

Tesla's Powerwall Battery and the Rise of Solar-Plus-Storage Systems

New York State Reaches Major Electricity Grid Milestone

How to Save \$1 Trillion and 2 Billion Barrels of Oil Per Year



Solutions

Journal

SUMMER 2015
VOL. 8 NO. 1



FURTHER FASTER TOGETHER

RMI and Carbon War Room Merge

SUMMER 2015 /

VOL. 8 NO. 1

18 FEATURE

IS PEAK ELECTRICITY PRICE COMING?
Tesla's Powerwall battery and the rise of cost-effective, grid-connected solar-plus-battery systems.



24 FEATURE

GOING FURTHER FASTER TOGETHER
Rocky Mountain Institute and Carbon War Room merge to speed the energy revolution.



30 FEATURE

THE CUSTOMER-CENTRIC ELECTRICITY GRID
New York State reaches a major milestone en route to the nation's first market platform for customer-sited clean-energy technologies.



36 FEATURE

MAKING WAVES IN THE SHIPPING INDUSTRY
Carbon War Room's Shipping Efficiency operation brings data transparency, capital, and demand for fuel-efficient ships to the high seas.



COLUMNS & DEPARTMENTS

04 CEO LETTER
ACCELERATING THE CLEAN ENERGY REVOLUTION

12 MY RMI
VENTURE CAPITALIST GARY RIESCHEL ON CHINA

06 AMORY'S ANGLE
THE OIL PRICE ROLLER COASTER

14 QUESTION & ANSWER
ASPEN SKIING COMPANY'S AUDEN SCHENDLER ON CORPORATE SOCIAL RESPONSIBILITY

11 RMI IN BRIEF
NEWS FROM AROUND THE INSTITUTE

16 INNOVATION BEACON
FINDING THE THERMAL COMFORT ZONE

42 WALK THE WALK
HAVE SPREADSHEET, WILL TRAVEL

44 TRANSPORTATION 2.0
MEET THE NEW MOBILITY

47 BY THE NUMBERS
THE FUTURE OF PERSONAL MOBILITY

IMAGES: Cover illustration copyright Rocky Mountain Institute, by Andy Potts. Solar panels image courtesy of SolarCity. Lovins and Branson composite image copyright Rocky Mountain Institute. New York City image copyright Thinkstock / Vilches. Container ship image copyright Thinkstock.

Our Printing and Paper

This issue of *Solutions Journal* is printed on elemental chlorine-free paper. Specifically, it is #2 FSC-certified CPC Matte Book and FSC-certified CPC Matter Cover, Sappi Papers in Minnesota, sourced from SFI-certified pulp. Using certified paper products promotes environmentally appropriate and economically viable management of the world's forests.

Staff

Editorial Director – Peter Bronski Art Director – Romy Purshouse
Writer/Editor – Laurie Guevara-Stone Designer – Chris Rowe
Writer/Editor – David Labrador

by Jules Kortenhorst



Accelerating the Clean Energy Revolution

Rooftop solar combined with batteries will be cost effective for millions of customers in the years just ahead.



The global transformation of energy use continues, and there are recent encouraging signs that it's as strong as ever. We've seen progress on the fronts of rooftop solar, electric vehicles, and energy efficiency, including—most excitedly—their integration.

For example, in early April SolarCity and Nest announced a partnership to make their technologies jointly available to customers in California, opening possibilities to better integrate rooftop solar's electricity production with a home's thermostat and air conditioning. At the Bloomberg New Energy Finance (BNEF) Future of Energy summit in New York City in mid-April, analysts shared the latest data showing that in 2013 for the first time renewable electricity beat fossil fuels for new capacity additions globally. And earlier this year, the International Energy Agency announced that for the first time in 40 years energy-related CO₂ emissions were stable even as the global economy grew.

For sure our job is far from done. Much remains to do with dwindling time to do it. But these milestones demonstrate that the revolution is gaining momentum.

In this issue of *Solutions Journal*, you'll read many other exciting stories about how we're transforming global energy use to create a clean, prosperous, and

secure future. In our main feature, we discuss Rocky Mountain Institute's strategic merger with Carbon War Room (CWR), a complementary nonprofit that similarly seeks gigaton-scale carbon emissions reductions through profitable market-based solutions. Publicly announced in December 2014, these first months of 2015 have seen several examples of RMI and CWR going further, faster, together—in the Caribbean with the Ten Island Challenge to transition island-nations from fossil-fuel dependence to efficiency and renewables (read about our recently announced partnership with the Clinton Climate Initiative), in the next stage of the Shipping Efficiency operation to reduce the carbon intensity and improve the fuel efficiency of the world's shipping fleet, and with the Business Renewables Center to accelerate renewable energy purchasing among Fortune 500 companies.

You'll also read how RMI is at the heart of the electricity system's evolution, coming at the challenges and opportunities from both sides of the equation: as a strategic advisor to New York's Reforming the Energy Vision regulatory proceeding, which reached a major milestone earlier this year, and with our recently released report *The Economics of Load Defection*, about how grid-connected solar-plus-battery systems could supply a majority of customers' electricity within the next 10–15 years.

For the second year in a row, RMI is also proud to be part of a BNEF FiRe award at the Finance for Resilience event in April. Last year our Business Renewables Center won. This year, beEdison—powered by the truSolar platform co-developed by RMI to create a FICO-like risk score for commercial solar projects—won. We're equally excited about the launch of our new mobility program, with an opportunity for the U.S. to save \$1 trillion and 2 billion



Corporations and other institutional buyers accounted for nearly one-quarter of new installed wind capacity in the U.S. in 2014.

barrels of oil per year. And speaking of oil, our esteemed chief scientist Amory Lovins weighs in on the causes and effects of oil's recent price drop.

Finally, on the home front, construction on RMI's Innovation Center in Basalt, Colorado, continues, with occupancy anticipated for late this year. In this issue, we take a look at the cutting-edge ways we're addressing the thermal comfort of staff and visitors, a key component of making the building one of the single most energy-efficient buildings of its size in its climate zone anywhere.

These and other stories within these pages are more signs than ever that a clean, prosperous, and secure energy future is within grasp. But will we seize it within enough time, before the worst effects of climate change take hold? Will businesses around the world grasp this enormous economic opportunity to lead the transition? And will customers and society fully grasp

the vast range of economic, equity, security, and environmental co-benefits?

Looking ahead to the 21st United Nations conference on climate change in Paris this upcoming December, there's hope that the joint U.S.-China greenhouse gas emissions announcement of late 2014 paved the way for real international agreements. In the meantime, RMI and CWR's market-based solutions forge ahead, driving an energy transformation and gigaton-scale carbon emissions reductions that—with our diverse industry and philanthropic partners—are changing the world.

You are one of those partners. As our fiscal year draws to a close at the end of June, you are as integral to the energy revolution as ever. Thank you for your support. ☀

Jules Kortenhorst

BE PART OF THE SOLUTION

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

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

WWW.RMI.ORG/DONATE

IMAGES: Kortenhorst image copyright Rocky Mountain Institute. Rooftop solar image copyright Thinkstock/hansenn. Wind turbines image copyright Thinkstock/kojihirano.



by Amory Lovins

The Oil Price Roller Coaster

Why do oil prices go down? Because they went up. Why do oil prices go up? Because they went down. That's what they do. To avoid oil-price volatility, you must kick the oil habit.

You can do this by switching to efficiency and renewables. You'll get cheaper energy services at steady prices; free price insurance; and lower risks to climate, health, environment, global development and security, and America's independence and reputation.

In contrast, the oil for which the U.S. pays \$1 billion a day—and paid \$2 billion a day until mid-2014, when \$100+ per-barrel prices halved—comes with price risk and far bigger hidden costs that at least triple the real societal cost to upwards of \$4 billion a day.

So why, after four relatively placid years, did the world oil price tumble starting in mid-2014, and what's next?

WHY OIL PRICES FLUCTUATE

People burn 1.3 cubic miles of oil a year, or 93 million barrels a day (each barrel equal to 42 U.S. gallons or 159 liters). Scott Pugh, energy advisor to the Department of Homeland Security, visualizes those barrels, each 20 inches in diameter, laid end-to-end and joined to form a pipeline. It'd stretch 1.8 times around the earth. To traverse that pipeline in 24 hours, the oil must flow at 1,835 miles per hour—2.44 times the speed of sound.

Crude oil's price fluctuates at more like the speed of light, varying with global, regional, local, and firm-specific market conditions.



With cheaper per-barrel oil prices and global oversupply, high-cost producers are being severely tested.



Oil's place in the global energy mix is transforming, including in mobility, which uses three-fifths of world oil.

Despite many complexities, some broad observations are usually valid.

Oil prices tend to rise with instability in major exporters—Persian Gulf, Nigeria, Venezuela, Russia—though diversified supplies, suppliers, and delivery routes have made markets more placid. Strong economic growth also tends to raise prices—until they get high enough to dampen or reverse the economic growth. Conversely, oil prices fall when major exporters do what John D. Rockefeller used to do regularly: “sweat the market” with oversupply to bankrupt high-cost producers and thus raise one's own monopoly rents.

CAUSES OF THE CURRENT PRICE DROP

Instability and surplus are both occurring today, but surplus is proving more important. The world market is glutted with several million extra barrels per day (Mbb/d), mainly from fracked U.S. oil and Canadian tar sands. The U.S. is now the world's largest oil producer, with output at a 31-year high.

Late last year, the Saudis and allies announced they wouldn't cut output to rebalance the market as they had in the past. Why should they? They'd simply give up market share to higher-cost producers.

“To avoid oil-price volatility, you must kick the oil habit. Yet we still burn 93 million barrels each day.”

And the Saudis didn't cause the imbalance; North Americans and other non-OPEC members did.

Until recently, only the Saudis (and to a lesser extent their Gulf allies) had big surplus production capacity, and at the world's lowest cost. Saudi oil costs about one-tenth as much to extract as fracked U.S. oil or Alberta tar sands need to break even. Now an added reality is roiling markets: only the Saudis have enough *cash* to weather a prolonged price drop. While Iran, Iraq, Venezuela, Russia, and Nigeria are financially stressed, the Saudis claim 2.5 Mbb/d spare oil capacity and \$0.7–0.9 trillion of monetary reserves—enough to sustain several years of \$50 oil and keep funding their \$40-billion renewable-power program (meant to save oil for export).

Against that backdrop, competitors are fish in a barrel. The biggest oil companies' capital expenditures quintupled since 2000 but their production barely budged. That's a seriously diminishing return per barrel at any price, let alone lower prices that undermine profitability. When oil prices suddenly fell

nearly 60 percent in seven months, firms frantically cut costs and axed massive Arctic, deepwater, and other high-cost projects. In what analysts Wood Mackenzie call “the biggest threat to oil and gas industry earnings and financial solidity since the financial crash of 2008,” investments may fall by \$200+ billion this year.

Tar-sand and fracking operators will be severely tested: frackers in the oil-rich Bakken are producing a gusher of red ink despite falling service costs and continuing technological improvement. Even those

North American operators who survive the downturn may lose skittish investors to safer pursuits—such as renewable power, whose lower risks now attract capital several percentage points cheaper than utilities get. It was, after all, the former Saudi oil minister, Sheikh Ahmed Zaki Yamani, who famously said, “The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.”

