

Solutions

Journal

SPRING 2018
VOL. 11 NO. 1



UNSTOPPABLE MOMENTUM

**ON A GLOBAL STAGE, RMI AND PARTNERS LAUNCH
AMERICA'S PLEDGE FOR CLIMATE ACTION**

PLUS: AMORY'S ANGLE, A REAL ESTATE DEVELOPER COMMITS TO NET-ZERO
ENERGY, HOW YOU CAN SAVE ENERGY AT HOME, AND MORE



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WE'LL (STILL) ALWAYS HAVE PARIS

US cities, states, and businesses are still committed and accountable to meeting the goals of the Paris Climate Agreement

By Jules Kortenhorst

On November 11 in Bonn, Germany, at the United Nations climate conference, I was thrilled to be part of the announcement of an extraordinary message from America to the world: the United States is going to meet its commitments under the Paris Agreement. While the current presidential administration plans to leave the agreement, US states, cities, and businesses have emerged, through efforts such as We Are Still In, as the new face of American climate leadership on the global stage, and America's Pledge provides the proof that that leadership is still potent.

America's Pledge is an effort to quantify and communicate the full range of climate action and commitments from US real-economy actors, which is enormous. If the US nonfederal actors that have committed to the Paris Agreement were a country, they would be the world's third-largest economy. The initiative was supported by Rocky Mountain Institute and launched in July 2017 by

Michael Bloomberg and California Governor Jerry Brown, who were present in Bonn together with other governors and mayors, senators, business leaders, and thousands of others drawn to the unofficial US pavilion. It was an exciting and uplifting event, as you will read in the pages of this magazine (see "Fighting Climate Change on a Global Stage" on p. 14).

And the energy has spread far beyond Bonn. This April, I attended energy week in Berlin, Germany, alongside more than 2,000 policymakers, business executives, innovators, and energy activists from every corner of the globe discussing and accelerating the energy transition. The panel discussion I was part of noted how capital is rapidly shifting toward the energy solutions of the future. At Start Up Energy Transition, we were part of the jury evaluating the innovations of cleantech entrepreneurs from around the world. And at Event Horizon 2018, in the setting of an empty coal-fired power plant, blockchain gurus mingled

Addressing the crowd at the America's Pledge report launch in Bonn, Germany.





with energy practitioners to figure out how this technology can disrupt the existing energy system. Energy Web Foundation, which was created by RMI and Grid Singularity, co-convened Event Horizon and was featured extensively. The world is moving forward toward a completely new energy system, despite hesitance in Washington to be part of that transition.

In this issue of *Solutions Journal*, we share some of that progress, including the many ways that RMI is playing a direct role in the markets with uniquely disruptive market affiliates and subsidiaries. We know that markets sometimes need a nudge to switch from long-established ways of doing business, even when alternatives are available that are cleaner and more profitable. Even sliced bread didn't catch on at first! That's why we're working to spread technologies and ideas ranging from real-time emissions analysis to energy applications on the blockchain by participating in markets ourselves.

We also share the ways that RMI staff are taking the energy revolution to the streets where they live, and show how you can, too. RMI staff use everything from tandem bicycles and green roofs to solar ovens in their own lives, as you can read about in these pages. We hear from Amory about why electric savings from increased efficiency have lagged fuel savings, and the profit opportunity that untapped efficiency represents. We also hear from one of our newest RMI employees about her work with data for sustainability in her native India and beyond.

And we get the news from Blair Madden Bui about how she put a major commercial real estate developer on the path to a 100 percent net-zero energy portfolio.

I also have sad news to report. Just before the holidays at the end of 2017, Maurice Meehan, the director of our Global Shipping Operations, passed away unexpectedly and far too soon. For many at RMI, Maurice was more than a colleague; he was a mentor and a friend. We join his family in mourning his passing and celebrating his life, which was full of joy, hard and successful work, and compassion. It is in remembrance of him and his spirit of dedication to addressing the biggest issues of our times that we carry on with our own work, and hope to achieve the sustainable future that he strove for. I hope you'll join us.

Claire Henly, an RMI manager, moderated a conversation at Event Horizon 2018 about the use of blockchain technology in the energy sector.

Jules Kortenhorst
is chief executive
officer of Rocky
Mountain Institute.

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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.

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A COMPLEX CURRENT

Why are we saving electricity only half as fast as fuels?

By Amory B. Lovins

Something very odd is happening in the US energy system, and hardly anyone has noticed.

To make a dollar of real gross domestic product (GDP) in 2017, the US used 65 percent less oil than in 1975 (despite 1982–2008 stagnation in new autos' efficiency), 66 percent less directly used natural gas (direct fuel or feedstock, not power-plant fuel), and 57 percent less total primary energy. Yet *electric* intensity—total electricity consumed per dollar of real GDP—fell by only 31 percent. That's less than half the percentage savings in oil or gas, the economy's main direct fuels (since 93 percent of US coal is burned to make electricity). So why is *electric* intensity going down only half as fast as total energy intensity, especially *fuel* intensity? The answer to this riddle is complex but important.

Utility energy efficiency programs save energy at a lower cost than coal-fired plants produce it.

IT'S NOT ABOUT PRICE OR POTENTIAL

Slower electricity savings aren't due to relative prices. Producing and delivering electricity takes huge capital investments; generating power from fuel loses about two-thirds of its energy; and the grid loses another 5 percent or so. For these three reasons, electricity is even costlier than oil. Its 2017 average US retail price is equivalent in heat content (without counting relative efficiency of use) to crude oil at \$180/barrel, 2.4 times the average world price. Thus cutting electric intensity would seem to have a strong financial incentive—yet it lags far behind.

Nor is the cost-effective potential to save energy smaller for electricity than for oil and gas: their potentials are at least comparable. Some engineers miss this point by noting that over half of electricity runs motors, mostly big ones that are



already around 90 percent efficient. But in fact, the way those motors are specified and used cuts their typical operating efficiency by at least half. Even bigger losses arise downstream in the equipment motors drive, such as inefficient air conditioners cooling inefficient buildings, or inefficient pumps whose effort (in pumping loops) is roughly 90 percent wasted on needless pipe friction. The biggest unseen part of these opportunities is in whole-system design: for example, the most efficient new and retrofit US office buildings were over twice as efficient in 2015 as they were in 2010, using the same technologies but in more intelligent selections and combinations.

During 1986–92, Rocky Mountain Institute conducted a uniquely detailed assessment of potential electric end-use efficiency: Competitek's six-volume, 2,509-page, 5,135-footnote *The State of the Art* series. It showed that full practical retrofit with about a thousand technologies could ultimately save three-fourths of 1986 US electricity, at an average technical cost equivalent to about 1.2¢/kWh. (All costs in this article are in constant 2013 \$.)

Some who hadn't read the analyses, or their later summaries in the *Technology Atlas* series by RMI's spinoff E Source, thought those savings sounded extreme. Yet the utility industry's Electric Power Research Institute concurrently found, and summarized in a joint article, a potential to save 39–59 percent of US electricity just in the 1990s, at an average technical cost around 3.3¢/kWh. Comparisons by Oak Ridge National Laboratory and myself found that simple methodological differences accounted for virtually the whole disparity in the savings' quantity and cost.

The target kept moving: efficiency opportunities grew more than they were captured. By 2011, RMI's *Reinventing Fire* synthesis, relying mainly on National Academies and Lawrence Berkeley National Lab analyses, found that three-fourths of US 2010 electricity use could be saved by 2050 (and more thereafter) at an average technical cost of roughly 0.64¢/kWh—half the late-1980s cost. That so much electricity-saving potential remains on the table testifies not just to electric intensity's painfully slow decline, but to the constant innovation—in design, technology, finance, marketing, delivery, and business models—that keeps new low-hanging fruit ripening faster than it can be harvested.

Utilities' programs to help customers save electricity are not optimally designed and have transaction costs (albeit very small ones if well designed), so they've lately cost an average of roughly 2–3¢ per saved kWh, as documented by

“That so much electricity-saving potential remains on the table testifies not just to electric intensity's painfully slow decline, but to the constant innovation that keeps new low-hanging fruit ripening faster than it can be harvested.”

the American Council for an Energy-Efficient Economy, Lawrence Berkeley National Laboratory, and E Source. But that's still cheaper than just running the average US coal (~3.3¢/kWh) or nuclear (~3.9¢/kWh) power plant, even if building it cost nothing. Moreover, efficiency is already delivered, but delivering the average kWh from a central station to your meter costs an average of ~4.1¢ to pay for the grid's costs and losses.

So if neither potential savings nor relative prices explain why the United States has so far saved electricity less than half as fast as oil and directly used gas, what could? At least nine reasons seem plausible.

PRICES, SUBSIDIES, AND BILLING

First comes pricing. Fuel prices change far faster and are far more volatile than electricity prices, making efficient fuel use seem more attractive and front-of-mind. Unlike fuels, retail electricity is often still priced at its embedded average cost, concealing the often-higher marginal cost of new supplies or less-efficient existing supplies. The same practice often conceals the far higher price of electricity at peak periods or seasons: most large businesses pay time-varying prices for electricity and fuels, and everyone pays gasoline and diesel prices that vary with market prices, but few households or small businesses pay such real-time electricity prices. Indeed, hot afternoons downtown can cost utilities dollars to deliver a kilowatt-hour that they sell for dimes or even for cents; they rarely charge their real cost of grid

Basic causes of electricity's inefficient use are often built into long-lived capital stocks, like building envelopes. Replacing windows is among the costlier ways to improve most buildings.



congestion, but cross-subsidize it from sales at other times or to other customers. In contrast, fuel prices typically reflect actual delivery costs, and fuels that cost more to haul to remote and rural areas are priced higher. For social equity reasons, rural electric cooperatives like the one I belong to were therefore built with federal financing to help equalize electricity prices between urban and rural areas. Co-ops sell 11 percent of US electricity to 80 percent of US counties.

made in nuclear plants, 80 times, getting 34 percent of the subsidies to deliver 1.9 percent of the primary energy. No wonder utilities were investing about \$1 per household per day to build power plants they didn't need and couldn't afford: their subsidies nearly equaled their investment. That wasn't a free lunch; it was a lunch the taxpayers paid them to eat. The feast continues: nuclear subsidies expanded in 2005 rivaled or exceeded construction costs even after those had risen severalfold, and the last two new reactors now being built, if completed despite their builder's bankruptcy, would get bigger operating subsidies than wind power. Even today, America is far from energy prices that tell the truth. Energy subsidies, especially to traditional giant power plants and their fuels, are so entrenched that taxpayers' largesse keeps rising when it should be eliminated.

“The reasons electric savings have lagged fuel savings all represent business opportunities that will gain more attention as their financial rewards and carbon leverage become more obvious.”

