasoning. It is always willing to learn as an organization, be responsive to what is needed in the world, and innovate our ideas. I find that really invigorating. The third reason is that I have had the opportunity at RMI to work on so many different kinds of projects and topics. It's always interesting and I'm always learning something. I've never gotten bored at RMI.

And finally, it's the people. When I started at RMI we had 30 or 40 people. Even though we've grown to over 200, the people at RMI are the kinds of people I want to be around. If I'm going to spend a lot of time at work, I want to be around people who push me to improve and be as impactful as I can be.

You're now the managing director of RMI's China Program. Why did you decide to take on that position and move to China?

For most of my career, my real passion has been the electricity sector, and I have done tons of work on process—how to get people in the electricity sector to innovate and problem solve, how do you get them to work in a different way to make transformative ideas stick? To me it seemed like an important opportunity to push that thinking

further into an arena that is totally different but incredibly important. China consumes 25 percent of the world's coal. Last year people in China bought 50 percent of the world's electric vehicles. The scale of things in China is unimaginable.

Beijing has about 25 million people, which is larger than every single US state except for California and Texas. When I started to understand not only the scale of the impact on climate but also the scale of the opportunity to make a difference on climate, I couldn't say no. You can't be serious about wanting to solve the climate problem without considering China. China is also incredibly willing to take an experimental prototyping approach.

Working on electricity regulation in the United States, it takes a long time to make change, because everyone wants things to be perfect before trying something new. The Chinese say, "Let's just put

“The speed at which China can act is impressive, and it's the speed that we need in order to tackle the global climate problem.”

something out there and try it, and as we learn more, we'll make it better.” The speed at which China can act is impressive, and it's the speed that we need in order to tackle the global climate problem. Also, I'd be remiss if I didn't mention the amazing food!

What are you most excited about that you're working on now?

The Chinese power sector produces 10 percent of the world's carbon emissions and 35 percent of air pollution emissions. China is really investing in and building renewables. In fact, China built more solar last year than the total solar in the United States. But the problem is that China is building renewable energy systems faster than they are figuring out how to integrate that energy into the grid. Even though China produces a lot of electricity from solar and wind, the country is curtailing a lot of it—last year China curtailed maybe 20 percent of its renewable energy—because of the way the electricity system is operated. So that's a huge problem, and China is committed to fixing it. And if it's not fixed, it risks slowing future growth of renewables.

RMI's power sector work in China is focused on that problem. We're advising the national government and the people designing China's power market reforms. We're helping them implement wholesale power markets.* They've identified eight provinces that are going to implement wholesale markets as pilots. We believe if they do it well, it could eliminate the curtailment problem, and also shift generation from low-efficiency coal plants to high-efficiency coal plants. They could save 1 percent of global carbon emissions just by implementing wholesale power markets with no added cost, and actually with saving \$10 to \$14 billion a year in fuel costs. That is so exciting because it's a perfect example of a leverage point. You can make one change—shifting how power is dispatched—and set the foundation for renewables to be the future.

What project/impact from the past are you most proud of?

I've worked on so many different projects over the years that I'm honored to have been a part of, but e-Lab is probably the one I'm most proud of because it was such a bold step for RMI and for the industry, and it has had so much impact. Right after we released our book *Reinventing Fire*, our power team took a step back and asked, What does the *Reinventing Fire* analysis imply for what RMI should be doing in the power sector to make the biggest difference? We came up with the e-Lab concept, to create a space where decision makers and change agents in the industry could actually come together to figure how to collaborate together, innovate, and problem solve in a different way that can create big, lasting change. We were looking at the dimension of change through people and institutions. It was a radical departure of what RMI had done in the past, and a lot of people both in and out of RMI were very skeptical at first.

Now it has grown into a program that's highly respected and known around the country, is a core thing that we do, and is making a material difference. We have had dozens of teams come through our e-Lab change labs, and e-Lab has helped them implement and accelerate the changes they're trying to make.

RMI only has 200 people, and we obviously cannot solve the world's problems on our own. Things like e-Lab allow us to empower other change agents in the world—that's scaling. That's how we can respond to the urgency and scale of climate change.

Laurie Stone is a senior writer/editor at Rocky Mountain Institute.

What is one thing readers can do to help create a low-carbon future?

I know you expect me to say something like install LED lightbulbs, or purchase an EV, or donate to RMI. And you should do those things. But what I actually want to say is just to be conscious of your choices. So many times, people think their choices don't matter, and they don't notice they're using so much energy because as a society we've gotten so used to our energy-intensive lifestyles. We've forgotten that we can actually be just as happy (or happier) while using less energy. So, I'd ask people to just notice, and to question what they can do easily to significantly reduce their energy consumption. Turn off the lights when you leave a room; try out Meatless Mondays.

For me in China, I bike everywhere I go. I started biking because as a foreigner I can't drive here, and shared bikes were everywhere. But it's been really wonderful to realize that I can actually get to work significantly faster on a bike than in a taxi or on the subway. It's better for me, it gives me a few minutes to take a breath and think about my day. But it took me moving to Beijing where I'm not allowed to drive to really build that into my day to day.

What is your most memorable RMI moment?

One thing I will never forget was at RMI's 25th anniversary party. I had only been at RMI a couple of years, and Amory gave a speech called "Imagine a World." To me, RMI had always been about technology and economics and facts. Listening to our founder give a talk about what our work meant to him and his vision for the future was eye opening to me. He asked people to imagine a world that is peaceful, prosperous, just, and life sustaining, and that working together we can make it happen. I will never forget it because it reminds me how important the work is that we do, that it is not just about facts and figures but about bringing our whole selves and hearts and passions to our work. And it has shaped how I think about my role both at RMI and in the world. [You can read Amory's speech at rmi.org/insight/imagine-a-world/].

**Currently the Chinese government allocates an entitlement of annual hours of production to each coal generator, on a more-or-less equal basis. In a wholesale market, electricity produced by different generators is bought at the wholesale market price by an entity—usually a utility—that resells that power to the end user.*

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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; the San Francisco Bay Area; Washington, D.C.; and Beijing.