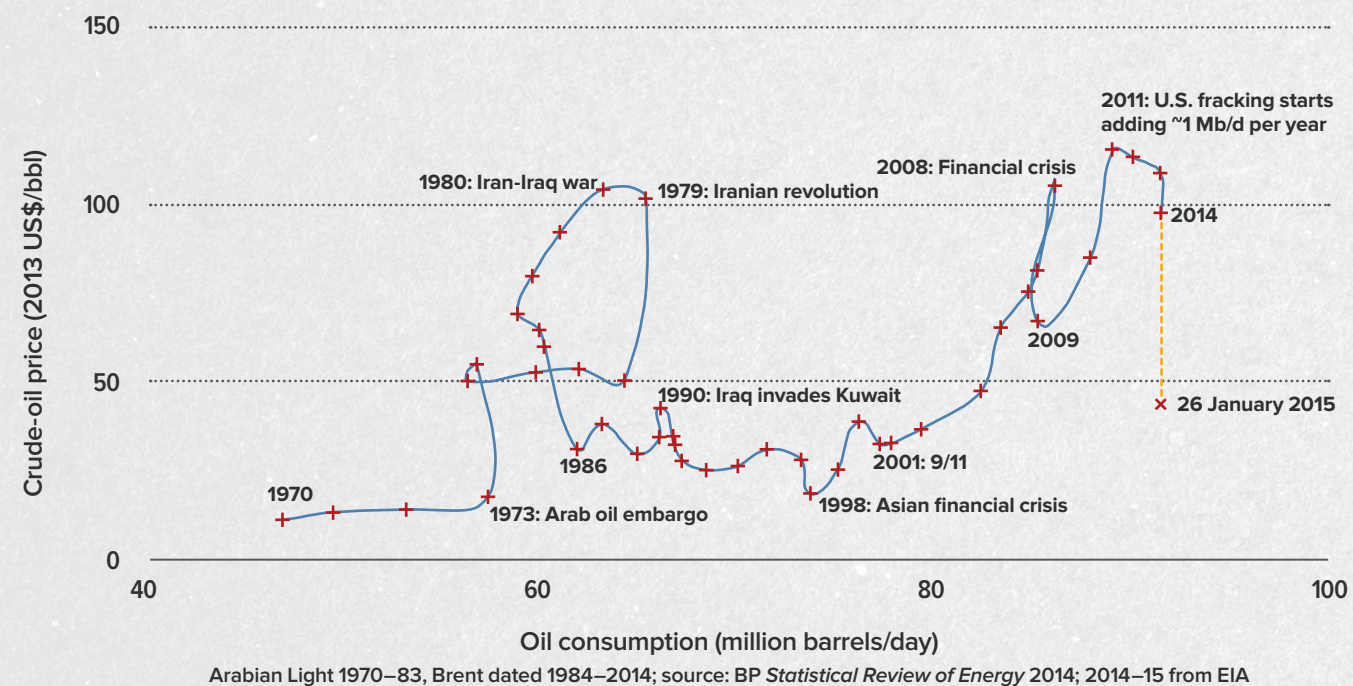
THE DEMAND SIDE STRIKES AGAIN

All this talk of oversupply is lopsided, though, because it leaves out half the supply/demand balance. The tepid global economy, with deflationary pressures in Europe and Japan, slowing growth in China, political gridlock in the U.S., and the gloom of uncertainty everywhere, continues to weigh on oil demand. But so, very importantly, does the invisible “fifth fuel”—energy efficiency, which the International Energy Agency recently found is even bigger than any other fuel.

Rich countries' oil use peaked in 2005. Developing countries' oil demand is

IMAGES: Lovins image copyright Rocky Mountain Institute; Oil rig workers image copyright Thinkstock / Shutterstock; Offshore oil rig image copyright Thinkstock / curraheeshutter.

World oil consumption vs. real crude-oil price, 1970–2014



moderating. Start with mobility, which uses three-fifths of world oil. Strong auto efficiency standards already widely adopted (including China and India) will keep gasoline demand subdued or even shrinking, despite sharply lower fuel prices.

U.S. driving has been falling since 2007 and hasn't rebounded with nearly halved gasoline prices. Bloomberg New Energy Finance (BNEF) notes that in the past 10 years, Americans' driving fell 10 percent below trend, while in the past 13, their vehicles got 29 percent more efficient. Result: innumerable negabarrels.

Thus, what's normally described as an oil supply surplus is at least equally a shortfall in forecast demand. Suppliers invested to meet demand that's not there. The resulting oversupply pushes prices down relentlessly. This deflation could

be quite persistent. As the International Energy Agency said on 16 January 2015, "It is clear that the market is undergoing a historic shift. OPEC's embrace of market forces...is a game changer... Oil's place in the global energy mix is also transforming... [T]he next few years could...prove a period of reckoning for a market and an industry that, through the course of their 150-year history, have had to periodically reinvent themselves."

In short, the oil industry pays far too little attention to demand. As my November 2014 Shell paper "Efficiency: The rest of the iceberg" explains, suppliers can run their tankers into that iceberg and sink without ever knowing what they hit, because it's not on their chart and they're hardly tracking it. The notion that countries like the United States could profitably eliminate oil use by 2050 (see RMI's *Winning the Oil Endgame*,

2004, and *Reinventing Fire*, 2011) may be novel, yet huge and lucrative oil savings aren't: they're well demonstrated but conveniently ignored.

UNDERLYING OIL-MARKET DYNAMICS

Oil prices have yo-yoed persistently since 1973. Graphing world oil use vs. price reveals multiple loop-the-loops when oil prices rose so high that efficiency, alternative supplies, and elastic consumer behavior shrank demand, crashing prices. Gradually demand regrew at lower prices until the cycle repeated. BP's CEO warns that the oil industry now faces its deepest slump since 1986, and it's a very deep slump indeed.

Meanwhile, the costly projects needed to find and exploit big new frontier oilfields often take a decade or more to build, while oil's biggest competitors—including slumping demand through efficiency gains—can emerge much faster. This was revealed in 1977–85, when the U.S. cut its oil use per dollar of GDP by 35 percent. In those eight years, GDP rose 27 percent,

oil use fell 17 percent, oil imports fell 50 percent, and imports from the Persian Gulf fell 87 percent.

The biggest U.S. contribution came when President Ford's 1975 auto standards raised new domestic cars' efficiency 7.6 miles per U.S. gallon (mpg) during 1977–85. They drove 1 percent fewer miles on 20 percent fewer gallons. The U.S. proved it could save oil faster than OPEC could adapt to selling less oil.

Starting in 1981, the Reagan Administration strove to expand big, slow, costly supplies from fossil fuels plus nuclear energy. Efficiency proved faster, grabbed the customers, crashed prices in 1984–6, and bankrupted suppliers. Policymakers, alas, hit the snooze button. By the 1991 Gulf War,



IMAGES: Gasoline prices image copyright Thinkstock/ Dewitt. Caulkins family photo courtesy of Mary Caulkins.

we put our kids in 0.56-mpg tanks because we hadn't put them in 32-mpg cars—enough to displace Persian Gulf oil. After 20-plus years of stagnant auto efficiency standards, net oil imports rebounded to 60 percent of oil use in 2005. Regaining their 1973 level has taken 40 years.

HOW LONG WILL LOW PRICES LAST, AND WHAT WILL HAPPEN MEANWHILE?

Frackers, sweating on the junk-bond treadmill to keep drilling to sustain cashflow, are praying oil prices will rebound swiftly. Their prayers may go unanswered. Drilling has fallen in peripheral areas but continues in the richest core areas, such as the North American Bakken, keeping output high and prices low. Meanwhile, inventories of cheaper oil are brimming—at their highest U.S. level since 1931. These huge stockpiles may require even bigger supply cuts to rebalance the market. That prolongation could prove very painful for frackers and their investors, and fatal for tar-sands operators, with oil prices remaining low enough to deter new fracking. The simplest way to raise prices would be for oil giants to stop mining their money-losing Alberta tar sands whose oil the Keystone XL pipeline was supposed to carry.

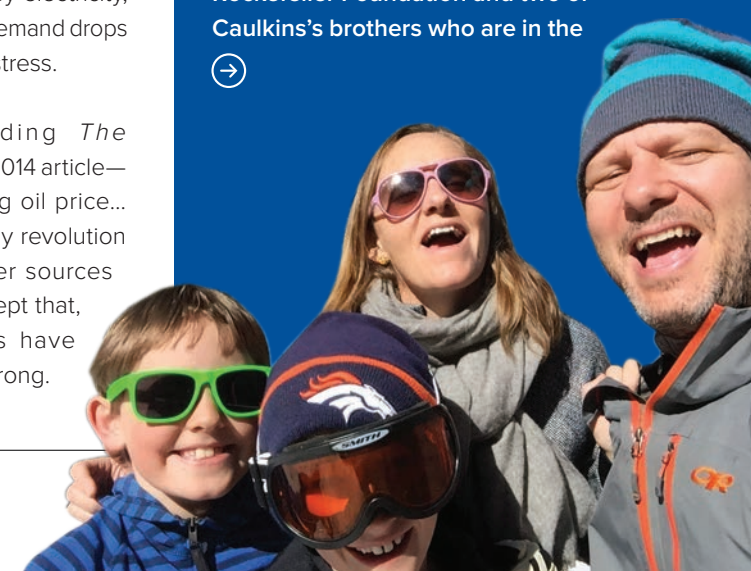
Cheaper oil's basic dynamic could become self-reinforcing. It defers development of costlier, often higher-carbon resources. This buys more time for efficiency and renewables to get bigger, hence cheaper, hence bigger, hence cheaper—even as cheaper oil seems to superficially compete with them—further softening demand and requiring even bigger supply cuts that take still longer. The next stage of the mobility revolution begins to emerge too, replacing many private autos with shareable and even autonomous ones powered by electricity, not gasoline. All the while, oil demand drops further, deepening drillers' distress.

Some alarmists—including *The Independent* in a December 2014 article—have warned "the collapsing oil price... could derail the green energy revolution by making renewable power sources prohibitively bad value." Except that, as Bloomberg and others have countered, that's precisely wrong.

Goodbye, Oil Stocks: Divesting for Impact

Mary Caulkins and husband Karl Kister are Colorado-based philanthropists who put their money where their mouth is. Longtime supporters of RMI, they were inspired by organizations like 350.org that urge colleges to divest their endowments of oil stocks as a way to bring awareness to concerns over climate change, global security, and fossil fuels. In 2013 Caulkins and Kister decided to do the same. They had their financial advisor sell their oil stocks and donate the proceeds to RMI. "While some people would consider it rash, and most financial advisors would advise against it, for us it was a new way to think about money and value," explains Caulkins, who just completed eight years on RMI's Board of Trustees. "The greater value to me and Karl is the exciting work that RMI is doing. We are investing in clean, smart, innovative energy systems instead of climate insecurity."

Caulkins and Kister are also leading by example, starting a ripple effect within their own philanthropic circle. In the year-plus since Caulkins and Kister divested, many more individuals and foundations have followed suit, including the Rockefeller Foundation and two of Caulkins's brothers who are in the



“The story should not be how falling oil prices will impact the shift to clean energy, it should be how the shift to clean energy is impacting the oil price.”

What does the renewable energy revolution have to do with cheaper oil? Almost nothing, and that's the point. Less than five percent of the world's electricity and less than one percent of U.S. electricity is made from oil, so oil and renewable power scarcely compete. Electricity's competitive landscape is virtually oil-free except on some islands and such other remote sites as mines and military bases where imported diesel and heavy fuel oil power the generators. On the contrary, cheaper oil means less fracked oil, less byproduct natural gas, higher gas prices, hence even more-competitive wind and solar power. And as batteries get cheaper, electric cars will increasingly threaten oil's core mobility market.

Cheaper gasoline may admittedly stretch the payback of electric cars, but residential electricity averaging 13¢/kWh runs a Nissan LEAF at less than half the cost per mile of \$2 gasoline in a typical 25-mpg car. BNEF estimates that 37-percent-cheaper gasoline could cut electric vehicles' share of the 2020 U.S. auto fleet from 9 percent to 6 percent. Yet electric autos continue to get cheaper while customer adoption grows—Norway's strong “feebate” boosted their 2014 market share to 12.5 percent.

CONCLUSIONS

BNEF Advisory Board Chairman Michael Liebreich said: “The orthodox view of unlimited oil demand growth simply does

not hold in a world of superefficient engines, electric vehicles, desperate air pollution problems, and action on climate. The U.S. economy has grown by 8.9 percent since 2007, while demand for finished petroleum products has dropped by 10.5 percent. Improvements in gas mileage and reduction in miles driven per person have had more impact on cutting U.S. oil imports than unconventional production. The story should not be how falling oil prices will impact the shift to clean energy, it should be how the shift to clean energy is impacting the oil price.”

Further, as efficiency and renewables take over global energy markets—because they work better, cost less, deploy faster and more flexibly, and incur less risk—oil and coal companies will own ever more carbon that's unburnable for climate reasons, but they'll own still more carbon that's unsellable because it can't compete. These firms are more at risk from market competition than from climate regulation.