Prices are distorted by subsidies. When most of the US electricity system was built, and probably still today (though modern subsidy analyses are sparse and often deliberately biased), electricity was subsidized far more than fuels. Rick Heede's detailed RMI analysis, summarized in *The Wall Street Journal* on September 17, 1985, found that electricity got 65 percent of fiscal-year 1984 federal energy subsidies while delivering only 13 percent of the energy, cutting electricity's price by about one-fifth. Electricity was at least 48 times more subsidized per unit than energy efficiency—and if

Then there are promotional tariffs. Some electric utilities wisely charge higher prices for greater usage (“inverted block rates”) to reflect their higher costs of meeting increased demand, but promotional practices seem more common. Many utilities still discount and cross-subsidize electricity for some uses and users to try to boost demand—notably for electric heating and for big, relatively steady loads like data centers. Some electric utilities' marketers work harder to sell more electricity than their efficiency staffs work to help save it. That's rare with fuels: filling stations charge the same per gallon whether you're tanking up a Humvee or a Prius. And as structural shifts in the economy make the next kilowatt-hour less likely to go to manufacturing

than to an air-conditioned, computer-intensive office complex, utilities gain more incentive to load costs onto such commercial buildings so they can cut prices to more price-sensitive customers like industry and households—maximizing their own sales, revenues, and (absent regulatory reform) profits.

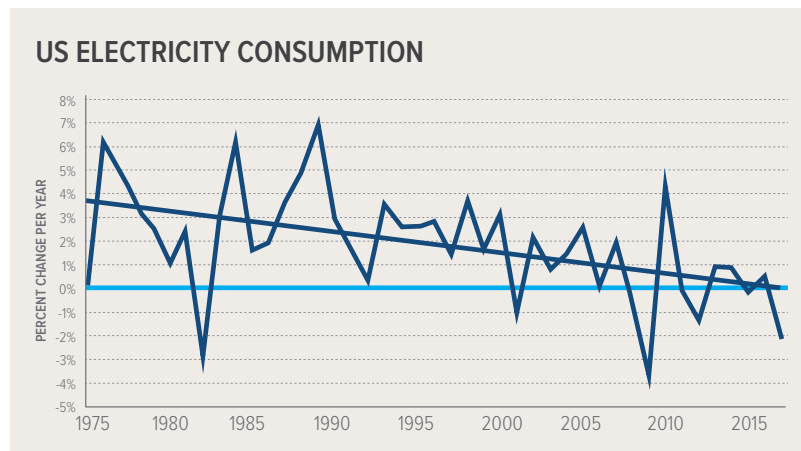
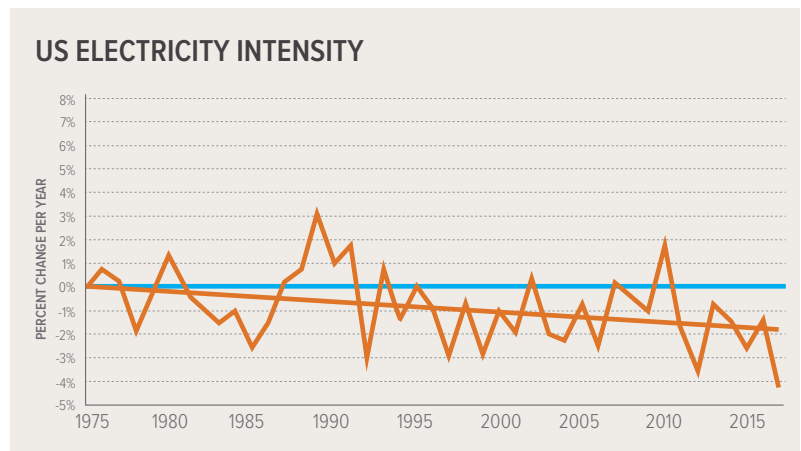
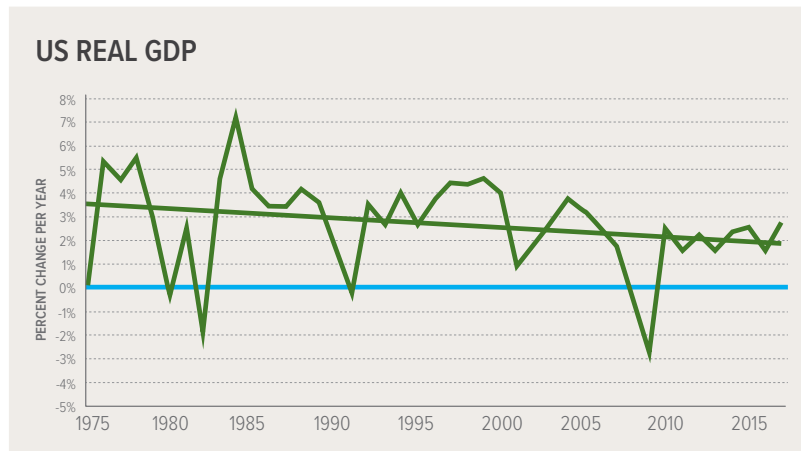
The way electricity is billed makes a big difference too. Every time you fuel your auto, you receive a price signal, and you know where the fuel went. If autos refilled themselves and drivers were auto-billed afterward, they'd spend more on fuel. But that's actually how we buy electricity. Your monthly-in-arrears electric bill isn't itemized, so you can't tell which device used how much, and you only "see" how much total electricity you consumed over the previous month. It's as if the supermarket posted no prices, you took home your cartful of food and ate it, and only *then* you got a single un-itemized bill for the past month's shopping—so how could you tell that tuna was costly and kale was a bargain? In contrast, prepaid electricity (the same as filling your car *before* you drive) creates vigorous investments in efficiency and demand management. And the more information customers have on where their electricity goes, the more mindfully they tend to use it.

Electricity's wholesale costs are more dominated by fixed than by variable costs, compared to fuels, where the commodity price dominates. This gives electricity providers a bigger incentive to promote and sustain high and steady demand to cover the fixed costs of paying off their huge long-term capital investments—especially if they've overbuilt, as many have, or if they believe traditional rate-of-return regulation rewards them for investing more capital.

REGULATORY AND MARKET FAILURES

Misdesigned regulation also gives many providers of electricity utterly perverse incentives. Except in the 16 states (with seven more pending) that now reward utilities for cutting customers' bills, not for selling customers more electricity, utilities have a direct incentive to sell more electricity. Conversely, if they sell less, their mainly fixed costs must be spread over fewer units of electricity sold, making electricity prices rise and further encouraging efficient use—the "death spiral" I described in *Foreign Affairs* in 1976. But there's a smarter alternative. Stagnating or falling sales

FIGURES: Annual rates of change and linear trends in US real GDP, electricity use per dollar of real GDP, and electricity use, 1975–2017. Data from US Energy Information Administration, not weather adjusted.



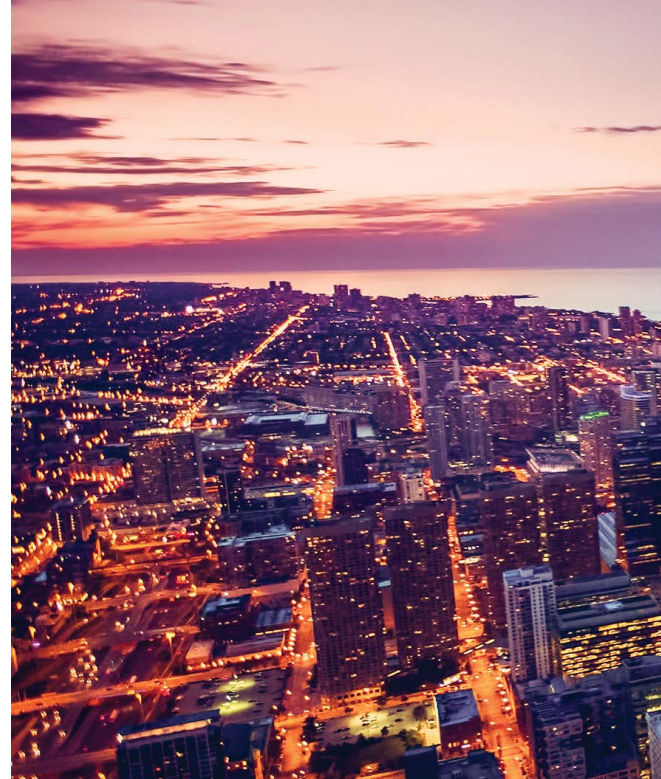
make electric utilities, like gas utilities earlier, more motivated to seek state regulatory reform that makes a virtue of necessity by protecting their revenues through “decoupling” from sales volumes (and preferably also sharing savings with customers). These reforms, officially favored by Edison Electric Institute and the American Gas Association (gas is decoupled in 23 states with five pending), should further accelerate efficiency as it becomes utilities’ most profitable investment.

Saving electricity faces more and tougher structural obstacles than saving fuel. Devices that use electricity are more likely to be bought by a different party than will pay the energy bills, creating a “split incentive.” Buildings use nearly three-fourths of US electricity, roughly half each in commercial buildings and households. In rental properties, why should the landlord improve efficiency for the building when tenants pay the utility bills, why should the tenants improve a building they don’t own, and why should they even improve their own equipment if their electric bill is prorated on floorspace rather than submetered? In households, many appliances are bought by a developer, landlord, or public housing authority who doesn’t pay the energy bills, whereas an industrial boiler, heavy vehicle, fleet van, or personal auto is more likely to be chosen by its subsequent fuel-buyer. No wonder electricity use in buildings is less sensitive to price than in industry.

Further, many smaller electricity-using devices—and, despite widespread Energy Star labeling (a wildly cost-effective voluntary information program that the White House wants to cancel), some bigger ones too—still lack the efficiency labels or standards that most fuel-using devices display, so buyers can’t as easily judge their efficiency as they can read the mpg sticker on a car. And the basic causes of electricity’s inefficient use are often built into long-lived capital stocks, like building envelopes, that turn over slowly and are harder to fix than, say, buying a more efficient furnace or car on a faster replacement cycle.

WE’RE A DECADE PAST PEAK ELECTRICITY

Given all these obstacles to using electricity in a way that saves money, it’s not surprising that US electric intensity didn’t start falling consistently until 1994. Nobody knows why that was the



year the tide turned, but turn it did, and now this long-delayed trend—an average drop of 1.5 percent per year—is solid and strengthening. US electric intensity fell in 21 of the past 24 years, all but two of which experienced real GDP growth. Simple trend-line analysis (see figures on p. 7) shows that GDP growth slowed, electric intensity fell at a comparable pace, and absolute electricity consumption fell at their combined rate. Consumption peaked in 2007 and fell in six of the past 10 years. Its decomposed trend line hit zero annual growth in 2009 (2006 per capita, before the recession) and continues to trend downward. In 2017, GDP grew 2.3 percent while electricity use fell 2.1 percent, so electric intensity fell by a record 4.3 percent. Yet official forecasts still show 0.6 percent annual growth to 2050.

RMI ANALYSIS

Similar trends are now evident in most industrialized and some developing countries. The rest mainly see slow demand growth that is rapidly tipping their over-ordered power supplies from scarcity to glut, turning supposedly vital new plants—especially Chinese and Indian coal plants—into prestranded assets.