Investors increasingly understand these differences and value their ability to deploy capital with more granularity, speed, transparency, and risk avoidance—not least in geopolitical stability, national security, and fairer global development. Oil companies' varying abilities to repurpose their capabilities and assets to thrive in this new energy world will ultimately divide the quick from the dead. 🌱

Amory Lovins is cofounder, chief scientist, and chairman emeritus of Rocky Mountain Institute. He wrote about energy efficiency's 'secret revolution' in the Summer 2014 issue of Solutions Journal.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/reinventingfire



process of divesting. Which is one reason Caulkins talks about her decision: “We come from a culture of privacy around money. So it's a little bit radical to speak about this. But we put ourselves out there to encourage others not to be afraid of taking the same steps.”

Impact investing—investing in companies with the intention of generating a social or environmental impact along with a financial return—is growing, according to the *Financial Times* and *Forbes*. It also usually meets and often exceeds the performance of comparable traditional investments, according to a March 2015 report from Morgan Stanley. Think of Caulkins and Kister's efforts as the flip side of impact investment—they're instead practicing impact *divestment*. Instead of putting their money into investments they *do* want, they're pulling their money out of investments they *don't* want, to redeploy it in ways that reflect their values—including investing in RMI.

That approach holds powerful sway in the court of public opinion on issues. “I think if the ‘movement’ takes hold, which is our hope, then we will see positive change,” adds Caulkins. “It may not be a straight line to the oil companies but a broader signal that our society would like to change how it uses resources.” And it's a savvy prudential move too: analysis shows that broad stock portfolios would have performed the same (or even slightly better) without their fossil-fuel stocks; their volatility adds unwanted risk; and in the longer run, clean energy will outperform them.

—LAURIE GUEVARA-STONE

RMI in Brief

NEWS FROM AROUND THE INSTITUTE

By Peter Bronski



2ND ANNUAL e-LAB ACCELERATOR HELD IN UTAH

In March 2015, RMI staff, expert national faculty from e-Lab, and 12 diverse project teams—ranging from California to New Jersey and New Mexico to Alaska—came together for RMI's second annual Accelerator, held at Sundance Mountain Resort in Utah. With projects spanning resilient community microgrids, battery energy storage, electric vehicle adoption and grid integration, progressive utility business models, and more, the four-day intensive work session sped progress on electricity innovation.

SPINOFF BLACK BEAR ENERGY LAUNCHES

Companies with large real estate portfolios have a tremendous value creation opportunity on their vacant rooftops, which are ripe for on-site renewable technologies such as commercial-scale solar. Seeing a market need, RMI thus helped launch Black Bear Energy as a “buyer's rep” company to aid companies navigating a complex landscape of options.

BUSINESS RENEWABLES CENTER ACCELERATES CORPORATE RENEWABLES

Officially launched February 2015—and the recipient of a Bloomberg New Energy Finance FiRe award in April 2014—RMI's Business Renewables Center streamlines and accelerates corporate purchasing of large-scale, off-site renewable energy such as wind and utility-scale solar. The BRC's membership includes renewable energy project developers, deal intermediaries such as consultancies and law firms, and corporate buyers totaling more than \$430 billion in annual revenue, including GM, eBay, Bloomberg, Kaiser Permanente, Johnson & Johnson, Salesforce.com, Sprint, and HP. A May 2015 event in San Francisco—co-hosted with NGO partners World Wildlife Fund, World Resources Institute, and BSR—brought in more than 130 attendees.

REPEAT WIN AT BLOOMBERG NEW ENERGY FINANCE FIRE AWARDS

In April 2015, beEdison—a solar diligence platform—won a Finance for Resilience (FiRe) award at Bloomberg New Energy Finance's summit in New York City. beEdison is powered by the truSolar standard, a FICO-like risk assessment for solar projects that RMI, Distributed Sun, and a consortia of partners developed.

e-LAB LEAP INITIATIVE EMPOWERS LOW-INCOME CUSTOMERS

Working first in New York State but ultimately expanding beyond it, e-Lab's recently launched Leap initiative is focused on ensuring that low- and fixed-income customers are part of the electricity grid's evolution, rather than getting left behind by it. In cooperation with a broad suite of state and local agencies, advocacy and community organizations, technology providers, and others, it is answering critical questions about affordable access to clean energy technologies and developing solutions that empower and improve the lives of low-income households and communities.

CARIBBEAN PARTNERSHIP WITH CLINTON CLIMATE INITIATIVE

In late May, RMI and Carbon War Room announced a new partnership with the Clinton Climate Initiative, an initiative of the Clinton Foundation. Focused on the transition to renewable energy and energy efficiency in the Caribbean region, it complements RMI and Carbon War Room's Ten Island Challenge and creates an integrated team that will work seamlessly together to ensure success.

IMAGE: e-Lab people image copyright Rocky Mountain Institute.

By David Labrador

Think Globally, Act Globally

VENTURE CAPITALIST
GARY RIESCHEL ON
RMI IN CHINA



Gary Rieschel has built a phenomenally successful set of businesses in a career that straddles the tech revolution in the United States and Asia. Along the way, he refined a global perspective on what makes true transformation happen. A resident of Shanghai for the past ten years, he and his family are committed to changing China's environmental tragedy into a success story the whole world can learn from. That's why Rieschel has been such a strong supporter of Reinventing Fire: China. "You have to align yourself with people that have the discipline, the dedication, and the stamina, frankly, for what it takes to actually get things done," says Rieschel. "How many have done what Amory and Rocky Mountain Institute have done and been hammering away at this for 30 years? You look for people who appreciate that this is not an instant fix."

Reinventing Fire: China takes that long view. Its rigorous analysis and companion policy recommendations identify the maximum share energy efficiency and clean energy could provide to support China's forecasted economic growth through 2050. RF: China is a from-the-ground-up Chinese version of *Reinventing Fire* (RMI's analysis for the U.S. published in 2011).

Rieschel knows a thing or two about economic growth. Qiming Venture Partners—a \$1.6-billion fund he founded

and manages—focuses on early-stage investments in China, where it's one of the top venture-capital firms. But it's only the latest in a long line of start-ups in Silicon Valley, Japan, and China. He was an executive in the early years of Intel and Cisco, and helped to bring the IT revolution to Asia by building joint ventures between American tech giants and Asian partners. He quickly moved into venture capital as a leader of firms like Softbank Venture Capital and Ignition Partners, before moving with his family to China in 2006.

CHINA'S ENVIRONMENTAL CHALLENGES

Rieschel also has a deep-seated passion for the environment. "It stems from reading books and getting involved in activities in Oregon when I was a kid," he says. "Rachel Carson was one of my heroes growing up." Today he and his wife, Yucca Wong Rieschel, are active supporters of environmental and educational causes. So they feel acutely challenged by the environmental degradation in China. Some in China talk of the 'three T problem'—\$1 trillion each to clean up the water, the land, and the air. It is shorthand for the scale of the problem, says Rieschel. "The key is, there's no such thing as a small problem in China. And there really isn't a good example of how to do it at the scale of the problems that China has." Making headway thus requires huge ambition, bold action, and relentless patience—all guiding principles of RMI and its *Reinventing Fire* synthesis.

Rieschel thought this pragmatic approach could really help China, and the world. Jack Wadsworth, an old friend and Morgan Stanley veteran with decades of experience in East Asia, invited Rieschel to a summit at Amory's home three years ago. "*Reinventing Fire* had just come out, and the thing that I liked about RMI's approach is the Chinese are generally technocrats; they look for solutions," says Rieschel.



"What it does is outline a very strong economic rationale for choices that could be translated into decisive action in China."

Ultimately, Reinventing Fire: China would not be happening without the support of Rieschel, Wadsworth, and others like them. Rieschel has generously supported the project from its inception, both financially and strategically. He has been indispensable advising, guiding, and making introductions for the RMI team in China. For Rieschel it was a natural progression—"being in China, realizing exactly how awful the environmental situation is here, looking at RMI as a really strong potential solution base for that, and then helping fund and promote RMI's entry to China."

SOLUTIONS FOR THE WORLD

The project has since evolved into a major collaboration between the Energy Research Institute of China's National Development and Reform Commission, the NDRC-sponsored Energy Foundation China, the

China Energy Group at Lawrence Berkeley National Laboratory, and RMI. The hope and intent is for Reinventing Fire: China's analysis and policy recommendations (to be published later this summer) to help inform China's upcoming 13th Five-Year Plan—and the future of global climate.

"Some of what happens in China may be perfectly appropriate for what's going to be required in Nigeria and India," says Rieschel. "You're going to have a larger palette of solutions the world can choose from. If we can find examples over the next three to five years of China's successfully implementing *Reinventing Fire* concepts, then you can go to the rest of the world and say, 'People in the United States have done this, people in China did something a little different. What solution works best for you?'"

⊕ WEB EXTRA

For more information on this topic visit:
rmi.org/reinventing_fire_china

"There's no such thing as a small problem in China. Making headway requires huge ambition, bold action, and relentless patience."



Interviewed by Peter Bronski

On Corporate Social Responsibility

VP OF SUSTAINABILITY AT ASPEN SKIING COMPANY AUDEN SCHENDLER ON CLIMATE CHANGE, SKIING, AND WHY CORPORATE SUSTAINABILITY IS HARDER THAN WE THINK

Auden Schendler is the outspoken vice president of sustainability at Aspen Skiing Company. He joined Skico, as it's known to locals, in 2000 after a three-year stint at RMI during which he first ventured into the realm of corporate social responsibility (CSR). Since then he's been a veritable one-man tour de force in the CSR world. He's lectured from Harvard and Yale to Google and Starbucks. He's been profiled in the pages of *Outside* and *Fast Company*. His writing has appeared in publications ranging from *Harvard Business Review* to *Scientific American*. He's been the recipient of global warming innovator recognition from both *TIME* magazine and the U.S. Environmental Protection Agency. And he's the author, in 2009, of *Getting Green Done: Hard Truths from the Front Lines of the Sustainability Revolution*.

Solutions Journal: This year Aspen had its second-driest January since 1935, recording just 5.26 inches when the monthly average is five times that. Meanwhile, meager snowpacks from California to Washington forced the early closure of many ski areas. Is skiing one of the front lines of climate change? And what does Aspen Skico predict for the years ahead?

Auden Schendler: We're definitely on front lines of climate change. You are seeing the future today. What we fear is warmer weather, more rain than snow, and persistent droughts. The fear is you're in an increasingly challenging environment to run a ski business. But the broader issue is that everybody's on the front lines, not just skiing. The bigger issue is the economic impact of climate change, and people's willingness or ability to go on vacation. Climate change anywhere affects us here.

SJ: Much like the small Caribbean island-nations we're working with right now on the Ten Island Challenge, ski areas contribute a comparatively negligible amount of carbon emissions yet disproportionately feel the impact of climate change. What's the value of leading by example with sustainability?

AS: All the ground work we do for efficiency, renewables, sustainable operations is not about solving climate change, because it's of course not enough. It's about credibility when you talk to powerful people, or lobby in Congress on climate. You have to walk the talk. You have to show you are diligent, that you are legitimately trying, before you can call for broader action. Aspen has the resources to pursue solutions. If we don't do it, I don't know who is going to. We're also very high profile, so when we do things, it gets press. You could argue we're obligated to lead.



As part of its sustainability commitment to walk the talk, Aspen Skiing Company has invested in solar PV locally in the Roaring Fork Valley.



IMAGES: Schendler, Aspen skiing, and solar farm images courtesy of Auden Schendler; Getting Green Done image courtesy of Pete Garceau/PublicAffairs.

SJ: *Grist* once called you a “corporate sustainability guru.” Chief sustainability officer and positions like it seem to have gone from niche and stereotyped to fairly mainstream, at least among major progressive corporations. What does that say about the future of business?

AS: When I was at Bowdoin College, I couldn't major even in environmental studies, let alone sustainability. No one knew what it was. Bowdoin said you have to study something 'real,' which was biology for me. All that has changed now. There are great undergrad and graduate sustainability and business sustainability programs. That's incredibly encouraging. And yes, there are now a lot of CSOs [chief sustainability officers] in business.

But the vast majority of those people are dealing with operational greening: efficiency, renewables, supply chain, waste issues. They're very much in a box and don't have the power to actually drive

the required change we need. What has to happen is the visionaries need to be the CEOs. They need to speak out. We desperately need senior business voices demanding action on climate at the policy level—CSOs talking with government affairs people, backed by CEOs. There's a big gap. Greening your operation and reducing your carbon footprint has very little to do with sustainability, because you're not solving climate change by doing that. You have to make the leap to policy advocacy.