New US building standards that came into force in about half the states in 2012–13, expanding private and utility investment in efficiency (\$7 billion in 2013 from utilities alone), and more and better efficiency vendors, hardware, finance, and design methods all seem bound to speed this trend. LED



lighting alone will ultimately save close to an eighth of the world's electricity. And while fossil-fueled and nuclear electricity keeps costing ever more, efficiency (like renewables) keeps costing ever less because it improves faster than it depletes.

EFFICIENT USE CUTS MOST UTILITIES' REVENUES, NOT THEIR COSTS

Some utilities still cling to shreds of hope that electric demand will magically rebound. They'll probably be disappointed. A decade after peak electricity, US utilities urgently need business models robust against the "new normal" of stagnant or shrinking demand—a foundation of the next economy. RMI's *Reinventing Fire* shows that even a complete switch to electric autos, and extensive electrification of heat applications too, will offset only about half the decline in electricity demand.

Beneath the complex causes of falling electric intensity are two simple insights. First, customers are figuring out that they'll get better service at lower cost by using fewer electrons more productively, so that's the mix they'll buy—from their utility or from someone else.

Second, the reasons electric savings have lagged fuel savings all represent business opportunities that will gain more attention as their financial rewards and carbon leverage become more obvious. Efficiency's enemies keep trying to block it. But ultimately the fourfold, and by then probably greater, gain in electric productivity,

already costing a tenth the average retail price—less than just *operating* existing thermal power stations—will be captured. Its economic potential will not forever languish unused.

As that potential is realized, utilities that sell electrons will face disastrous declines in sales and revenues. They can survive only by financing or providing the *services* customers want, like hot showers and cold beer—a model Thomas Edison pioneered in the 1880s so more-efficient lamps would reduce the costs and increase the profits of his lighting-services business. But he was overruled in 1892 when New York Edison Company switched to selling kilowatt-hours. Ever since, utilities have sold electricity (except in street lighting) as a commodity, so customer efficiency cuts their revenues, not their costs.

That upside-down business model cannot long survive customers' accelerating switch to buying negawatts whenever they're cheaper than megawatts—which nowadays is virtually always. So if you can no longer deny or overcome the fundamental forces that are making your customers buy ever less of your product, best to sell or lease them what they want electricity *for*, aligning your interests with theirs. 🌱

Updated from first publication by Forbes on April 25, 2017, at <https://www.forbes.com/sites/amorylovins/2017/04/25/why-are-we-saving-electricity-only-half-as-fast-as-fuels/>. Visit the online version for hyperlinks to sources referenced in the article.

Buildings use nearly three-fourths of US electricity, but split incentives create obstacles to energy efficiency.

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

⊕ WEB EXTRA

For more information on this topic visit: www.rmi.org/our-work/electricity/

RMI IN BRIEF

News From Around the Institute



The largest multitenant leased net-zero energy project in the US is home to RMI's Boulder, Colorado, office.

A MODEL FOR SCALING NET-ZERO ENERGY LEASED BUILDINGS

RMI's new office in Boulder, Colorado, is the largest multitenant leased net-zero energy project in the country. And the innovative lease that makes it possible and profitable for both the developer and the tenant is paving the way for others to follow, as highlighted in RMI's guide *Best Practices for Leasing Net-Zero Energy Buildings*. And, through the Boulder Energy Challenge, the team is providing training to area developers to put these concepts into practice, and make high-performance buildings a solution to the city's target of reducing carbon emissions by 80 percent by 2050.

RMI RECEIVES OFFICIAL REGISTRATION AS A FOREIGN NGO IN CHINA

RMI's Beijing office received its official registration as an international NGO from China's Ministry of Public Security. The National Energy Administration (NEA) will supervise RMI's operations in China. As the only foreign NGO to be supervised by the NEA, Rocky Mountain Institute looks forward to continuing to support China's energy transformation and sustainable development in the long term.

EQUIPPING CITY LEADERS TO TAKE ACTION ON CLIMATE COMMITMENTS

The Carbon-Free City Handbook, released at COP23 in Bonn, Germany, reveals 22 actions—and associated resources—for cities around the world to move toward climate neutrality, seeing results within one year. This new RMI resource helps city leaders and staff implement climate policies and actions that resolutely place their communities on an aggressive path toward sustainable, low-carbon economies. Read more on p. 21.

DRIVING TOWARD A NEW MOBILITY FUTURE

With help from RMI, Austin, Texas, is working to shift its mobility system to one that enables shared, electric, and autonomous mobility services. As part of that effort, the RMI mobility team recently codeveloped and deployed the Market District commuting pilot, created a low-price purchase/finance program for electric vehicles for drivers of the Ride Austin transportation network company, and identified 330 vehicles in the City of Austin's fleet to be replaced by electric vehicles. The City has agreed to purchase those vehicles by 2020.

MORE ISLANDS GO RENEWABLE

The British Virgin Islands and Barbuda have retained RMI's islands team to redesign their electricity systems, which were severely damaged last year by Hurricanes Irma and Maria. The focus of the system redesign is to shift from centralized fossil-fuel systems to decentralized renewable systems. Meanwhile, with help from RMI, Saint Lucia is constructing the country's first utility-scale solar farm and Saint Vincent and the Grenadines is planning for its first solar-plus-battery storage microgrid system on the island of Mayreau, which will be the first of its kind for the Eastern Caribbean.

RMI REIMAGINES THE UTILITY

As the power system becomes increasingly distributed and decarbonized, the question, What is the right role and business model for electric utilities? is getting a lot of attention. RMI's new report, *Reimagining the Utility: Evolving the Functions and Business Model of Utilities to Achieve a Low-Carbon Grid*, provides an analytical lens for evaluating utility reform. The report discusses how decision makers in the industry must adapt their operating strategies to achieve win-win solutions for industry incumbents, new market entrants, customers, and the environment.



The drivers in the Run on Less proved that 10 mpg is possible.

RUN ON LESS PROVES EFFICIENT TRUCKING IS POSSIBLE

Run on Less, a first of its kind cross-country road show, proved that 10 mpg is possible for big rigs using efficiency technologies that are available on the market today. If the 1.7 million trucks on North American highways today achieved the same level of efficiency as the trucks that participated in Run on Less, they would save 9.7 billion gallons of diesel fuel, \$24.3 billion, and 98 million tons of CO₂ each year.

YOUR PLANE RELEASES CARBON. WE PUT IT BACK.



The Good Traveler is an easy way to make air travel more sustainable.

FREQUENT FLIERS FIGHTING CARBON

RMI staff fly all over the world and that releases carbon, so we are now mitigating the carbon impact of our journeys by supporting projects that take carbon out of the atmosphere. The Good Traveler initiative, managed by RMI, allows anyone to pay for carbon offsets, which are projects that are certified to take climate-wrecking greenhouse gases out of the atmosphere, or prevent them from being released, while doing some extra good like restoring wetlands, growing forests, or catalyzing new efficiency technologies. You can use The Good Traveler, too. A single \$2 purchase offsets the carbon you release in 1,000 miles of flying or 400 miles of driving—that's equivalent to about 156 kilos of carbon dioxide. Learn more at thegoodtraveler.org.

THE POWER TO CHOOSE CLEAN ENERGY IN REAL TIME

WattTime—an RMI subsidiary—and Microsoft recently launched a new way to give customers the power to understand and reduce their carbon emissions. Microsoft's free and open-source Real-Time Carbon Emissions Platform will be the first software to automatically detect the precise carbon emissions caused by using or generating electricity at any particular time and place in Europe, in real time.

RMI PODCASTS: A NEW WAY TO CONNECT

In April 2017, RMI launched its first podcast with an interview with CEO Jules Kortenhorst about "applied hope." Since then, we have aired 19 podcasts with experts covering topics such as community-scale solar, global climate finance, net-zero energy homes, and more. Our podcasts have also covered events live from Climate Week and COP23. Now you can listen to them all at rmi.org/about/news-and-press/.

WHAT IT'S LIKE TO BE A FIRST MOVER

Blair Madden Bui on committing to a portfolio of net-zero energy buildings

By Kelly Vaughn

When asked, “Why are you pursuing net-zero energy,” Blair Madden Bui answered simply “Why not?”

This response is incredibly characteristic of the subtle tenacity and vision embodied by the chief executive officer of the John Madden Company—a pioneer of commercial real estate development in Colorado’s greater Denver area since the 1960s.

Today, the company’s goal is to maintain this same pioneer spirit by prioritizing sustainability. Since taking up her position in 2014, Madden Bui has set the John Madden Company’s entire building portfolio—consisting of close to 800,000 ft² of space—on an ambitious pathway to net-zero energy (NZE). No other real estate portfolio of this size in the nation can claim that. But this “why not?” attitude that fundamentally shapes her thinking means that Madden Bui saw opportunity where others may only see risk or cost.

BUILDING AND ALIGNING VALUE

For the John Madden Company, energy performance is not a novelty or a tagline—it’s a necessity that’s core to its business strategy. With major corporate tenants including Charter, Fidelity, Newmont, and Global Medical Response, the company needs to meet the growing demands of savvy tenants who are seeking office locations that boost their employees’ health and productivity, build a sense of community, and say something about what their



brands stand for. Sustainable office space delivers all those benefits.

“Tenants care about the workspaces they are creating for their employees,” said Madden Bui. “When Fidelity came to our campus, they required that we recommission buildings for LEED certification—to provide a space for their employees to thrive in. Companies care about sustainability because they care about their teams and see the effect on their bottom line.”

Building value for the future, not just the present, prompted Madden Bui to pursue a long-term NZE strategy for not just individual buildings, but the entire portfolio, setting her and her company on an exciting but somewhat unknown path to an entirely new echelon of industry leadership.

IT'S A MARATHON, NOT A SPRINT

To turn promise into practice, Madden Bui sought the support of Rocky Mountain Institute (at the recommendation of RMI board member Tom Dinwoodie) in 2012 to lay the foundation for the company's net-zero energy strategy. The partnership flourished from there, and has since resulted in a body of work that elegantly blends Madden Bui's market influence with philanthropic support to leverage all aspects of RMI's “think-do-scale” change model to make meaningful progress in reducing the carbon footprint of US commercial buildings.

“Putting all of our buildings on a pathway to zero is a bold goal and incredibly complex to achieve,” said Madden Bui. “It is a process over time that will ultimately yield great results, but requires the right steps in the right order. That's why we're working with RMI.”

The importance of having a clear goal around the beginning of a project and aligning stakeholders around it was an early lesson. The John Madden Company team recalls a significant learning experience in a design charrette on a new project where a net-zero energy goal was considered, but the team quickly recognized that it was too late in the design process to achieve it successfully or cost-effectively.

“We realized that we couldn't tackle this overnight,” said Madden Bui. “Instead, we had to manage a paradigm shift in how we build and

improve our portfolio over a longer period of time. It's a process that won't happen overnight. We expect our path to net-zero energy will take at least 20 years, but starting somewhere was important to our team and our tenants.”