“We badly need corporations to not only green their operations, but to change policy. You have to make the leap to policy advocacy.”



SJ: Your book *Getting Green Done* described some of the challenges of implementing sustainability in a corporate environment. What has changed and what have you learned since its publication in 2009? And to the point of the title, what does it take to get green done in corporations today?

AS: Two key things have changed: 1) All the tough stuff I was trying to get done, and that RMI has long advocated like energy efficiency and renewable energy, all that is now becoming business as usual. That hasn't always been the case. Now you can't afford *not* to do efficiency, to replace light bulbs, to build green buildings. This is all mainstream. That's all really good news. The problem is that corporations tend to cut 5 to 10 percent of their carbon footprint if they're lucky, but not the whole enchilada. And 2) that's why we need to advocate for policy change. It's become apparent we're not going to get to the fix without policy. We badly need corporations to not only green their operations, but to change policy. 🌱

Peter Bronski is editorial director of Rocky Mountain Institute and Carbon War Room.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/natural+capitalism

By Charles C. Poling

Finding the Comfort Zone

RMI'S UNDER-CONSTRUCTION INNOVATION CENTER IN BASALT, CO, PUSHES THE BOUNDARIES OF THERMAL COMFORT—CONDITION THE PERSON, NOT JUST THE SPACE



Some 30 years ago, Rocky Mountain Institute cofounder and chief scientist Amory Lovins was relaxing in a home in Japan one winter's day when he realized it wasn't heated. "Why don't you heat your house?" he asked his hostess. "Why should I?" she replied. "Is the house cold?"

Her response embodies a perspective that seems obvious but is seldom practiced: condition the person, not the space. It's inefficient to heat or cool the whole space when we occupy only a tiny fraction of it.

Today, that principle and the underlying notion of thermal comfort are key to achieving net-zero energy consumption at RMI's Innovation Center, a 15,610-square-foot office building under construction in Basalt, Colorado. When completed

in late 2015, the building will include a convening hall, office space for 50 staff, and support space.

By designing around the question "are you comfortable?" instead of "what's the temperature?", RMI and partners are creating a model office building that will use a fraction of the energy typical for a building this size. It'll combine passive solar heating, passive cooling, daylighting, operable shading, natural ventilation, a super-airtight and heavily insulated building envelope, and

onsite electric-vehicle charging stations. Thermal comfort techniques top off the energy savings, enabling RMI to achieve breakthrough energy efficiencies.

Cara Carmichael, a manager in RMI's buildings practice, coordinates the design and construction team that includes design architect ZGF Architects, general contractor JE Dunn, John Breshears of the firm a2 for high-performance design consultation, and Graybeal Architects as local architect.

NOT TOO HOT, NOT TOO COLD

The idea of maintaining thermal comfort usually comes down to setting a thermostat to keep the air within a certain temperature range. But conditioning a person to feel

comfortable involves at least six variables: air temperature, air speed, humidity, clothing level, activity level, and the temperature of surfaces such as walls, windows, desks, tables, and seats. As it turns out, conditioning people to feel comfortable through these variables proves far more efficient than conditioning the space those people occupy.

For the Innovation Center, the RMI design team managed all six variables while still meeting "the comfort standards of most people—90 percent—within a greatly expanded air temperature range," says Chris McClurg, a senior associate in RMI's buildings practice. Call it the Goldilocks zone, neither too hot nor too cold.

"Conditioning people to feel comfortable proves far more efficient than conditioning the space those people occupy."

Large south-facing windows enable direct solar gain, which heats thermal mass in the floors in the winter and re-radiates heat to occupants so they feel warm even if the air is slightly cool. In the summer, carefully placed operable windows draw in chilly night air that cools off the thermal mass, pleasantly tempering the next day's higher temperatures.

More prosaically, RMI encourages everyone, from staff to visitors, to dress appropriately, such as wearing a sweater in winter and short sleeves in summer. Natural ventilation, efficient ceiling fans, and personal USB-powered fans regulate airspeed, another important factor in warm weather. Accessories like radiant underfoot pads or heated mouse pads also help in the coldest weather.

THE HYPERCHAIR

Staff will also enjoy one piece of brand-new technology: the Hyperchair. Developed by the University of California, Berkeley's Center for the Built Environment and RMI senior fellow Peter Rumsey, this normal-looking office chair works like a heated and ventilated car seat. Users adjust built-in fans and heating elements to their taste. A rechargeable laptop battery runs the chair.

Combining these people-focused options widened the air temperature range in which people in the building would feel comfortable from the typical 68–72 degrees Fahrenheit to 62–84 degrees, McClurg says.

The payoff was huge. "We were able to eliminate our cooling system entirely,"

says Carmichael. "We minimized our heating system such that it only takes the equivalent of 13 hair dryers to heat the entire building." The only mechanical equipment will be a heat exchanger between outgoing stale air and incoming fresh air.

The Innovation Center has a design energy use intensity of 18 kBtu per square foot per year, she says, just one-fourth the typical small office building's score of around 70 kBtu. An 80-kW grid-tied solar array will power the Innovation Center's remaining anemic energy needs.

RMI planned the Innovation Center as a practical, replicable model. Since 90 percent of commercial buildings are less than 25,000 square feet, most of those are offices, and three-fourths are likely to be retrofitted by 2035, the path blazed by the Innovation Center can lead to vast energy savings. Says Carmichael: "Thermal comfort and the passive approach can be applied to any building." 🌱

Charles C. Poling is a New Mexico-based freelance writer whose architecture writing has appeared in Dwell, New Mexico Magazine, and others. He wrote about Houston's HOUZE in the Summer 2014 issue of Solutions Journal.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/rmi_innovation_center

IMAGE: Innovation Center rendering courtesy of ZGF Architects.

IS PEAK ELECTRICITY PRICE COMING?

COST-EFFECTIVE, GRID-CONNECTED SOLAR-PLUS-BATTERY SYSTEMS ARE COMING SOON FOR MANY CUSTOMERS IN MANY PLACES, SHOWS RMI'S NEW REPORT *THE ECONOMICS OF LOAD DEFECTION*, SERIOUSLY CHALLENGING TRADITIONAL UTILITY BUSINESS MODELS BUT INSULATING CUSTOMERS FROM RISING RETAIL ELECTRICITY PRICES ALONG THE WAY.

By David Labrador

Residential rooftop solar enjoyed 50-percent annual growth in 2012, 2013, and 2014, according to the Solar Energy Industries Association. That rise of solar PV has eroded the energy sales of certain utilities. In response, some are fighting back, proposing new charges to preserve revenue. One recently succeeded.

On February 27 Salt River Project, one of Arizona's largest utilities, finally succeeded where nearly two dozen others failed in the past three years: it won the right to impose new demand charges—an average of \$50 per month—on grid-tied customers who produce their own solar power. (Although a recent anti-trust lawsuit brought by SolarCity suggests forthcoming chapters in this ongoing story.)

Why the persistent push from certain utilities for such new charges? Because some see solar and other customer-sited technologies as a threat to their traditional business model—and they're right to worry. According to a new analysis from RMI with HOMER Energy and other partners, customer "load defection"—customers' shift from getting electricity from their utility to getting electricity from solar panels on their roofs—could become much bigger in the near future, especially when solar is paired with battery energy storage.

Tesla's recently announced Powerwall—about five years ahead of industry price forecasts—is accelerating the economics of solar-plus-battery systems. SolarCity plans to offer it as part of a residential package for homeowners, paired with rooftop solar.



“The increasing adoption of solar-plus-battery systems along with other customer-centric distributed energy resources is going to present a huge challenge to regulatory constructs and utility business models,” says Leia Guccione, a manager with RMI’s electricity practice and coauthor of the new report, *The Economics of Load Defection*. “The future looks a lot different than the way utilities have served their customers for the past 100 years.”

COST-EFFECTIVE SOLAR-PLUS-BATTERY SYSTEMS ARE COMING TO A CUSTOMER NEAR YOU ... SOON

At the core of this new analysis are two basic trends: 1) retail electricity from the grid is getting more expensive and 2) the costs for solar and battery technologies are rapidly declining. But when and where in the U.S. might those two curves cross? And how many customers and how much in electricity sales is at stake? The answer: a lot.

RMI’s analysis shows that in the Northeast U.S. alone, up to 50 percent of residential and 60 percent of commercial electricity customers could be “in the money” with grid-connected solar-plus-battery systems by 2030, just 15 years away. This would represent defection of 140 million kilowatt-hours (kWh) and \$35 billion in utility energy sales per year if customer adoption followed optimal economics. “The amount of load that’s at stake, the amount of kWh sales, it’s a lot of money,” says James Mandel, a principal in RMI’s electricity practice and another coauthor of the report. “It can be scary to think about how significant that difference is,” adds Guccione.

This new analysis follows on 2014’s *The Economics of Grid Defection*, which examined when and where it would be cost-effective for customers to cut the cord with their utility entirely through off-grid solar-plus-battery systems. However, true grid defection is unlikely for many customers. It’ll take more than pure economics to persuade them to make such a big shift in their electric service. That wouldn’t be an ideal outcome anyway for a whole host of reasons, including, for one, the extra cost of oversizing the system to offer stand-alone assurance and the inability to provide value and services back to the grid, since they’re no longer connected to it.

And so *The Economics of Load Defection* explored a far more probable scenario: customers will keep their utility, but they’ll also invest in grid-connected solar-plus-battery systems. That grid connection is crucial to the equation. With the grid as a confident backup for customers, they can more optimally size the solar-plus-battery system, making it smaller, cheaper, and thus cost-effective for more customers in more places sooner. “That’s much more attractive to customers,” says Guccione. “It’s a lot more likely that they’re going to invest in that kind of system.”

FOLLOW THE MONEY: INVESTORS AND BANKS WEIGH IN

If you want to see where the grid is headed in the future, you follow the money. By that measure, in the 14 months between *The Economics of Grid Defection* in February 2014 and *The Economics of Load Defection* in April 2015, the investors and banks have spoken loudly. It began when Barclays, citing RMI’s analysis, downgraded the credit rating of the U.S. electric utility sector. Others soon followed suit with analyses, reports, and investment discussion letters—Bank of America, Citigroup, Fitch Ratings, Goldman Sachs, Morgan Stanley, and UBS. All, in their own words, made a similar declaration: the traditional utility business model of building big, central power plants, financed via energy sales from the one-way transmission and delivery of electricity to customers, is facing serious challenges. “Our view is that the ‘we have done it like this for a century’ value chain in developed electricity markets will be turned upside down ... by solar and batteries,” declared UBS.

Now, in the month following the release of *The Economics of Load Defection*, the industry is again taking notice. *Bloomberg*, *Scientific American*, *The Economist*, *the Washington Post*, and many others have weighed in covering the trend and the new analysis, with *Forbes* declaring “utilities may lose more grid-connected customers, and billions of dollars.”

PEAK ELECTRICITY PRICE IS COMING

But what does all this mean for an individual customer like you or me? Simple: peak price (not to be confused with on- and off-peak rates for customers on a time-of-use rate structure with their utility). If you’re like the overwhelming



majority of electricity customers in the U.S. today, you pay a monthly electricity bill to your utility. On average nationwide, that bill—as measured by the per-kWh charge we pay for electricity—has been rising. And it will probably continue to climb, as factors like an aging power grid requiring new investment and the volatility of fossil fuel prices affect providers’ bottom line.

Meanwhile, since solar-plus-battery systems have rapidly falling costs and essentially zero operating costs over their 20-plus-year lifetime (since the sun’s rays arrive on your rooftop free of charge), customers who invest in these systems can insulate themselves from rising retail prices, effectively locking in a peak electricity price. For example, in Westchester County, NY, just outside New York City, by 2030 the average residential customer’s monthly electric bill could reach about \$357. With a grid-connected solar-plus-battery system, that could instead be \$268, a savings of more than \$1,000 per year. And that’s under some fairly conservative assumptions. For instance, it doesn’t account for utilities’ purchases of customers’ distributed

Beyond secondary values such as backup power, batteries have important benefits for rooftop solar grid integration, especially in places where customer adoption is high, such as California and Hawaii.

“In the Northeast U.S. alone, up to 50 percent of residential and 60 percent of commercial electricity customers could be ‘in the money’ with grid-connected solar-plus-battery systems by 2030, just 15 years away.”



Customers who invest in solar-plus-battery systems can insulate themselves from rising retail prices, effectively locking in a peak electricity price.

generation, something common today that would greatly improve the economics for customers.

That sum could greatly increase if utilities sold *and bought* electricity at prices based on its actual time-varying cost, as the smart meters now spreading across the country are meant to facilitate. Indeed, RMI's e-Lab, the National Renewable Energy Laboratory, Navigant Consulting, and the Electric Power Research Institute, among others, have all released studies on the myriad benefits distributed energy resources (DERs) can provide. Most recently, the Maine Public Utility Commission recently released the contentious numbers from a value-of-solar study that found solar's true grid value around \$0.33 per kWh, greater than customers were currently being compensated. And distributed storage could provide resilient services even if the grid failed.

A FORK IN THE ROAD FOR THE GRID'S EVOLUTION

Grid-connected solar-plus-battery systems will be the lowest-cost system in many markets within 10–15 years. This is shorter than the economic lives and cost-recovery periods of many of the major new central-generation assets either still in their cost-recovery period now or planned for construction. The financial stakes are big. Between 2010 and 2030, the grid will require an estimated \$2 trillion in investment, or about \$100 billion per

year. Even if only a fraction of customers for whom solar-plus-battery systems would make economic sense actually invest in them, that would still represent a sizeable chunk of revenue the grid and utilities were counting on.

"There's a real danger of central generation investing in increased capacity at the same time customers are making these distributed investments," says Mandel. "The end result would be way too much capital on both sides of the meter." All of these pressures move in the direction of the so-called "utility death spiral," a scenario where utilities, faced with fixed costs, must raise rates on dwindling numbers of grid-reliant customers, driving more of them away, needing to raise rates still higher to break even, and so on.

The grid is thus at a fork in the road. Solar PV and batteries will play a central role in the future grid, but exactly what role—integrated into an optimized grid of the future or seen as a subversive threat to today's legacy grid—is yet to be decided. That means that decisions made today about rate structures, utility business models, and regulatory reform will have important implications, because they set the grid more toward one trajectory or the other.

"While the task may seem overwhelming, we need to start tackling it as soon as possible," says Guccione. "It's only going to become more

difficult to turn the ship. We really need to start today." A few already have, such as New York State's Reforming the Energy Vision regulatory proceeding.

EMBRACING SOLAR AND BATTERIES FOR SOCIETY'S BENEFIT

So what now? "Grid-connected solar-plus-battery systems definitely present opportunities," says Guccione. "They're disruptive opportunities, but they're opportunities nonetheless." RMI sees this unfolding shift in the technology and economics of electricity as a chance for all stakeholders to evolve a better future together, not as a threat. "There is potential, with new rate structures and new business models, for customers to provide valuable services back to the system," says Guccione, "and to help speed the transition to something that's lower-carbon, more reliable, and much more dynamic than what we have today, because those distributed resources remain connected to the grid."

"Batteries and solar both provide a lot of value to the electricity system," says Mandel. "They can do things like defer upgrades; they can provide services that normally a utility has to pay a lot of money for: they can decongest areas, they can reduce peaks and make the load flatter, which lowers costs." That is, distributed solar generation—especially because it's greatest around peak loads on hot, sunny days when electricity is costliest to supply—not only deprives utilities of revenue but also relieves them of commensurate or greater cost. This could benefit both parties so long as they coordinate and plan accordingly.

"Many grid operators don't see solar and batteries as assets; they see them as hurdles," says Matt Roberts, executive director of the Energy Storage Association. "That's only because this is how the system is designed. So they're not resistant to solar; they're not resistant to storage. Everyone loves clean energy in the end. It's just at what benefit vs. at what cost?" And, he says, are there price signals and is there a marketplace for that value to transact? Right now, the answer is largely no.

"It's pretty urgent from our perspective for distribution systems to account for the fact that they're going to have solar and batteries on their



"Solar PV and batteries will play a central role in the future grid, but exactly *what* role—integrated into an optimized grid of the future or seen as a subversive threat to today's legacy grid—is yet to be decided."

network," RMI's Mandel continues, "they should be looking for opportunities to take advantage of it." And some are. For example, progressive California utility San Diego Gas & Electric in March brought a team to RMI's e-Lab Accelerator event in Utah to explore solutions for customer-sited battery energy storage.

THE TIME TO ADJUST IS NOW

Realizing these transformations will require all stakeholders to work together to design and move towards a radically different future. Happily, RMI's recently released report seems to be prompting those discussions. "The fact that we have gotten feedback from diverse corners of the industry—utilities, regulators, solar and battery companies—has been an encouraging sign that the right people are in the right conversations and that this work is reaching its intended audiences," says Guccione.

"We've had numerous inquiries from utilities wondering how to adjust their business models to account for distributed resources," says Mandel. "If there are only ten or fifteen years before these systems are economic, it's not a lot of time." But if done right, he says, "these customer-sited technologies will let us have cheaper, cleaner, more reliable power—to me that's a really big thing, and it's really good news." 🌞

David Labrador is a writer/editor for Rocky Mountain Institute and Carbon War Room.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/electricity_load_deflection

GOING FURTHER FASTER TOGETHER

ROCKY MOUNTAIN INSTITUTE AND CARBON WAR ROOM MERGE
TO SPEED THE ENERGY REVOLUTION AND CREATE A CLEAN,
PROSPEROUS, AND SECURE LOW-CARBON FUTURE.

By Laurie Guevara-Stone





RMI helped the Empire State Building save \$7.5 million over 3 years through a deep energy retrofit.

When Amory Lovins cofounded Rocky Mountain Institute in 1982, the world was coming out of the oil crises of the 1970s and gasoline cost 91 cents per gallon. “Global warming” and “climate change” weren’t yet everyday household terms, but RMI’s staff was already hard at work on market-based solutions that could cost-effectively drive the shift from fossil fuels to energy efficiency and renewable energy. The diverse benefits of that work were manifold: for the health of our economy, our environment, ourselves, and our national security. The opportunities and benefits are arguably even greater today. So is the urgency of action.

The stark impacts of climate change are visible seemingly everywhere—from the devastating Pakistan floods in 2010, to the destruction of Hurricane Sandy in 2012, to the devastating wildfires in Australia in 2014, to the worsening drought in California today. The world’s experts say these events are becoming more severe, causing annual losses of \$200 billion—a quadrupled toll in thirty years. Humankind is almost certainly on a path to cross the 2-degree-Celsius threshold most climate scientists agree we must stay below to forestall the worst effects of global warming.

“We need an energy revolution now,” says Jules Kortenhorst, CEO of Rocky Mountain Institute and Carbon War Room. “That’s why the merger of RMI and Carbon War Room—two leading NGOs working on market-based solutions for a clean economy—is so crucial.” The merger was publicly announced in December 2014, and in the months since, the joint organization has been working harder and faster than ever. “There is a unique window of opportunity to accelerate the energy transformation to create a clean, prosperous, and secure low-carbon future for us all,” Kortenhorst continues. “RMI and CWR can build upon our historical results, and focus on amplifying our impact beyond the sum of what we can do independently.”

YEARS AND DECADES OF RESPECTIVE STRENGTHS AND SUCCESSES

RMI has made great progress over the past 33 years, putting energy efficiency and “negawatts” on the map as the most cost-effective and untapped energy resource, advancing radically fuel-efficient autos whose fitness facilitates electrified powertrains, introducing the world to ideas like ‘tunneling through the cost barrier’ to make big energy savings cheaper than small ones, and other victories.

Over those decades, RMI proved the case for breakthrough deep energy retrofits, including the more recent retrofit of the Empire State Building, which has now scaled to hundreds of big buildings across the country, and it doubled the energy efficiency gains of retrofits for the U.S. government’s General Services Administration, the largest landlord in the country.

In electricity, RMI for three decades has pioneered the modern combination of efficiency, renewables, distributed generation, and new business models. In recent years, RMI pointed the U.S. Department of Energy and solar industry toward balance-of-system costs as a crucial driver of total cost, convened the Electricity Innovation Lab (e-Lab) so diverse stakeholders can tackle complex challenges together, done groundbreaking analysis on solar and battery trajectories now cited widely throughout the financial sector, and is serving as a strategic advisor to New York State on the most closely watched U.S. regulatory reform initiative.

RMI is also helping communities such as Fort Collins, Colorado, and Arizona State University achieve their ambitions for zero and low-carbon energy systems. And in China, RMI’s unprecedented pan-Pacific partnership of government agencies and nonprofit organizations aims to inform the 13th Five-Year Plan by illuminating the maximum share of efficiency and renewables that could fuel China’s rapidly growing economy while shrinking carbon emissions.

Meanwhile, Carbon War Room—though RMI’s junior by more than two decades—has built a growing catalog of strong successes as well. In 2009, the world was facing one of the worst financial crises since the Great Depression of the 1930s, and many were calling the UN climate summit in Copenhagen a failure. That same year, Sir Richard



Branson founded Carbon War Room to harness the power of entrepreneurs to implement market-driven solutions to climate change and create a post-carbon economy. Over the past six years, CWR has honed a bold, entrepreneurial approach to remove market barriers by closing information gaps and reducing transaction costs to get money flowing to efficient and renewable solutions. Core successes include launching the world’s first shipping efficiency rating system and America’s first commercial PACE financing program.

CWR’s Trucking Efficiency operation is improving freight fuel economy with RMI spinoff the North American Council for Freight Efficiency (NACFE).

BECOMING ONE TO SCALE BIGGER SOLUTIONS FASTER

Now the two organizations have come together to drive greater impact and scale solutions faster. Though founded decades apart, they share a common vision: that investing in a clean-energy, climate-safe future reaps great rewards for economy, public health, environment, and security.

“RMI and CWR can build upon our historical results, and focus on amplifying our impact beyond the sum of what we can do independently.”

Meet Carbon War Room—A Timeline

2009

Sir Richard Branson founds Carbon War Room with other like-minded entrepreneurs



APRIL 2010

Holds first Creating Climate Wealth Summit in Washington, D.C.



DECEMBER 2010

Launches the A to G GHG Emissions Rating, the world’s first shipping efficiency rating program, with RightShip

SEPTEMBER 2011

Helps launch the world’s first official commercial property assessed clean energy (PACE) program



DECEMBER 2011

RenewableJetFuels.org launches to inform major fuel purchasers, investors, policy makers, and other key stakeholders

JUNE 2012

Launches the Ten Island Challenge to work with ten Caribbean islands to accelerate their transition to 100-percent renewable economies

IMAGES: Previous page illustration copyright Rocky Mountain Institute, by Andy Potts, Empire State Building image copyright Thinkstock / peder77, Trucking image copyright Thinkstock / BIG_TAU, Branson and Figures images courtesy of Carbon War Room.

“It’s already clear that the result is much more than the sum of the parts.”

The organizations’ synergies are many. CWR’s entrepreneurial emphasis and financial expertise complement RMI’s strong technical depth. RMI is best at developing new concepts and developing them through early adoption, CWR at scaling them to become really big. CWR is more tactical and achieves quicker wins; RMI embeds in the long game of transforming enormously complex systems over decades. To combine these diverse strengths, RMI and CWR now operate as distinct business units of the combined organization (still called Rocky Mountain Institute) with one Board and one CEO. Both units closely collaborate across their respective operations under a Board-approved joint strategy. It’s already clear that the result is, as hoped, much more than the sum of the parts.

RMI and CWR’s Ten Island Challenge recently announced a partnership with the Clinton Foundation to transition Caribbean island-nations from fossil fuels to efficiency and renewables.

“Current efforts to address the climate change challenge are clearly not at sufficient speed and scale across society—from local to international politics, to business practice, to consumer behavior,” says José María Figueres, chair of the newly combined Board. “We need to move much further, much faster. Under one umbrella, the combined organization will generate breakthrough insights, partner with early adopters, create replicable solutions, engage



with markets to remove transaction barriers, and close information gaps, all in order to scale impact and transform global energy use.”

SPEEDING THE ENERGY REVOLUTION

An energy revolution is rising all around us. In each of the past four years, the world has invested more than a quarter-trillion dollars to add over 80 billion watts of renewables (excluding big hydro dams). Generating capacity added last year was 37 percent renewable in the United States, 53 percent in the world, 68 percent in China, and 72 percent in Europe. And this growth is accelerating: solar power is scaling faster than cellphones. Electric vehicle sales are scaling twice as fast as hybrid cars did at the same point in their market introduction. Shrewd companies are realizing the enormous business opportunities that climate solutions present.