A PATH FOR OTHERS TO FOLLOW

Today, movement is happening thanks, in large part, to the continued philanthropic and market partnership between the John Madden Company and RMI. One by one, the team is chipping away at the seemingly unsurmountable market barriers that have held developers back from pursuing NZE in their leased commercial projects.

One of those barriers is the complexity of lease agreements needed to support a successful NZE project that has multiple tenants. RMI and our partners successfully addressed that barrier during RMI's move to Boulder Commons, a first-of-its kind NZE mixed-use space in Boulder, Colorado. Thanks to Madden Bui's support, the RMI team was able to capture and share a collection of best practices and recommendations in the recently published *Best Practices for Leasing Net-Zero Energy Buildings* to help other developers pursue NZE more quickly and efficiently.

Another barrier is the perceived cost challenge associated with pursuing NZE. But Madden Bui and the team are debunking that myth as well. This past winter, the John Madden Company received \$7.1 million in commercial property assessed clean energy (C-PACE) financing—the largest ever financed through Colorado's C-PACE program—to fund a deep retrofit project of Denver's Fiddler's Green Center that will save 30 percent in annual energy and maintenance costs. Madden Bui points to this as an example of the way that going green can open up formerly unavailable sources of capital.

“The building sector is risk averse. Nobody wants to go first. So Madden Bui's role as a trendsetter is particularly powerful,” said Cara Carmichael, a manager with RMI's buildings program and long-time collaborator with the John Madden Company. “Her ability to motivate and champion her teams through a long process is invaluable, and generosity in sharing these learnings with the industry is rare.”

To this, Madden Bui simply replies, “Well, the industry is ready. It's time to move.” 🌱

Kelly Vaughn is a marketing director at Rocky Mountain Institute.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/our-work/buildings/pathways-to-zero/

FIGHTING CLIMATE CHANGE ON A GLOBAL STAGE

RMI and partners are quantifying the still-massive US action on our Paris Agreement commitments

By Paul Bodnar, Koben Calhoun, and Caroline Ott

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RMI CEO Jules Kortenhorst addresses the crowd at the launch of the America's Pledge phase 1 report.

On a brisk November Saturday in Bonn, Germany, Rocky Mountain Institute CEO Jules Kortenhorst is preparing to take the stage at the United Nations Climate Conference. He will introduce a lineup of global climate leaders, including the executive secretary of the United Nations Framework Convention on Climate Change (UNFCCC), the Fijian prime minister, and several US mayors and governors. He will ultimately turn the microphone to California Governor Jerry Brown and former New York City Mayor Michael Bloomberg to introduce America's Pledge: an initiative to showcase leadership by US states, cities, and businesses in the fight against climate change.



The UN climate conference—referred to as the Conference of the Parties or the COP—happens every year, but this past year was different. Following President Trump’s announcement of his intent to withdraw the United States from the Paris Agreement, the United States experienced an unprecedented swell of climate commitments by US states, cities, and businesses. Building on that momentum, last year’s COP featured a first-of-its-kind US Climate Action Center to showcase these new voices of American climate leadership. Over eight days, the 27,000-square-foot venue hosted 44 events featuring governors, senators, mayors, and business leaders. While it was not an official national pavilion, the US Climate Action Center nonetheless hosted one of the largest side events in COP history: the launch of America’s Pledge.

The America’s Pledge event on November 11, 2017, attracted over 1,000 people. The crowd was excited, hooting and hollering, some shouting and some weeping. The America’s Pledge phase 1 report was officially welcomed by the president of COP23, Fijian Prime Minister Frank Bainimarama, and the executive secretary of the UNFCCC, Patricia Espinosa. Former Mayor Bloomberg made America’s voice clear when he said, “If Washington won’t lead, mayors, governors, CEOs, and civil society will.” And Governor Brown brought the crowd to its feet when he declared, “We’re here, we’re in, and we’re not going away.” The world heard us, and folks at home were listening, too. On that day, #WeAreStillIn was one of the top trending topics on Twitter in the United States. The launch of America’s Pledge shifted the mood at COP from one of pessimism about US climate efforts to one of ambition for increasing momentum to reduce GHG

emissions, and hope for clear leadership from the United States on climate.

RMI was privileged to be a part of the team—led by Mayor Bloomberg and Governor Brown and including partners World Resources Institute, CDP (formerly the Carbon Disclosure Project), the University of Maryland Center for

“We’re here, we’re in, and we’re not going away.”

Global Sustainability, and other leading expert organizations—that contributed to the phase 1 report of America’s Pledge in Bonn. Both the findings of the report and its reception at the COP make us more hopeful than ever that the climate challenge can be overcome and that the United States is still an indispensable part of the solution. On the same theme, RMI also released *The Carbon-Free City Handbook* at COP23. The handbook is a guide to concrete actions and resources for cities around the world to move toward climate neutrality (see p. 21). Both resources have been referenced by climate leaders across the globe, and both have helped to kick-start a new era of climate leadership by states, cities, businesses, and other nonfederal actors.

THE ORIGINS OF AMERICA’S PLEDGE

In December 2015 in Paris, 195 nations reached an unprecedented consensus on a long-term global policy framework for climate action. Almost all parties to the Paris Agreement set national goals

PHOTO: courtesy Paul Bodnar



or targets for curbing their emissions by 2030 or sooner, and the United States pledged to reduce its emissions by 26–28 percent below 2005 levels by 2025. These commitments were critical to building political will and designing the agreement in such a way that it could achieve its objectives to limit global warming.

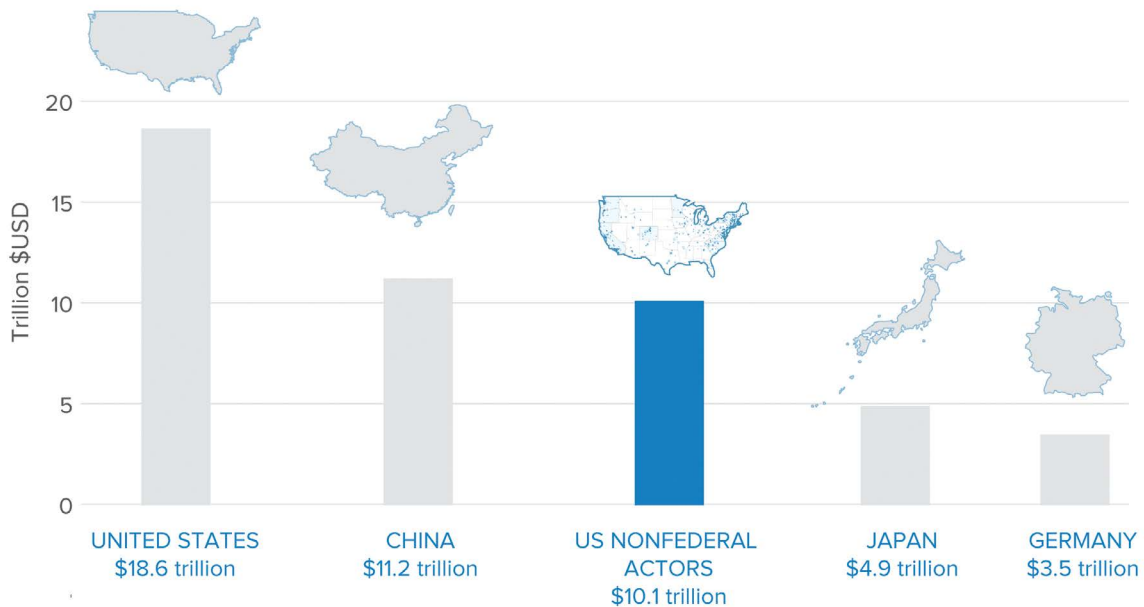
However, in June 2017, President Trump announced his intent to withdraw the United States from the Paris Agreement (a process that could only take formal effect in late 2020). Immediately following this announcement, an overwhelming number of American mayors, governors, CEOs, and other leaders spoke out under the banner “We Are Still In” to reaffirm their support for continued action on climate change and for the Paris Agreement itself. In July, Mayor Bloomberg and Governor Brown launched America’s Pledge, an analytical effort to quantify and communicate the efforts of various US climate action coalitions and campaigns. Since the launch of America’s Pledge, RMI has been hard at work alongside core partners at the University of Maryland and World Resources Institute.

Why the need for a new effort like America’s Pledge? The Paris Agreement is a treaty among nations, and subnational actors and businesses have traditionally been relegated to the side halls of UN climate meetings. Nations are accustomed to getting information about each other from their capitals. But following Trump’s announcement, there was no ready-made mechanism to reassure the rest of the world that American climate leadership continues to shine bright even when Washington goes dark. By analyzing, quantifying, and showcasing the progress and ambition of US states, cities, and businesses in decarbonizing our economy, America’s Pledge hopes to influence the ambition of other countries as they come back to the negotiating table to ratchet their national targets in 2020 and beyond.

NONFEDERAL ACTORS LEADING ON CLIMATE

Our analysis found that the real economy of the United States and its leaders in business, state and city governments, and universities are

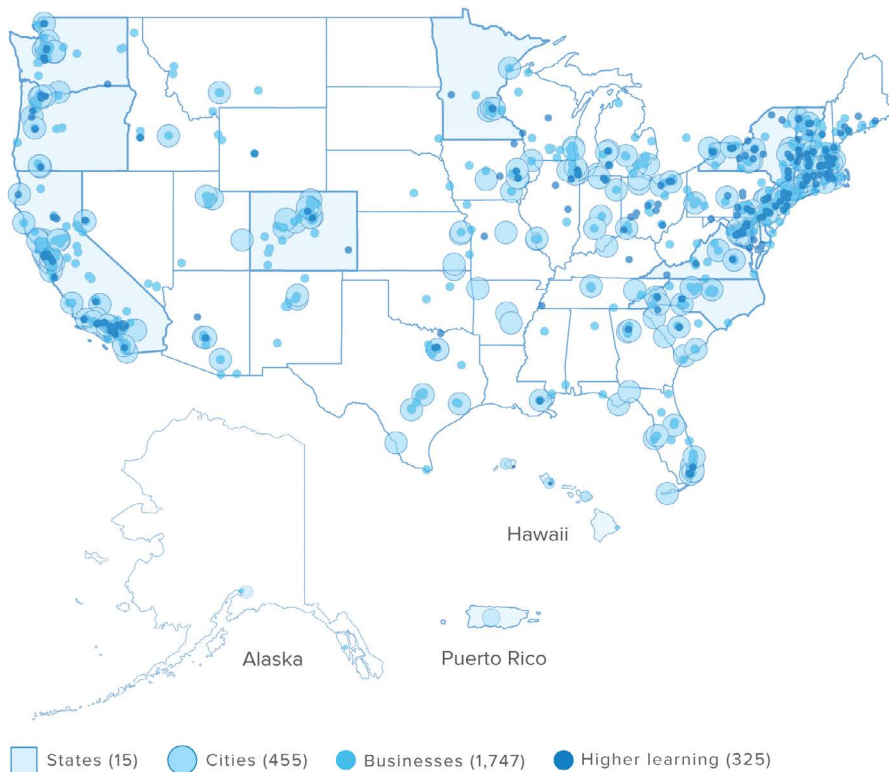
FIGURE 1: Gross Domestic Product of Largest Countries and of US States and Cities Supporting the Paris Agreement.



Source: America’s Pledge phase 1 report.



FIGURE 2: Networks Supporting the Paris Agreement Across the United States.



Note: Information represented on the map was based on available data as of October 1, 2017. The coalitions represented are dynamic and the data will change over time. Source: America's Pledge phase 1 report.

A deep-dive discussion of the America's Pledge report, with RMI's Koben Calhoun (far left) and Paul Bodnar (far right) alongside other contributors.



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The crowd in the pavilion was excited.

driving significant reductions in the nation's emissions output, and can help drive progress on our pledge under the Paris Agreement. States and cities representing more than half of the US economy have declared their support for the Paris Agreement. If these nonfederal actors were a country, they would be the world's third-largest economy.

In addition, over 1,300 businesses—representing \$25 trillion in market capitalization—and over 500 universities have adopted greenhouse gas emissions-reduction targets akin to the Nationally Determined Contributions of Paris Agreement Parties (NDCs). These NDCs are the quantified commitments of all the nations that signed the Paris Agreement. The America's Pledge phase 1 report gives other nations the confidence to stay committed to their own NDCs because it shows that it's still possible for America's pledge on climate action to be fulfilled, and for global contributions to still add up to a meaningful whole.

The report's findings should also give us confidence here at home in the United States, where the energy revolution is well underway. The commitments and actions quantified by America's Pledge, combined with falling clean technology prices and emerging market innovations, are driving the low-carbon transformation of the US economy. Between 2005 and 2015, the US economy grew by 15 percent while net greenhouse gas emissions fell by 11.5 percent. And it should come as no surprise. We found that, of the nation's largest 51 cities, 35 have energy reduction goals, as do 48 percent of Fortune 500 companies.

This transition to a low-carbon future is most pronounced in the power sector, where emissions have declined by 24 percent between 2005 and 2016. We found that corporations in the United States have signed deals to purchase more than 9 gigawatts of renewable energy in the past five years (and 96 percent of such deals involved a member of RMI's Business Renewables Center), while 43 cities have committed to using 100

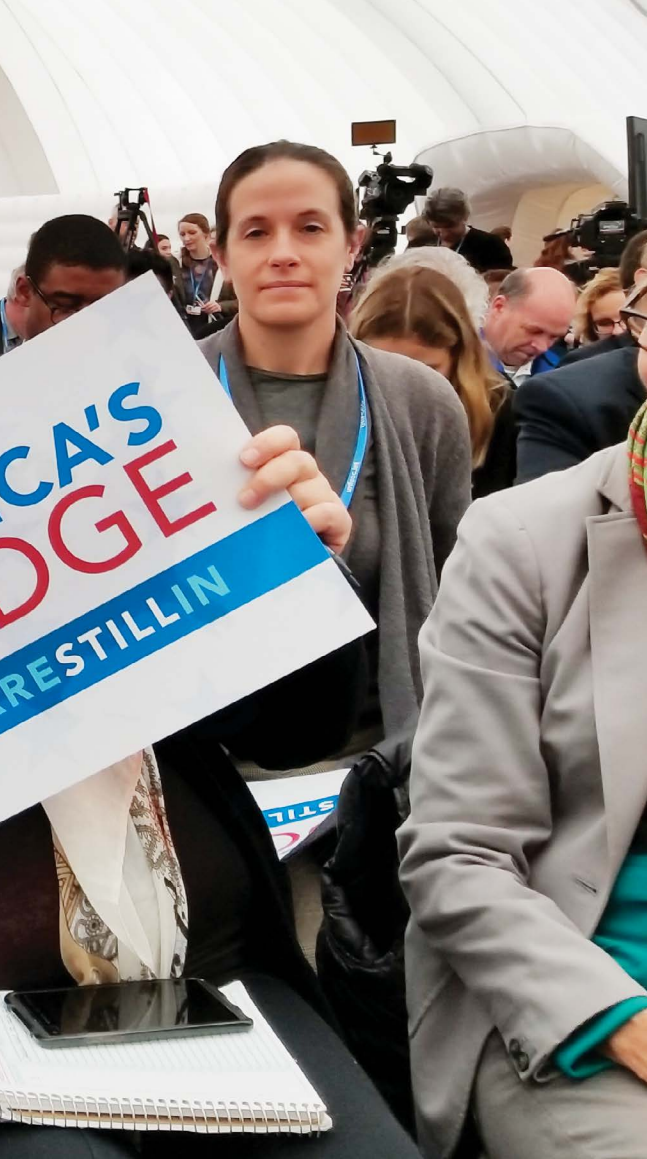


PHOTO: Schuyler Nulff/World Resources Institute

percent renewable energy in the near future. Meanwhile, the cost of solar power and battery energy storage (for things like electric vehicles) have both dropped by about 80 percent since 2010 and are still falling. Amory Lovins and RMI have been working toward a revolution in the way we produce and use energy for 35 years, and it is succeeding—and accelerating. But while this progress is encouraging, the decarbonization of the United States needs to bend down the emissions curve faster to hold within reach America's pledge to reduce its overall emissions by 26–28 percent by 2025 compared with 2005 levels—particularly in the face of federal inaction

RMI'S ROLE IN AMERICA'S PLEDGE

RMI has been helping states, cities, universities, corporations, and industry reduce their greenhouse gas emissions for decades, and not because the federal government told anyone to do so. Through our *Reinventing Fire* analysis, we showed that a pathway to a clean and low-carbon

future is not only possible, it's also profitable. For these and many other reasons, we strongly believe that Trump's intention to withdraw from the Paris Agreement does not mean that the United States will halt progress on addressing the impacts of climate change. We believe that success in this vital effort depends on individuals and markets,

“We believe that success in this vital effort depends on individuals and markets, not on policymakers and governments alone.”

not on policymakers and governments alone. That's why we're working harder—and with higher spirits—than ever.

In the partnership, RMI led on analytical efforts and products, while also advising on communications and stakeholder coordination. In the month following the launch of America's Pledge, RMI and World Resources Institute, in collaboration with Bloomberg Philanthropies and the office of Governor Brown of California, convened 50 experts in San Francisco to discuss analytic issues related to climate action by US subnational actors. RMI led several discussions and breakout sessions on the design of the America's Pledge phase 1 report, and also facilitated discussion on how this work relates to other coalitions and analyses.

During the following autumn, RMI co-lead the heavy work of analysis of the real economy, leading to the publication of the phase 1 report at COP23. In this role, RMI took the lead on analytics and drafting—including visuals—while also managing and coordinating inputs from expert reviewers. RMI staff presented the findings of the phase I report at multiple panels and events at COP23, including the US Climate Action Center flagship event moderated by RMI CEO Jules Kortenhorst, and a “deep dive” event featuring the authors of the report.

THE WORK CONTINUES

Building on the analysis outlined in the first report, the America's Pledge initiative is developing a more comprehensive analysis of the

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Koben Calhoun is a manager in RMI's buildings and electricity practices.

Caroline Ott is a senior associate on RMI's Climate Finance Team.

⊕ WEB EXTRA

For more information on this topic visit: www.americaspledgeonclimate.com

bottom-up contributions of real-economy actors to carbon emissions reductions, with an eye toward to the 2025 end date of the first US commitment under the Paris Agreement. This analysis will quantify how the commitments and actions of real-economy actors, in conjunction with market

lead on lowering that trajectory in line with the contribution the United States pledged as part of the Paris Agreement.

“Seeing those efforts brought together is what reveals the strength of our combined action, and shows us that we are effecting the energy revolution together.”

forces and remaining federal policies, will continue to shape the trajectory of US greenhouse gas emissions. This phase 2 analysis will be delivered later this year at the California Global Climate Action Summit. In addition to capturing additional data on commitments and actions of states, cities, and businesses, the phase 2 report will also present roadmaps for more ambitious action in key sectors of the US economy. The report will also feature a robust analysis of the current US greenhouse gas-emissions trajectory, and the potential for real-economy actors to continue to

In the meantime, America’s Pledge is influencing global and national climate conversations and actions. At the inaugural North American Climate Summit in Chicago, one month after COP23, former President Barack Obama recognized the monumental and critical work that US cities, states, businesses, and citizens are doing to continue movement on climate change. In his keynote remarks to the more than 50 mayors in attendance, Obama said: “The work is up to each of us—wherever we have some impact, wherever we have some influence. That’s why America’s Pledge on Climate is so important—it’s about more than living up to our responsibilities on the world stage, it’s about keeping our word on the world stage. And cities, states, businesses, universities, and nonprofits have emerged as the new face of American leadership on climate change.”

A few days later, at the One Planet Summit outside Paris, French President Emmanuel Macron, too, endorsed America’s Pledge, saying: “We are here today because a lot of us decided not to accept the decision of the American federal government to leave the Paris Agreement. And we say, America’s Pledge, thank you for starting this initiative...the states, the cities, the businesses, who said, ‘we’re going to take another path.’ It is wonderful.”

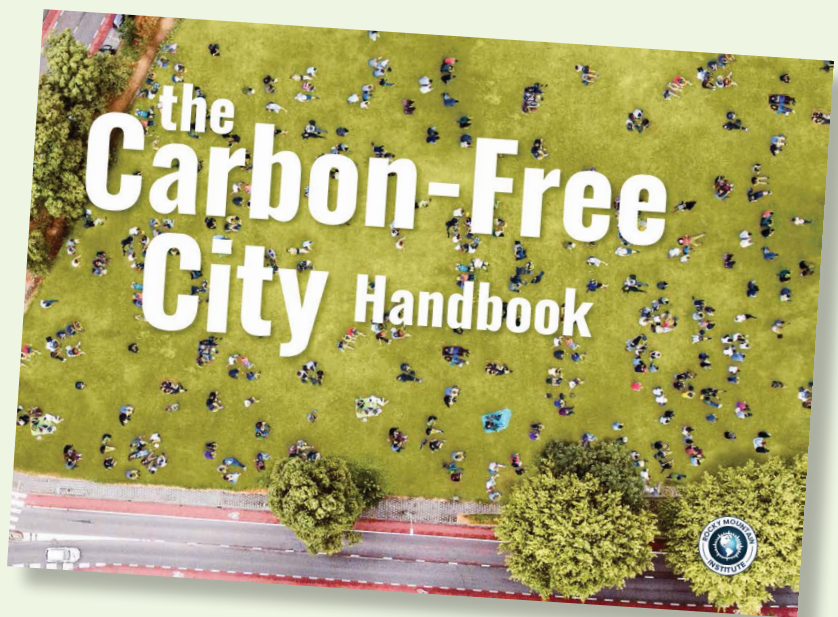
Seeing most of the US economy reaffirm its commitment to the strong climate action set in motion by the Paris Agreement is wonderful. Knowing that our nation is still hard at work to reduce our greenhouse gas emissions and decarbonize our economy is a comfort, and it is important, too, so that the world can keep the faith with other efforts and hold us accountable for ours. That’s why we’re proud to be part of the America’s Pledge effort, grateful for the opportunity presented by Mayor Bloomberg and Governor Brown to dive deeper in our understanding of US decarbonization, and excited to help communicate those efforts to the world. Working in isolation, it can feel as though every corporate board, every city council, and every state legislature is tilting at windmills. Seeing those efforts brought together is what reveals the strength of our combined action, and shows us that we are effecting the energy revolution together. Which is the only way it can be done. 🌍

Launching the America’s Pledge report are (l to r) Paul Bodnar, Koben Calhoun, Caroline Ott, Kristin Igusky (of World Resources Institute), and Michael Bloomberg.