Global companies like IKEA, Google, Apple, Facebook, Salesforce, and Walmart have committed to 100 percent renewable power. Tesla’s stock is up an astounding 770 percent over the past two years and now has half the market value of General Motors. The NEX index—which tracks clean energy companies worldwide—grew by 50 percent over the past two years (far outperforming the general market) while equity raisings by quoted clean energy companies more than doubled. Many of the world’s top financial firms concur that the era of coal and of big power plants is drawing to a close; leading coal companies have already lost 90+ percent of their value.

“The transformation to a low-carbon future is arguably the greatest business opportunity of our time,” wrote Amory Lovins and Sir Richard Branson in a joint op-ed. “Combating climate change through energy efficiency, renewable energy technologies, clean transportation, and smarter land use can reap rewards as great economically as environmentally.”

GOING FURTHER, FASTER, TOGETHER

Yet we need to go further faster. Which is why the merger of two of the world’s preeminent nonprofit organizations tackling climate change through market-based solutions will turn our toughest long-term energy challenges into vast opportunities for entrepreneurs to create wealth. In the U.S. alone, Rocky Mountain Institute’s *Reinventing Fire* analysis found a 158-percent-bigger economy could entirely eliminate coal and oil consumption and use one-third less natural gas, yet cost \$5 trillion less than business as usual. So far, the U.S. is on that track, and ahead of target for renewables. We are closer than ever before to transforming the world to a low-carbon energy system. Rocky Mountain Institute and Carbon War Room are excited to have come together and forged a coordinated approach to making transformational impact worldwide.

Under a revised strategy approved earlier this year by the board, RMI and CWR will drive the greatest impact by:

- Developing breakthrough insights, business models, designs, and solutions.
- Partnering with early adopters to pilot and fine tune such breakthrough ideas.
- Creating replicable solutions that are profitable and able to rapidly scale.
- Identifying and removing market barriers such as information gaps and transaction costs.
- Scaling impact through broad outreach, resulting in large-scale adoption of new solutions.

United we stand to make a greater impact quicker, and this is already happening. Our first combined program, the Ten Island Challenge, is making progress in seven Caribbean countries. Caribbean economies suffer from some of the highest electricity prices in the world—perpetuating poverty, expanding national debts, and blocking sustainable



development. They are also on the front lines of climate change, facing nearer-term impacts from sea-level rise, increasing temperatures, and extreme weather events. Our combined organization is laying the groundwork to transform these islands’ energy systems from being dependent on expensive imported diesel to cleaner, cost-effective systems of efficiency and local renewables, while cutting electricity costs, boosting private investment, and enhancing and diversifying the local job market. We are demonstrating that entire economies can adopt low-carbon solutions while strengthening their economies.

And islands are just the beginning. We are closer than ever before to transforming the world to a low-carbon energy system—with the U.S. electric grid, scaling rooftop solar and other customer-sited and renewable energy technologies, in China, with building efficiency, and more. Rocky Mountain Institute and Carbon War Room are excited to be working together to achieve far more than we could separately. Together, we can go further and faster towards a clean, prosperous, and secure low-carbon energy future. 🌱

Reinventing Fire defined a path to an 80% renewable U.S. electric grid.

Laurie Guevara-Stone is a writer/editor for Rocky Mountain Institute and Carbon War Room.

WEB EXTRA

For more information on this topic visit: carbonwarroom.com

Meet Carbon War Room—A Timeline

OCTOBER 2012

Cargill, Huntsman, and UNIPEC—representing 350 million tonnes of commodities—declare they will use CWR and RightShip’s A to G Rating



OCTOBER 2013

Launches the Trucking Efficiency operation with RMI spin-off the North American Council for Freight Efficiency

JANUARY 2014

Prince Rupert Port Authority and Port Metro Vancouver become the first ports in the world to offer incentives to the most-efficient vessels

calling to their ports based on the A to G Rating, rewarding those shipowners who invest in more-efficient fleets

JUNE 2014

Delta Air Lines partners with Carbon War Room to accelerate low-carbon jet fuel production worldwide

JULY 2014

Receives NGO of the Year award from businessGreen



DECEMBER 2014

Merges with Rocky Mountain Institute



IMAGES: Island image copyright Thinkstock / Ingal. Electricity transmission lines image copyright Thinkstock / hxdyl. Shipping A to G and businessGreen images courtesy of Carbon War Room.

THE CUSTOMER-CENTRIC ELECTRICITY GRID



The New York State capitol at the head of Albany's Empire State Plaza (pictured) is the front line of some of the most progressive state-level regulatory reform for the nation's electricity system.

NEW YORK STATE, UNDER THE LEADERSHIP OF PUBLIC SERVICE COMMISSION CHAIR AUDREY ZIBELMAN, REACHES A MAJOR MILESTONE EN ROUTE TO THE NATION'S FIRST MARKET PLATFORM FOR CUSTOMER-SITED CLEAN-ENERGY TECHNOLOGIES.

By Jennie Lay

A two-plus-hour drive north from New York City along the Hudson River leads to the state capital of Albany. There the government buildings overlooking Empire State Plaza have become the front lines of regulatory reform for the nation's electricity system. The electricity industry of the future is coming, and it's probably coming here first.

In 2014, New York State launched Reforming the Energy Vision (REV), a regulatory proceeding aiming to rewrite from scratch how the state's electric grid operates. Alongside traditional assets such as big power plants and transmission lines, for the first time in the nation's history it will establish a market for customer-sited distributed energy resources (DERs) like rooftop solar, batteries, smart thermostats, and much more. This "distributed system platform" (DSP) places the customer at the center of the grid equation as never before.

"What's so unique about REV is the creation of this new model and also the level of ambition and very fundamental regulatory transformation that New York is proposing," says Lena Hansen, a principal in RMI's electricity practice. "This is not by any means incremental. They're taking a very whole-systems transformative approach."

At the end of February, state regulators reached a major milestone in that transformation, officially issuing an Order that lays out the regulatory policy framework and implementation plan for REV. Now it's time to make it a reality, and a second phase, now under way, will determine how.

THE ROAD TO REV

Undoubtedly, major storms such as Sandy and Irene helped motivate NY REV. The widespread and extended blackouts they caused exposed

vulnerabilities of the current grid, knocking out power for many customers for weeks, not just days.

"I heard one story of a woman whose grandmother had to walk down 26 flights of stairs to get water for days after Sandy. That gets to you," says Audrey Zibelman, chair of New York's Public Service Commission (PSC), the lead agency behind REV. "This is not the inconvenience of, 'Oh, I gotta empty my refrigerator and freezer because the meat spoiled.' This is, 'I don't really like the idea of my grandmother having to walk down a dark stairwell.' I think it sort of drove home to folks the importance of having a resilient grid and how these extreme weather events, climate change, can really affect us."

"The electricity industry of the future is coming, and it's probably coming here first ... placing the customer at the center of the grid equation as never before."

But acute major events like Superstorm Sandy weren't the only factors in play. There's also recognition that customers' relationship with the grid and their utility is changing in a big way. The traditional one-way delivery of electrons to end users like homeowners—and the monthly bills for that service—are giving way to a much more dynamic set of options that empower customers with choice for when and how they consume and produce electricity, how much that energy costs, how much carbon it produces (or not), and more.

In the February Order, the PSC asserts that it will “embrace the changes that are shaking the traditional system and turn them to New York’s economic and environmental advantage.” The PSC goes on to say that distributed energy resources should be “on a competitive par with centralized options,” and that utilities will have a new role in developing and operating distributed energy markets.

The state is betting that those distributed energy markets—and the customer-sited technologies behind them—can be a fundamental part of achieving six main goals for the state’s electricity system that include: maintaining affordable electric service for customers (also implying stable and predictable prices), generating local jobs and investment, keeping energy dollars in the state that would otherwise leave to buy fossil fuels, reducing greenhouse gas emissions and air pollution from New York’s grid, and enhancing the grid’s reliability and resilience.

A CHAMPION AT THE HELM

Major change such as this doesn’t happen without passionate, dedicated individuals behind it, and the face of that movement is the PSC’s Zibelman. One would be hard-pressed to find a better champion for NY REV.

“New York and its Hudson Valley just might prove to become the ‘Silicon Valley’ of the electricity system.”

Audrey Zibelman, chair of New York’s Public Service Commission, is the champion behind Reforming the Energy Vision (REV).

Before she chaired the NY PSC, her resume reads like a greatest hits of all the key state- and national-level board and committee positions: the New York State Energy Research and Development Authority, National Association of Regulatory Utility Commissioners, U.S. Department of Energy. But she also brings decades of electricity industry experience to the table, including as founder and former president and CEO of Viridity Energy, developers of a software platform that “transforms how energy customers interact proactively and productively with the electric grid.” If anyone can guide New York’s grid through a major transformation, it’s Zibelman and her staff.

“I first met Audrey when she was still at Viridity Energy,” recalls Hansen. “Seldom have I seen someone so passionate about this important work of creating the customer-centric 21st-century electricity grid. She brings a drive and dedication well-matched to big challenges like this that would otherwise be overwhelmingly daunting to many people.”

Ever humble, Zibelman is quick to deflect credit to the PSC staff who are in the trenches daily making REV happen.

But Zibelman and New York aren’t going it alone. They also have a consigliere in RMI, which is serving as a strategic advisor to the state on REV. RMI brings to bear its deep expertise on electricity economics and rate structures, utility business models, and state regulatory frameworks. A unique asset, too, is the RMI-convened Electricity Innovation Lab (e-Lab), which directly and comprehensively tackles the challenges of building a 21st-century electricity grid that’s efficient, clean, affordable, resilient, and rich in customer-sited distributed technologies.

“What New York is trying to do has largely not been done before, so there’s a big need to think creatively and holistically about what the solutions actually are that they should be considering,” says RMI’s Hansen. “We’re helping them with that. We’re helping facilitate conversations among the staff and also with national-level experts to whom we have access via our e-Lab. We’re serving as a conduit for good thinking from around the country into New York.”



Such thinking includes that of Richard Sedano, U.S. programs director for the Vermont-based Regulatory Assistance Project, an eLab member and nonprofit that advises public officials on energy policy and regulation.

THE EVOLVING UTILITY ROLE

New York’s evolving electricity system may be customer-centric, but utilities still play a vital role. They will continue to manage and operate the grid, and they’ll take on the role of operating markets for distributed energy resources and integrating those resources into the grid. And they’ll also benefit from the services DERs can provide and help to optimize their value for grid and society, beyond the traditional value that typically accrues to the individual customer using distributed technology.

Of course, that’s all easier said than done. “It’s very difficult for organizations that have operated basically the same way for 100 years to shift the way they think about customers and resources and the way they think about their business model,” Hansen says. New York’s utilities are actively engaged with REV and figuring out how to make changes that meet society’s needs while remaining financially viable.

REV transforms technological progress into “the first chapter in a new story [for utilities] where they become the platform by which these new resources can be developed and used to the best interest of both the individual consumer and society as a whole,” Zibelman says. For example, utility Con

Edison’s Brooklyn-Queens Demand Management project is pursuing myriad DERs as a cost-effective alternative to what would otherwise be a \$2-billion substation upgrade. Just as New York City’s water supply saved billions of dollars by protecting upstate reservoir watersheds rather than building huge plants to clean up water after it got avoidably contaminated, ConEd is pioneering downstream, customer-focused, least-cost solutions.

“I think all eyes are on New York right now to see how the REV framework ultimately gets implemented, because that could be a game changer in a lot of markets,” says Mark Higgins, senior director and head of government and utility consulting at Stratagen, a clean energy strategy consulting firm. “You could see a lot of other jurisdictions try to adopt something similar if utilities are able to move to a new business model that proves to be successful while also enabling a robust, competitive market for DERs. That’s the market I’m following most closely; they’re creating a very innovative regulatory framework.”

A CRADLE OF ENTREPRENEURSHIP

A cradle of entrepreneurship With this new electricity marketplace also comes the opportunity for investment and entrepreneurship from tech companies. “NY REV anticipates transforming grid operations and customer options by enabling distributed energy resources to be fully utilized along the entire electricity value chain,” says Sunil Cherian, founder and CEO of Spirae, an innovative technology company that focuses on

In February 2015, New York approved REV’s Track One order, the first major milestone on route to making REV a reality.