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A TOOL FOR CITIES TO TAKE URGENT CLIMATE ACTION



By Jacob Corvidae

At COP23 in November, Rocky Mountain Institute also launched *The Carbon-Free City Handbook*, a global action guide for cities, which has changed the conversation around city climate action. America's Pledge and #WeAreStillIn have been crucial to galvanizing US efforts around climate change. Still, for cities in the United States and the rest of the world, moving from climate commitments to climate action is often fraught with numerous barriers and delays. We created *The Carbon-Free City Handbook* to help cities take action this year.

With this book, we have upended the status quo. We no longer endorse the industry-wide recommendation that cities start their climate actions by creating comprehensive climate action plans. The resources most cities have for climate action are highly constrained, both in terms of budget and staffing. Our new mantra: if cities have to choose between making plans or making progress, then make progress. We don't have time to wait. As former Mayor of Vancouver Gregor Robertson wrote in the book's opening, "We are excited about the progress we've made, but this is just the start. We need to take bold action to tackle climate change." *The Carbon-Free City Handbook* makes this possible.

The book's 22 "no-regrets" actions can move a city toward carbon neutrality, can be launched by a city within a year, have been proven to be viable, and are applicable to most cities with a population over 100,000 globally.

Nearly 1,000 copies of the book have been distributed at gatherings of city leaders interested in climate action, and more than 1,500 electronic versions have been downloaded since its launch. "This handbook is exactly what our cities need," said Amanda Eichel, executive director of the Global Covenant of Mayors for Climate and Energy, which represents 7,400 cities. "It's accessible and helps them move from general strategies to specific actions. We'll be sharing RMI's handbook to help our cities act now and raise the ambition on climate action."

Other city networks, such as the Mayors National Climate Action Agenda and the Urban Sustainability Directors Network, are sharing RMI's city work with their members. Interest in the handbook has led to a workshop for cities across Alberta, Canada, and a commissioner from Ontario, Canada, has been providing copies to cities across the province. We've also had follow-ups from across the United States, including Alaska, California, Colorado, Illinois, Iowa, Michigan, and Virginia. Finally, a Chinese translation was provided to cities in the Alliance of Pioneer Peaking Cities, and the Chinese central government has stated that the handbook has been very useful in its planning.

Some of RMI's initiatives are building upon this work to further engage cities. Working through existing city-led networks, our Residential Energy+ initiative is providing technical assistance to cities to help them launch or improve programs to reduce residential energy use, including exploring how to move toward net-zero energy construction. We are also providing expertise in utility-scale renewables procurement through our Business Renewables Center to help cities secure a clean energy supply, and model the benefits to their communities.

RMI will continue to use the book in our efforts to help cities move from concept to action. You can, too; we encourage you to share *The Carbon-Free City Handbook* with your local leaders.

The Rockefeller Brothers Fund, which underwrote the *Handbook*, is now supporting RMI in creating a companion piece for states and regional governments to support actions that they can take to drive larger-scale efforts than cities can, and support the cities in pursuing a clean, prosperous, and secure energy future. 🌱

Jacob Corvidae is a manager in RMI's buildings practice.

THIS LITTLE THINK-TANK GOES TO MARKET

RMI intervenes directly in markets to
spread and scale profitable energy innovations

By David Labrador





You may not know it, but when you take a flight, buy something that was delivered on a truck, heat your home with natural gas, or use electricity, there's a chance that Rocky Mountain Institute is part of the market that you're buying from.

At RMI, we believe that industry and business are the keys to transforming the global energy system and arresting global warming, because when markets lead, change happens at massive scale. The problem of climate change is global: no single government's policy can solve it. Even now that every government in the world has united against climate change in the Paris Agreement, markets are still the key. But can markets create a low-carbon future on their own? The answer is, not soon enough to stop catastrophic warming.

Sometimes markets need a nudge to shift from old ways of doing business, despite having cheaper, better, lower-carbon alternatives that are market-ready. The radio industry didn't move from AM to FM for decades. That's why RMI, with support from our donors and partners, intervenes in markets to help transform their energy use. When all else fails (or is taking too long) RMI takes proven, market-based solutions that can be replicated and implemented now and helps them to scale rapidly by working through subsidiaries or market affiliates to demonstrate and spread them. Here, we describe how some of RMI's subsidiaries and affiliates are filling unique and disruptive needs in the market.

SAVING OIL AND GAS

The Global Race for Zero Methane Emissions Challenge

Methane gas is a byproduct of oil and gas production that dwarfs carbon with its global warming potential. Over 20 years, methane can warm the Earth 85 times more than the same amount of CO₂ (25 times more than CO₂ over 100 years). The oil and gas industry lets a lot of methane escape through leaking, venting, and flaring (intentionally burning excess methane) even though it is a primary component of natural gas; all that wasted methane is worth a lot of money! Harnessing the wasted methane and converting it into valuable energy would remove the equivalent of almost six gigatons of CO₂ emissions every year, or 8 percent of global

SoCore Energy's 3 MW Carrizozo solar project, in New Mexico, will sell its output at a record-low price to Otero County Electric Cooperative. RMI provided project analysis and supported the competitive procurement process.



Ian Kelly, an RMI manager, addressing attendees of the Business Renewables Center’s Members Meeting.

greenhouse gases. And the methane that is burned off in flares alone is worth \$30 billion. RMI and the World Bank determined that 80 percent of that value can be profitably captured, but letting the industry know it’s possible is not enough. There are more than 16,000 methane flares around the world and the best business models and technologies for capturing methane and bringing it to market are not widely understood.

That’s why RMI’s Global Race for Zero Methane Emissions Challenge is working to rapidly stimulate a new “flare to value” service industry that will operate at scale. Projects can be developed more quickly with modular, standardized technology solutions while attracting new finance and adopting much more efficient project development and contracting approaches. We’re presenting a business case to oil and gas operators that abates methane-emitting flares and vents at no cost to the companies, with no asset liability, and no operational risk. And it’s working: since late last year we have supported demonstration projects that test new contracting, new financial models, and fast deployment. In addition, 10 international oil and gas companies—BP, Eni, ExxonMobil, Gazprom, Repsol, Shell, Statoil, Total, Qatar Petroleum, and Wintershall—have signed on to a set of guiding principles aimed at reducing methane emissions that RMI developed with partners.

The North American Council for Freight Efficiency

A similar opportunity is present for trucking; heavy-duty trucks in the United States consume about 25 billion gallons of fuel every year, costing trucking companies millions of dollars and releasing billions of tons of CO₂, and much of that fuel could be saved. Most trucks could be built and operated more efficiently with proven, existing techniques. The trouble is there are thousands of trucking fleets and they are uncertain about which fuel-saving technologies and business models are best. That’s why we work with an organization that RMI spun off many years ago, The North American Council for Freight Efficiency (NACFE), to intervene directly in the trucking industry.

With NACFE, we’re helping technology providers, trucking companies, and manufacturers make business decisions that save fuel and money. We publish an ongoing series of Confidence Reports that provide industry stakeholders with trusted information that increases confidence and successful investments in proven technologies. NACFE and RMI have completed 16 such reports covering nearly 85 technologies, and we spread trusted information through annual fleet fuel studies and online platforms.

NACFE and RMI also demonstrated the best ways to save fuel in a first-of-its-kind cross-

country trucking roadshow called Run on Less. Over 17 days last year, seven tractor-trailers, loaded with their normal freight, converged on a trucking industry conference in Atlanta hauling loads from as far away as California and North Dakota and averaging 10.1 mpg, compared with a national average of 6.4 mpg for tractor-trailers. Fuel savings like that mean a lot to trucking industry folks, and Run on Less showed that they are achievable in real-world conditions, not just on a test track.

DISPLACING FOSSIL FUELS WITH RENEWABLE ENERGY

Since 2009, the prices of wind power, solar power, and battery energy storage have all fallen by between 66 and 86 percent. Now, buying those resources new is more economical than just operating existing coal and nuclear power plants. Yet due to inertia, complexity, and risk avoidance, consumers of electricity are slow to change over. Electricity markets are the greatest opportunity to decarbonize the global energy system, and RMI is acting in them through several market participants.

The Business Renewables Center

US corporations are some of the biggest customers of electricity; however, five years ago, only seven of them had ever procured renewable energy in large-scale, off-site deals. Corporations were mostly adding solar panels on their own roofs. Market barriers like deal complexity and risk were hindering corporations from buying wind and solar power at large scale. To help them, RMI founded the Business Renewables Center

(BRC) with 28 companies, including renewable energy dealmakers and large corporate clients including General Motors, Kaiser Permanente, and Owens Corning. The BRC and its members share hard-earned knowledge about how to

“Industry and business are the keys to transforming the global energy system, because when markets lead, change happens at massive scale.”

approach and operate in the renewables market, including standardized contracts and market intelligence. As a result, the market has taken off. Now the BRC has 230 members that have completed more than 12 gigawatts of renewable energy deals, which constitutes 96 percent of all large-scale renewable energy deals in North America not done by an electric utility. That massive corporate energy purchase further shifts grid supply from coal and gas plants to renewable power.

As part of RMI's support for China's efforts to transition to an economy powered by clean energy, we took the BRC to China in 2017. RMI's BRC China team is partnering with corporate buyers to make it easier to procure renewable power there. Through in-depth research and relationships with buyers, generators, and the government in China, our team is identifying emerging opportunities and helping buyers find innovative ways to make use of recent power-market reforms.



RMI director Richard Ward (foreground) and team working in the field on capturing methane emissions.

Black Bear Energy

Not every company is a behemoth with utility-scale energy demand. For those with less demand, putting solar panels on their own facilities is a financially attractive and environmentally friendly strategy, as are battery energy storage and other elements of renewable procurement. However, the transactional complexity often lies far outside the expertise of a traditional real estate owner or corporate entity. To catalyze the market for meeting their needs, RMI seeded Black Bear Energy in 2015 to act as a buyer's representative for large property owners and occupiers in their procurement of renewable energy and clean technology. Black Bear Energy is a for-profit company that helps clients deploy solar power and energy storage projects to their specifications at the most competitive terms in the market. Black Bear's clients own, manage, or control more than 3 billion square feet of real estate, and counting.

Shine

The price of solar power may be dropping fast, but there is a sweet spot in the market where it can drop even faster: community-scale solar. At this scale—between 0.5 and 5 megawatts—solar generation benefits from economies of scale without requiring infrastructure to interconnect with the electric grid the way a vast solar farm does. In order to take full advantage of this opportunity, RMI created the Shine™ program to act as a buyer's representative and to move

the market toward standardized, modular solar technology that will cut project costs further and speed solar adoption. Community-scale solar is the fastest-growing solar segment and may be the right solution for customers as varied as multifamily dwellings, commercial, municipal, and industrial properties, electric co-ops, municipal utilities, and universities. Late last year, a Shine-supported development in New Mexico reported the lowest ever US price for community-scale solar power delivered to the electric grid: less than 4.5 cents per kilowatt-hour.

WattTime

Wind and solar power are putting more energy on the grid than ever before, but how much clean power is *really* displacing dirty power and saving the most carbon? Wouldn't it be great if clean energy were generated where it takes the place of the dirtiest energy? Thanks to RMI's WattTime subsidiary, customers have the power to choose higher-impact clean energy.

WattTime is the brainchild of researchers from the University of California, Berkeley who perfected the analysis of the exact emissions that power a grid at a specific time and place. They came to RMI to help bring their solutions to the mass market, and RMI incorporated WattTime as a nonprofit subsidiary in 2017. It is analyzing planned renewable energy projects to find what location will deliver the greatest environmental benefit for the same investment. Because of the

We're catalyzing solar markets for users of all sizes, including utilities, communities, and corporations and developers.



variety of power sources on different regional electric grids, WattTime has shown that some North American solar projects displace as much as three times as much CO₂ as similar projects in other locations. Developers and buyers of renewable energy projects want to maximize environmental benefits, and WattTime is showing them how they can both do that, and prove it.

WattTime's automated emissions reduction technology is also helping customers large and small to choose clean energy—and can be embedded in any energy-using, internet-connected device, like a smart thermostat or water heater. The software automatically tracks the actual emissions impacts associated with electricity use—both in real time and with ahead-of-time predictions—enabling these devices to draw power from the grid when electricity is the cleanest. RMI and WattTime aim to make the technology ubiquitous so that the entire appliance market is optimized for the cleanest possible operating times.

Energy Web Foundation

When it comes to complexity serving as a barrier to the wide adoption of a technology, blockchain takes the cake. Most of us are uneasily aware that blockchains are what underlie digital currencies like Bitcoin, but would rather not get any deeper into it. And yet blockchain technology has the potential to revolutionize the energy sector by massively integrating distributed energy resources into the electric system. That's why RMI joined with Grid Singularity, an energy-focused blockchain developer, to found the Energy Web Foundation (EWF).

Blockchains are decentralized networks that securely run computations and record digital transactions without a central clearinghouse, allowing millions of assets to change hands and transactions to take place with unprecedented speed and security. And that is just what is needed to allow millions of energy devices—like HVAC systems, water heaters, electric vehicles, batteries, and the solar panels on your house—to provide services to each other, to utilities, and to the electric grid, and get paid for it. If utilities or grid operators had to keep track of every solar panel and every electric vehicle battery, the cost and trouble would be prohibitive. But with blockchains like EWF's, all those resources can work together to provide services that, until now, only a billion-dollar substation or power plant

could provide. EWF is working with affiliated companies to demonstrate applications like streamlined utility billing and smart tracking of renewable energy certification, as well as the management of energy service transactions.

“Electricity markets are the greatest opportunity to decarbonize the global energy system, and RMI is acting in them through several market participants.”

TAKING CARBON BACK

The Good Traveler

RMI focuses on using energy more cleanly to avoid releasing more carbon into the atmosphere, but we also get involved when clean energy isn't yet an option. That's why RMI administers The Good Traveler, a unique nonprofit collaboration with airports that helps organizations and individuals reduce the unavoidable carbon footprint of their travel.

The goal of The Good Traveler is to catalyze aviation-sector carbon reduction efforts such as aggregating funding for new sustainable aviation fuel while mitigating the immediate climate impact of a rapidly growing industry. Until additional sustainable aviation fuel supply becomes available, The Good Traveler program counteracts emissions through a diverse portfolio of carbon-offset projects that keep carbon out of the atmosphere. These projects include planting forests, building new wind and solar farms, and implementing energy efficiency technologies for heavy-duty transport.

You can offset your own carbon footprint through The Good Traveler the next time you fly. It's a good deal: \$2 offsets the carbon released by a 1,000-mile flight, about the distance from Dallas to Detroit. And if you participate, you'll be directly intervening in the markets while helping transform global energy use to create a clean, prosperous, and secure low-carbon future. The vast reach and power of markets are what will ultimately change the world in time to save our climate. At RMI, we're doing our best to expedite those transformations. We encourage you to join us in accelerating the clean energy revolution. 🌱

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

+ WEB EXTRA

For more information on this topic, visit rmi.org/our-work/

HOW YOU CAN TRANSFORM YOUR ENERGY USE

The energy revolution is something we can all be a part of, as RMI staff show

By Laurie Guevara-Stone





At Rocky Mountain Institute, we work hard to create a clean, prosperous, and secure low-carbon future. Many of the projects we work on involve entire countries (e.g., Reinventing Fire: China), entire industries (e.g., shipping and trucking), and very large energy consumers (e.g., corporations like Walmart and General Motors through our Business Renewables Center, and commercial building portfolio owners through our Portfolio Energy Optimization initiative). But many of the things we work on can be done by you, in your own home and everyday life, to save energy, money, and carbon emissions.

There are some things that can be done simply with little to no cost. And other things may have a higher up-front cost, but pay off in the long run. Here are some meaningful ways that you can join the energy revolution in your own life.

BE FLEXIBLE WITH YOUR DEMAND

Find out when demand for electricity from your local utility is at its peak, and make sure to run your appliances at off-peak hours. By shifting your demand, you can help utilities avoid using fossil fuel-powered “peaking” plants, which fire up only when demand is at its highest. Some utilities offer a time-of-use plan, selling cheaper electricity during off-peak hours. But even without such a plan, you can easily save energy by running your dishwasher, washing machine, and other appliances during off-peak times. RMI’s research has shown that demand flexibility can unlock \$13 billion per year of avoided investments in the electric grid and 10 to 40 percent savings on customer bills.

“An energy retrofit of your home can be as easy as switching out your compact fluorescent bulbs for LEDs, installing smart thermostats, or upgrading to more efficient appliances.”

You can also invest in smart appliances that are enabled with technology from RMI’s subsidiary, WattTime. WattTime technology automatically syncs the times your appliances use power to

moments when your local grid is supplying clean energy, so that you can choose to lower your carbon emissions without impacting costs or comfort. WattTime's software is now in select smart thermostats, electric vehicle chargers, HVAC systems, and more. Enabling water heaters and air conditioners to adjust their timing just slightly could reduce carbon emissions in the United States by over 6 million tons per year—the equivalent of taking 1 million cars off the road.

“Getting rid of a vehicle can save the average US family over \$5,000 per year while greatly reducing CO₂ emissions.”

“Using internet-enabled devices equipped with WattTime software could help you reduce your carbon footprint substantially with little or no effort,” says Jamie Mandel, a principal in RMI's Disruptive Technologies initiative. “Demand flexibility is a huge opportunity both for the grid and for you as a consumer. And it's getting easier as, increasingly, your devices can automatically use electricity at off-peak times.”

PURCHASE CARBON OFFSETS

If you take a round-trip flight from New York to California in the summer, you can generate 0.9 tons of carbon. A simple and low-cost way to lower the carbon footprint of your air travel is to purchase carbon offsets. For example, through The Good Traveler program, your purchase of carbon offsets can support tree planting at the Arcata Community Forest in Northern California—which

captures atmospheric carbon—or wind power at the Big Smile Wind Farm at Dempsey Ridge—which displaces carbon-emitting power plants—among other carbon-reduction programs. With the number of air passengers expected to double by 2035, the need for carbon reduction will grow. “By purchasing carbon offsets, people can support climate action with very little effort,” says Adam Klauber, director of RMI's Sustainable Aviation program, which oversees The Good Traveler. “RMI is also working to integrate sustainable jet fuel, which will be a game-changer for decarbonizing the fast-growing aviation industry.”

WEATHERIZE YOUR HOME

Weatherizing your home may seem like a huge undertaking. But it can be as simple as caulking your windows and adding window film. If you want to go a bit further, invest in an energy audit and/or blower door test. Many utility companies offer rebates for these undertakings. Once you find out where your home is leaking, add insulation to those areas, especially in attics, walls, and underinsulated cavities. “After I upgraded the insulation in my attic and encapsulated, sealed, and insulated my crawl space, my house used less energy and became much more comfortable,” says Ellen Franconi, a manager in RMI's buildings practice.

RETROFIT YOUR HOME

An energy retrofit of your home can be as easy as switching out your compact fluorescent bulbs for LEDs, installing smart thermostats, or upgrading to more efficient appliances. You could even go further than the low-hanging fruit and implement a deep energy retrofit, cutting your energy use by as much as 90 percent. This could entail upgrading your heating and cooling systems for higher efficiency (and greater safety), insulating your hot water pipes and replacing your water heater with a high-efficiency heater, and increasing natural daylighting.

Existing US homes account for 20 percent of the country's primary energy consumption, and every step you take to retrofit your home is better for your health, your pocketbook, and the planet. “We're working to make it easier and more cost-effective for people to have better homes,” says Jacob Corvidae, a manager in RMI's Residential Energy+ initiative. “We want our lives to be

Weatherizing your home can be as simple as caulking your windows.





healthy, comfortable, and financially strong, and to contribute to the greater good. It's time to take those ambitions and bring them home."

GET RID OF YOUR CAR

Most of our personal cars in the United States sit unused 95 percent of the time. It's getting easier to move past the individual car ownership paradigm every day. RMI believes that a recent convergence of societal trends and technological advances will lead to electric, autonomous Mobility as a Service, which has the potential to break our dependence on personally owned vehicles. Jerry Weiland, managing director in RMI's Mobility Transformation program, believes this mobility future means fewer cars will be needed to move greater numbers of people more efficiently with lower cost and less climate impact. "We're going to have an opportunity to share cars," says Weiland, "and this mobility-on-demand paradigm will make it easy and cost-effective for people to have alternatives to owning and driving their own cars alone."

Getting rid of a vehicle can save the average US family over \$5,000 per year while greatly reducing CO₂ emissions. Plus, when you get rid of your car, new real estate opens up in your home—your garage. Start a rock band, build a gym, set up an art studio—the possibilities are endless. Repurposing your garage to additional living space is a sound investment, as the value of the

average garage's 570 ft² of added living space is approximately \$70,000 per home—using the 2016 national average for single-family home sales of about \$123/ft².

RMI's Mobility Transformation program is currently working with the City of Austin, Texas, to help it become the nexus of "new mobility," including mobility on demand, and to create a scalable model for other cities both nationally and globally.