IMAGES: Previous page New York capitol image copyright Thinkstock / KMickey, Zibelman image copyright Rocky Mountain Institute, by John Bulmer Photography, Brooklyn Bridge with Manhattan image copyright Thinkstock / nyson.



Long known as one of the country's traditional financial hubs, New York is now becoming a hub for electricity system innovation and entrepreneurship.

smart grid solutions, including grid integration of distributed energy resources. "This transformation [will] open up opportunities for business and technology innovation driving entrepreneurialism and investments." In other words, New York and its Hudson Valley just might prove to become the 'Silicon Valley' of the electricity system.

Public-private partnerships like the New York State Smart Grid Consortium will play an important role, too, bringing together the utilities, entrepreneurs, policy makers, and researchers to find the most promising smart grid technology solutions and bring them to customers.

"The increased reliance on distributed energy resources, the majority of which will be privately owned, will also introduce a broad range of potential new stakeholders to the New York's power markets," says James Gallagher, executive director of the New York State Smart Grid Consortium. "REV will involve the introduction of advanced power technologies, sophisticated and expanded communication systems, smarter grid-integrated buildings, and improved tools that will allow customers to better manage their energy use and bills. The net result of all of these efforts will be a substantially smarter grid for New York State."

A TESTBED FOR INNOVATION

Already, we're seeing the first signs. Demonstrating the kind of on-the-ground program that is custom-tailored for REV, investor-owned utility Exelon Corporation and energy infrastructure developer Anbaric Transmission have joined forces to create a series of 10- to 200-megawatt microgrids at five sites throughout Long Island, New York City, and upstate New York.

At Skidmore College, one of the largest solar PV arrays in New York was completed in October 2014. It will generate an estimated 2.6 million kilowatt-hours per year, enough to meet 12 percent of Skidmore's needs and reduce greenhouse gas emissions by the equivalent of taking 412 cars off the road each year. The project was designed to take pressure off the grid and help make the school's system cleaner and more resilient, and was supported by Governor Cuomo's NY-Sun initiative and NYSERDA.

On the Clarkson University campus in upstate New York, the Potsdam microgrid is being created by a partnership between the school, GE Global Research and GE Energy Consulting, National Grid, and the Department of Energy's National Renewable Energy Laboratory. This microgrid will serve the entire community, powering essential services like the

hospital, emergency service providers, housing, fuel, and food providers in the case of a power outage.

The State is making a big investment to ensure that projects like these are successful. In addition to the ongoing \$1 billion NY-SUN initiative and \$1 billion NY Green Bank, there's also a \$40 million NY-Prize competition for community microgrids and—just announced in April 2015 by the Governor's office—a new \$160 million Clean Energy Fund directly in support of REV.

Seeing REV fully blossom will admittedly take time. Such sweeping state regulatory reform doesn't happen overnight. Which is why we can expect to see demonstration projects start rolling out this summer, as both a way to explore some of the cutting-edge opportunities REV will unlock and test and answer important questions before a broader state-wide rollout. For example, utility Iberdrola brought a team including community and university representatives to RMI's March 2015 eLab Accelerator boot camp to speed along the first of what could become several smart energy communities to show what the REV vision could do if applied in a particular place.

THE ROAD AHEAD

This two-way flow of electrons, services, and values won't happen without the communications infrastructure to relay all that data and decision making.

Adding a layer of IT to the grid is essential. Communication between the utility and customers becomes critical when distributed energy resources

"Customers' relationship with the grid and their utility is changing in a big way. But the future grid still has a grid, and the state's utilities will run it."

enter the mix. "Smart grid is a term you could interpret many different ways and means many different things, but at the most basic level, it's a question of how you make the grid intelligent using IT," says Dan Cross-Call, a senior associate in RMI's electricity practice. "Which way are electrons flowing? Who is providing or consuming what energy services at what times in what places?"

"The technology will evolve. It's evolving fast," Zibelman says. "Our goal is really to make sure the government doesn't get in the way by regulatory models that are old-school rather than new-school. We don't want the regulatory [piece] to be a drag on the transformation."

"Nobody wants the utilities to go bust," Hansen adds. "That would be good for no one." The future grid still—crucially—has a grid, and the state's utilities will run it. Distributed energy resources like rooftop solar will be a part of that grid, and REV's innovative platform will ensure that they're an integral part of a strengthened, resilient, affordable, cleaner grid.

Long Islander and New York native Billy Joel famously sang in his 1976 song that he'd "seen the lights go out on Broadway." With NY REV ushering in the grid of the future, those lights may stay on ... powered by the sun, first-of-their-kind customer-centric energy markets, and a whole new way of planning for and operating the state's electricity system. 🌞

Jennie Lay is a freelance writer and editor whose work has appeared in High Country News, Bulletin of the Atomic Scientists, and Wilderness, among others. She wrote about truSolar in the Summer 2014 issue of Solutions Journal.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/electricity

IMAGES: Lower Manhattan image copyright Thinkstock / Ultimata_Galina; Hudson Valley image copyright Thinkstock / Songquan Deng.



MAKING WAVES IN THE SHIPPING INDUSTRY

CARBON WAR ROOM'S SHIPPING EFFICIENCY OPERATION BRINGS DATA TRANSPARENCY, CAPITAL, AND DEMAND FOR FUEL-EFFICIENT SHIPS TO THE HIGH SEAS, SAVING MONEY AND CARBON.

By Helen Marks

The next time you buy a new pair of shoes, or frozen shrimp, or a children's action figure toy, or just about anything else, consider this: it probably came to you by boat—a very big boat.

Some 90 percent of the world's goods are transported by the international shipping industry, estimates the International Chamber of Shipping. And though more efficient than other forms of cargo like rail and truck, the shipping industry still has a big climate impact.

If the maritime shipping industry were a country it would be among the top ten producers of greenhouse gas (GHG) emissions globally, emitting 1 billion tonnes of CO₂e per year (more than that of Germany, the world's fourth-largest economy). If the industry maintains business-as-usual, that number is expected to grow an estimated 250 percent by 2050, leaving the industry responsible for 18 percent of global emissions, according to the United Nations' International Maritime Organization.

Shipping can thus be a powerful lever to tackle climate change, and Carbon War Room's Shipping Efficiency operation secured several major wins earlier this year. Many surround the operation's A to G GHG Emissions Rating, developed four years ago in partnership with globally recognized ship-vetting firm RightShip to help the industry identify and choose the most fuel-efficient ships.

The A to G Rating has gained substantial traction. One-fifth of the world's shipped goods are now moved by

“If the maritime shipping industry were a country it would be among the top ten producers of greenhouse gas (GHG) emissions globally.”



cargo owners using the rating system, a tripling in the past 2.5 years. Those companies represent 1.95 billion tonnes of cargo and 24,700 vessel movements per year. Recently, incentives offered by other industry players have further bolstered the Rating.

In January 2014, Prince Rupert Port Authority and Port Metro Vancouver became the first ports in the world to offer incentives to the most-efficient vessels calling to their ports based on the A to G Rating, rewarding those shipowners who invest in efficiency. Following the example these early leaders set, other ports are now expressing interest from Latin America to Europe to East Asia.

The industry took another big step in that direction in February 2015, when the Liberian Ship Registry, the second-largest in the world, began offering 50-percent tax breaks—a cumulative \$53 million tax incentive—for shipowners that retrofit their vessels using CWR's financing mechanism with EfficientShip Finance.

Meanwhile, energy efficiency is increasingly informing business decisions across the industry,

“One-fifth of the world’s shipped goods are now moved by cargo owners using the A to G rating system.”



including investments. As of April 2015, “banks are now publically stating that they use energy-efficiency data in deciding which vessels will receive financing—and which ones won’t. This is an exciting turning point,” says José María Figueres, chairman of the Board for the combined Rocky Mountain Institute and Carbon War Room. “As this trend continues, inefficient ships will become increasingly unmarketable.” These banks include HSH Nordbank and KfW IPEX-Bank, which have a combined loan volume of \$43.6 billion.

The industry’s growing prioritization of efficiency is creating a two-tier market in which more-efficient ships command a premium rate in the market. These have been hard-won victories years in the making, possible through sustained philanthropic support that allowed Carbon War Room to work with an industry initially reluctant to let outsiders in.

AN INVENTOR, AN INVESTOR, AND AN INNOVATOR WALK INTO A BAR

When the United Nations’ climate change negotiations failed in 2008, fueling a growing conviction that policy would be unable to lead the charge against climate change, there were wide calls for an entrepreneurial approach. In that context, Sir Richard Branson called a group of Virgin Group CEOs to his Caribbean home at Necker Island, where Carbon War Room was born in early 2009.

Carbon War Room’s idea was to identify and work in industries with significant carbon emissions and market barriers to their reduction. Early industry stakeholder talks included a fortuitous meeting between an investor-banker friend-of-a-friend of Branson’s and a Danish entrepreneur and inventor of a shipping industry air micro-bubble technology that helps ships slip through the water with less friction and thus improves fuel economy. They met in the basement of a private club in London, just off Berkeley Square, and dove headlong into a discussion of the global shipping market.

They noted that one ship—often worth tens of millions of dollars—is the equivalent of a power station on the water, with some of the world’s largest vessels emitting as much SO_x, for example, as one million cars. Improve ships, and you could flip a significant amount of carbon and other emissions.



But back in the basement in London, the Danish inventor asserted: “The market is broken. It’s plagued with market barriers. No one will ever buy my invention. Removing these market barriers will unlock innovation and sales of my technology, making me a millionaire!” The market barrier message resonated with CWR’s team, recalls Peter Boyd, then CWR’s COO: “It wasn’t about helping this one entrepreneur sell his technology. It was about fixing the market so that the best technologies—ones that would unlock fuel and carbon savings—would be purchased and succeed.”

DEVELOPING THE A TO G RATING

It quickly became clear that the market was not rewarding vessel energy efficiency; no one cared about efficiency solutions. With most fuel paid for by the cargo owner or charterer—a classic split-incentive—a shipowner couldn’t make a return for investing in clean technologies. Charterers would be stuck with the fuel bill at the end, but had no way of knowing if a better, cheaper choice existed. The closest proxy was a pay-to-play risk-vetting tool from RightShip that included environmental performance.

So, even with proven, available technologies in the marketplace, few retrofits were taking place and a lot of money was being left on the table. Even today, with lower bunker fuel prices, the industry can save tens of billions of dollars per year and reduce emissions by 30 percent by adopting technologies and operational measures, according to the IMO and Dutch consultancy CE Delft.

“In an analysis of retrofit opportunities for over 100 vessels, we found that at \$600 per tonne of heavy fuel oil, if the entire fleet were retrofitted with fuel-efficient technologies enabling just a 10-percent efficiency improvement, the industry would save \$16.6 billion on fuel costs and reduce greenhouse gas emissions by up to 87 million tonnes of CO₂ per year,” says Victoria Stulgis, senior associate of Shipping Efficiency.

At the time, the European Union (EU) was making headway with its Energy Label, which rated appliances with a set of energy-efficiency criteria, ranking them from A (most efficient) to G (least efficient). With this easy-to-use label gaining visibility, CWR pursued a similarly-styled A to G efficiency rating for shipping—it would help industry actors make informed choices based on cost and efficiency that would send market signals of efficiency’s importance in business decisions.

The team began looking for a partner to develop the required data for the rating, even as the Marine Environment Protection Committee of the IMO held its biennial meeting, where it became clear that improving the industry’s efficiency and unlocking significant gains would take decades in this forum. After observing the disheartening meeting, Carbon War Room and RightShip met at a café on the banks of the Thames, down the road from the IMO. A second thing became clear that day: RightShip could create the needed database and CWR could make it widely used.

In January 2014, Prince Rupert Port Authority and Port Metro Vancouver became the first ports in the world to offer incentives to the most-efficient vessels calling to their ports based on the A to G Rating.

IMAGES: Previous page image copyright Thinkstock / Stewart Sutton. Container port image copyright Thinkstock / chuyuu. Ships at dock image copyright Thinkstock / nattanant26.

Banks including HSH Nordbank and KfW IPEX-Bank are now publically stating that they use energy-efficiency data in deciding which vessels receive financing—and which ones won't.

Soon, ShippingEfficiency.org and the A to G GHG Emissions Rating were born, with a launch by Branson at the UN's 2010 climate negotiations.