INVEST IN AN ELECTRIC VEHICLE

Not up for completely getting rid of your car? Then invest in an electric vehicle (EV). Most US drivers drive less than 40 miles per day, easily within the range of most EVs. And newer EVs can go over 200 miles on a charge. Charging an EV is cheaper than filling up your vehicle's gas tank, and EVs need no oil changes, spark plug replacements, or several other kinds of costly maintenance. They also don't have any tailpipe emissions and, as more cities,



A home solar photovoltaic system is a great way to reduce your use of fossil fuels.

Getting rid of your car means you have room to start a rock band in your garage.



Even your family pet would enjoy a modern electric vehicle, which can go over 200 miles on a single charge.

communities, and homes supply electricity from renewable sources, EVs get even cleaner.

INVEST IN A SOLAR POWER SYSTEM

Producing your electricity with solar photovoltaic panels is a great way to reduce your use of fossil fuels. And these days there's a plethora of ways to get your electricity from the sun. If you have room at your home for solar panels, you can purchase a solar photovoltaic (PV) system outright, you can lease a PV system, or you can even sign up for a power purchase agreement in which you don't actually pay for the system, but just for the energy it produces.

If you have no space at your house or if you rent, you can still join in the solar revolution. You can subscribe to a community solar array—a solar PV plant near your home that is shared by multiple households. “Community-scale solar is rapidly proving to be the most affordable form of electricity available directly to customers, with guaranteed savings in some markets,” says Joseph Goodman, a principal in RMI's Shine™ initiative. “For example, some of the utilities we're working with in Texas can share the economic savings from community-scale solar with low-income households in their constituencies.”

ADD BATTERIES TO YOUR PV SYSTEM

Want to take it one step further? Invest in storage

as well. As battery costs continue to fall and utilities implement time-of-use or demand-charge rate structures that reward shifting the times you use energy, solar-plus-storage systems are becoming economically optimal in some parts of the country. Plus, they can offer other important benefits, such as backup power in the event of a blackout.

RMI's report *The Economics of Battery Energy Storage* details 13 services that batteries can provide, including allowing utilities to avoid investments in new natural gas plants to meet peak demand and reducing customer's energy bills. “In a growing number of markets in the United States and abroad, investing in solar-plus-storage can improve project economics compared with a stand-alone solar system, while also providing backup power to critical electric loads in the event of broader grid disruption,” says Jesse Morris, a principal in RMI's electricity practice.

SMALL STEPS MAKE BIG IMPACTS

As RMI continues to work with cities, states, governments, utilities, corporations, and more to transform global energy use, we can all do our part. Saving energy in our homes and our everyday lives—while it may seem small—can have a big impact on the world. What we do at RMI can be taken down to an individual level, helping people to take their own steps to save money, energy, and carbon. 🌱

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

⊕ WEB EXTRA

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RMI STAFF WHO WALK (OR RIDE!) THEIR TALK

Some RMI staff don't just work on resource efficiency at the office, they practice what they preach. Below we list a few ways that RMI team members save energy.

Every Tuesday morning, **THOMAS KOCH BLANK** (below, pedaling with Brad Mushovic) offers to pick up a colleague on his tandem bicycle, helping to cut down on vehicle miles traveled for commuting to the office.

VICTOR OLGAY has a green roof on his passive-solar superinsulated solar-powered house. Victor and his wife planted native grasses and sedum plants on the roof, creating another 600 ft² of habitat for birds, squirrels, and butterflies.

In 2016, **ELLEN FRANCONI** retrofitted her house, built in 1999, with all LED lighting, ENERGY STAR[®] appliances, an induction stove, a solar thermal system, and upgraded insulation, including R-50 Rockwool insulation in the attic.

PAOLO NATALI and his wife live in a 350 ft² home that contains everything they own.

ADAM KLAUBER installed a recirculation pump for instant hot water in the bathroom farthest from his basement water heater, saving thousands of gallons water per year and eliminating the wait for the shower to warm up.

CINDIE BAKER reinsulated and sealed her mountain home's overhangs, which not only reduced heating costs but also eliminated mice incursions and made her home quieter inside.

STEPHEN DOIG and family live in a totally off-grid solar-powered house in New Hampshire, and use any excess electricity that they produce to heat water that they store.



LAURIE GUEVARA-STONE built a solar oven into the south wall of her passive-solar PV-powered strawbale home, which she uses to cook and bake without using any fuel while keeping the heat out of the kitchen.

GREG RUCKS lives in a tent year-round (in the Colorado Rockies)—no heating or cooling energy used, not to mention no mortgage payments.

While **MOST RMI EMPLOYEES** choose to take public transit to work, at least 24 actually own no car, so they and their families rely on carshare, bikeshare, and public transit. Of the at least 12 RMI employees who own electric vehicles, seven charge their EVs from their home solar photovoltaic systems.



PHOTOS: left, iStock.com; right, Romy Purshouse; above right, Natasha Brand

BIG IDEAS, BIG OUTCOMES

An engineer takes her insights into data for sustainability to RMI and beyond

By Samhita Shiledar

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W e humans have been quite successful in our quest to uncover the hidden treasures of nature and improve quality of life. Our endeavors to increase the standard of living by keeping pace with the burgeoning demands of a population of 7 billion have moved us, in the words of Nobel prize-winning chemist Paul Crutzen, into the Anthropocene epoch in which humans have a drastic effect on the Earth. However, my career, both at Rocky Mountain Institute and elsewhere, has shown the potential for technology to revolutionize our efforts to reestablish environmental sustainability and reduce the disastrous effects of the Anthropocene.



I grew up in India and moved to the United States a couple of years ago. Along with the cultural and lifestyle differences between these countries, I observed the impacts of climate change in both countries, giving rise to social, ecological, and health issues on various scales. Realizing the importance of a green economy for sustainable development to ensure the balance between highly efficient innovations and low environmental risks, I felt a strong need to study effective, inclusive, and sustainable development models. Thus, I decided to pursue a master's degree in environmental sciences along with chemical engineering from the University of Michigan.

BIG DATA FOR SMALL FARMERS

Since I was a kid, I have been reading the heartbreaking stories of more than 300,000 suicides among farmers in India, which have been headlining the newspapers for two decades. The main reason behind these suicides was indebtedness due to farmland made barren by excessive fertilizer usage, lack of water reservoirs, and lack of access to advanced technologies. In order to contribute toward solving this issue, I, along with a few friends at the University of Michigan, started working on sustainable agriculture models as a part of our class projects and eventually cofounded our start-up: Cheruvu—Big Data for Small Farmers.

Imagine being a farmer who owns less than three acres of land. You have never conducted a soil test, you don't know what tomorrow's weather will look like, and your fertilizer use is simply based on your intuition. Sounds more like gambling than farming, doesn't it? Yet 97 percent of the 263 million farmers in India currently work exactly this way, leading to incredible economic risk, putting families in peril. Indian farmers are not following scientifically proven farming practices and are in dire need of information and technological improvements to make agriculture a sustainable endeavor.

Cheruvu addresses these inefficiencies in the current agricultural system by providing farmers with precise, localized recommendations for their farms. Using big data solutions and machine learning, we are innovating models to increase profitability and reduce risks by tracking and integrating key variables such as weather, soil nutrients, farming practices, and satellite

imagery. We provide farm-specific nutrient management guidance sheets to farmers, using local languages and farmer-friendly units, that walk a farmer through all the agricultural

“My career, both at RMI and elsewhere, has shown the potential for data to revolutionize our efforts to reestablish environmental sustainability and reduce the disastrous effects of the Anthropocene.”

processes of an entire crop cycle. Our vision is to improve the economic, environmental, and social sustainability of farmers in India and, eventually, in other developing countries. Just the simple process of fertilizer optimization can increase yields by 33 to 66 percent in the region without increasing the financial burden on farmers.

Our social enterprise model is a hybrid of local community workforce empowerment and data-driven decision support, engaging rural women as field managers to provide a service that directly impacts small-farmer productivity and household social well-being. Our work is being recognized by the government of India and other private players in India, as well as globally. We are looking forward to exciting partnership opportunities with some of those who have recognized us. We recently won the People's Choice award from *National Geographic's* CHASING GENIUS challenge, wherein one project idea was selected among thousands of applications received from 60 countries concerning issues of global health, world hunger, and environmental sustainability.

We are currently working with around 4,000 farmers in 54 villages in India and aim to reach 15,000 by this growing season. Collecting geographically and temporally diverse data from these farmers will help us build robust machine-learning algorithms to eventually inform better farming practices through crowd learning.

DATA SOLUTIONS FOR A MORE EFFICIENT MOBILITY SYSTEM

Data in the field of environmental sustainability has a wide spectrum of applications. Big data

Samhita Shiledar is an associate in the India mobility program and Office of the Chief Scientist at Rocky Mountain Institute.

has been heralded as “the next frontier for innovation, competition, and productivity” by the McKinsey Global Institute and has swept into multiple components of operations in virtually every business.

“The opportunity exists now to leapfrog the traditional mobility paradigm, avoiding the ‘lock-in’ effects of a system defined by high costs, heavy pollution, and inefficiency.”

At RMI, our India mobility team is exploring the role of data in creating a more efficient mobility system enabled by sharing. Today, many Western nations are grappling with the effects of mobility systems dominated by privately owned internal-combustion-engine vehicles and cities designed for cars, not people. Symptoms of the Western mobility model are already starting to manifest and could potentially worsen in India, even with a relatively low number of vehicles per capita—in India there are only 18 vehicles for every 1,000 people, while in the US there are about 800. As India continues to develop at a rapid pace, a catalyst is needed to create and invest in a shared, electric, and connected future in which mobility is accessible, safe, affordable, and clean. By sharing

vehicles (the way users of rideshare companies like Uber and Lyft do) fewer vehicles overall are needed. By making the vehicles electric, mobility can rely on clean renewables as they increasingly supply the grid. And by connecting all modes of transport and every segment of the mobility system, the whole system can run more efficiently, affordably, and reliably.

The opportunity exists now to leapfrog the traditional mobility paradigm, avoiding the “lock-in” effects of a system defined by high costs, heavy pollution, and inefficiency. Data ubiquity and connectivity—elements of big data—are key components in realizing a shared and clean mobility system. Interoperable transit data can connect infrastructure, businesses, and users to expand the transportation market. This leads to higher asset utilization rates and load factors across vehicle segments like trains, buses, and cars, potentially alleviating costly traffic, local air pollution, and global climate change. India is off to a great start—the government has already set ambitious goals to deploy 6 million to 7 million electric vehicles by 2020 and 175 gigawatts of renewable energy by 2022, efforts that RMI is supporting and I am proud to be working on.

Crutzen said that the “human butchering” of nature started with the Anthropocene; at RMI, we are creating a clean, prosperous, and secure low-carbon energy future to reverse it! 🌱

Team Cheruvu
(left to right):

Shamitha Keerthi,
Adithya Dahagama,
Kavya Vayyasi,
Aniket Deshmukh,
Samhita Shiledar,
and John Monnat



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Help spread the clean energy revolution. Join one of our giving circles and encourage your friends to become part of the solution!

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About Rocky Mountain Institute

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