INTEREST FROM FUEL BUYERS

Simultaneously, CWR began speaking to the charterers who'd benefit most from the rating. Getting charterers to use the rating to avoid the least-efficient vessels would generate demand for energy-efficient vessels and give shipowners a real market incentive to upgrade, thereby addressing the split incentive.

Shipping Efficiency partner RightShip worked with Cargill, Huntsman, and UNIPEC to help them develop policies to exclude ships with the poorest fuel economy. Representing 350 million tonnes of shipped commodities annually, these charterers helped foster momentum in the industry. As Jonathan Stoneley, then environment and compliance manager of Cargill Ocean Transportation said at the time, "We hope this action will demonstrate to shipowners that they can do more in terms of efficiency, and the market will reward them."

A LACK OF CAPITAL

Some companies were using their own money to finance one or two small upgrades that offered two-to six-percent improvements in fuel economy, but industry financiers weren't willing to supply loans for such a low-percentage return. In addition, such small fuel savings didn't result in better charter rates for shipowners. And, while blue-chip companies like giant AP Moller-Maersk were willing to finance the retrofits of vessels they chartered (and paid the fuel for) but didn't own, the majority of charterers didn't have that kind of capital and continued to suffer from the split incentive. So how to unlock double-digit returns?

Inspired by the property-assessed clean energy (PACE) financing that was then gaining ground in the building efficiency market, and was seen as a solution for landlord-tenant split incentives, CWR entered into a partnership with University College London (UCL) Energy Institute and PricewaterhouseCoopers to develop an energy service company-like, no-money-down finance model that would attract new sources of third-party capital and accelerate efficiency retrofits.

The resulting Self-Financing Fuel-Saving Mechanism looks at applying a bundle of four to seven proven fuel-saving technologies alongside advanced monitoring systems. This technology grouping conservatively boosts the savings from 2–6 percent to at least 10–15 percent. And the monitoring systems facilitate measuring and reporting of that effect. Private equity group EfficientShip Finance has since adopted the model, devoting an initial \$25 million to fund such retrofits.

"Carbon War Room's retrofit work is exactly what the industry needs," says Greek shipping tycoon Nicky Pappadakis. "Combining off-balance-sheet finance and bundles of efficiency technologies offers shipowners the perfect opportunity to improve their business and benefit from premium rates, while allowing their customers a 10–15 percent improvement in efficiency."

CHARTING THE COURSE AHEAD

RightShip data analysis shows that the average operating life of an A-rated vessel may be up to eight years longer than that of a G-rated vessel, and major shipping banks are acknowledging the existence of a two-tier market. Carsten Wiebers, global head of maritime industries at KfW IPEX-Bank, comments, "We see a clear trend towards a two-tier market of high- and low-efficiency vessels. More-energy-efficient vessels have an enhanced marketability as well as a higher revenue potential for the shipowner and thus a more favorable risk profile for financiers."

And, as the market offers increasing rewards to more-efficient ships, technology companies are beginning to gain traction in the market too. After enduring longstanding skepticism of his concept, the Danish inventor who introduced CWR to shipping has seen successful trials of his air lubrication technology with company Silverstream this year, paid for by Shell. "Silverstream's success paves the way for new technologies that unlock significant fuel savings, such as modern wind propulsion systems," says Alisdair Pettigrew, senior advisor to Carbon War Room.



Having a growing number of technologies retrofitted onto ships with rigorous and transparent trials is an essential stepping-stone to greater adoption. As shipowners benefit from earning a premium rate for efficient ships, they can have increasing confidence in technology performance and the returns they can expect. These early retrofitters will be rewarded, and will reinforce, the two-tier market between efficient and inefficient vessels that will become a critical driver of business decisions.

Meanwhile, stranded assets—ships deemed inadvisable investments by banks and equity lenders, imprudent insurance liabilities, and overall uneconomic for retrofits—will be retired. In the endgame, the world's fleet has been retrofitted, matching the efficiency of new-build ships, and the old oil-guzzlers unfit for retrofit have been retired as all vessels—retrofitted and new build—compete in an open, transparent market. 🌐

A two-tier market of high- and low-efficiency vessels is starting to emerge.

Dutch Postcode Lottery Awards Shipping Efficiency €1,000,000

The Dutch Postcode Lottery recently granted €1,000,000 to a joint RMI and CWR proposal, complementing the Lottery's existing funding of RMI and CWR. Using this additional funding and building on CWR's historical success, Shipping Efficiency will expand its efforts to support the shipping industry in realizing considerable emissions reduction and cost savings.



Helen Marks is a marketing manager at Rocky Mountain Institute and Carbon War Room.

WEB EXTRA

For more information on this topic visit: shippingefficiency.org

By Kaitlyn Bunker



Have Spreadsheet, Will Travel

AN ENGINEER RECORDS—AND REFLECTS ON—SIX MONTHS OF COMMUTING

I'm an engineer, so it may not surprise you that I kept track of my daily commute in a spreadsheet, just for fun, for my first six months at RMI. I am fortunate to have several options for getting to work at RMI's Boulder, CO, office, including bicycle, bus, and car. I've used them all, and I have a spreadsheet of data to prove it.

My favorite way to commute is by bicycle, about three and a half miles each way. My transition to biking was gradual. It started several years ago, while I was attending graduate school and driving about three miles each day to and from campus. I decided to try biking instead, initially once or twice per week. Soon, I was bike-commuting every day the weather was good, and then pretty much all the time throughout the spring, summer, and fall. Fast-forward to today. Each day, I decide how to get to and from work based on the weather, how I'm feeling that day, and what errands I need to run after work.

SAVING CASH, SAVING CARBON, BURNING CALORIES

In my first six months with RMI through February 2015, I made 214 one-way trips between home and RMI's Boulder office—47 percent by bicycle, 40 percent by public transit (bus), and the remaining 13 percent by car (either by driving or getting a ride in a car). But how did that compare to a baseline of driving to work every day?

Most people consider the "cost" of their commute in dollars, so let's start there. First, I should admit that, for me, any option other than driving is free, although they are not free for others—RMI provides employees with an EcoPass for riding the bus, and any maintenance needed for my bicycle is done by my husband, formally a bicycle mechanic. Because of



"Bicycle, bus, car—I've used them all, and I have a spreadsheet of data to prove it."

recent fluctuations in gasoline prices, I analyzed three different price cases: low (\$2 per gallon), medium (\$2.75), and high (\$3.50). Our car gets about 20 miles per gallon in Boulder's city driving conditions.

In these scenarios, each driving trip to or from work cost me somewhere between \$0.40 and \$0.70 in gasoline—not a huge amount—plus those modest miles' contribution to maintenance costs and their share of fixed costs (registration and insurance). But by driving only 13 percent of the time over the six-month period, I spent \$74–130 less than if I'd driven every trip. That might not sound like much over six months to some people, but that's still enough cash to buy about 12.5 burritos at Chipotle. Those with longer commutes would save more.

Then there's the environmental cost in carbon emissions. I assumed that my bicycle commute resulted in negligible CO₂ emissions, 8.88 kg of CO₂ emitted per gallon of gasoline for my car, and 0.107 kg of CO₂ emitted per passenger-mile on the bus. Compared to the baseline of driving in both directions every day, my actual commuting habits over six months saved ~260 kg of CO₂ emissions. I don't actively think about emissions when I'm deciding how to get to work each day, but seeing how these avoided CO₂ emissions added up really drove home the impact of my commuting choices.

Finally, there's the health cost. I started with a baseline of about 50 calories burned for each trip while either driving or sitting on the bus. I walk about half a mile to the bus

stop—for this I assumed burning an extra 50 calories. When I bike, I make the trip to work in about 25 minutes. According to an online calculator, biking at my moderate pace burns about 250 calories per trip. This resulted in 35,000 total calories burned by my mix of biking, riding the bus, and driving. When compared to driving to and from work every day, the difference is about 25,000 net calories burned. That's the equivalent of about 30 Chipotle burritos!

So over six months, my commuting choices resulted in far more calories burned (30 burritos) than money saved (12.5 burritos). I found this pretty exciting, even without taking into account the additional health benefits of breathing fresh air and soaking up vitamin D from the sun, or the mental health benefits of biking, walking, and taking the bus, including avoiding the stress of negotiating car traffic and finding a place to park.

A LARGER MOBILITY TRANSFORMATION

After looking at my own personal mobility transformation, I know that I am fortunate to live relatively close to my office in a bike-friendly community that also has a great bus system. This makes it easy for me to embrace multimodal commuting and choose the best way to get to work each day. I hope more communities around the country can move towards a similar mobility paradigm that makes it easier for many more commuters to make the transition that I have. Based on a quick look at my commuting experience over six months, it's clear that our climate, our wallets, and our waistlines would all benefit.

Kaitlyn Bunker is an associate at Rocky Mountain Institute.

⊕ WEB EXTRA

For more information on this topic visit: rmi.org/transportation

By Todd Neff

A Trillion Bucks Says You'll Sell Your Wheels

SAY GOODBYE TO TRAFFIC CONGESTION, PARKING PROBLEMS, DIRTY GASOLINE... AND CAR DRIVING AS YOU KNOW IT. MEET THE NEW MOBILITY, WHICH RMI—WITH INDUSTRY PARTNERS—IS USHERING IN.

Though driving is fun for some, for many it's a simple necessity of getting where we need to when we need to. We pay dearly for that, whether we realize it or not. We spend tens of thousands of dollars—and plenty more on gasoline, maintenance, insurance, and taxes—for an asset that sits parked 95 percent of its life. Then, even though our cars can seat four or more people, we usually drive alone—75 percent of American commuters are solo. There's also the interminable traffic congestion, in which we spend an average 38 hours per year. And of course the air pollution from tailpipe emissions, accounting for ~20 percent of all U.S. carbon emissions.

This "privilege" doesn't come cheap. Americans spend \$1.2 trillion a year on our personal mobility—20 percent of household incomes, on average. That equates to about \$0.59 per mile, which adds up quickly when the typical American driver tallies ~13,500 miles per year. And none of those numbers include the additional \$2 trillion or so annually that pollution, sitting in traffic, roads and parking lots, and accidents cost us.

But there's a better way... one that can ultimately save \$1 trillion of direct costs, 2 billion barrels of oil, and 1 gigaton of carbon emissions per year, according to Jerry Weiland, a 30-year veteran of General Motors and managing director of RMI's mobility program. In this not-too-distant future, per-mile mobility costs are slashed from \$0.59 to just \$0.15. RMI views this opportunity as an enormous prize to be split among consumers, entrepreneurs, wise incumbents, and progressive cities.

This new mobility builds upon RMI's proud legacy of work on cost-effective, oil-free transportation embodied in the Hypercar

concept, *Winning the Oil Endgame*, and *Reinventing Fire*. Expanding from the concept of more-efficient, better-designed vehicles, RMI's team believes the future of mobility will look very different from its past. The confluence of several major trends is the front line of this fundamental mobility transformation.

On the societal front, the rise of peer-to-peer networks, smartphones, apps, and the sharing economy (think AirBnB, Uber, Lyft, Car2Go, ZipCar, and many others) are changing perspectives on whether we own and how we access and use assets like cars and houses. Plus, as a nation we're driving

"The new mobility can save \$1 trillion, 2 billion barrels of oil, and 1 gigaton of carbon emissions per year."

less. Among Millennials there's a distinct departure from the car-centric worldview of their Boomer parents, with vehicle ownership and even driver's license rates on the decline. Meanwhile, total vehicle-miles traveled (VMTs) peaked in 2007, and per-capita VMTs have been declining even more sharply since.

Our vehicles are transforming too, seeming to come out of science fiction, and demonstrating a quantum leap from the internal combustion engine autos we've been driving until now: self-driving cars and electric vehicles like the Tesla Model S, Nissan LEAF, Chevy Volt, and BMW i3. Automakers already sell cars with parking automation, adaptive cruise control, lane keeping, and other driver-assist features. And incumbents plus new entrants such as Google and Apple have put millions of miles on self-driving vehicles, which are already legal on the roads in California, Nevada, Florida, Michigan, and Washington, D.C.



Car sharing and public transit are part of an urban transition to mobility as a service.

The sum of these trends is far greater than the parts, and point to a very different future of new mobility with four elements at the core.

The first is mobility as a service. "We're going to share cars," says Weiland. "They're going to be running 12-hour days at very high levels of utilization." Since the mobility is there when you need it and not when you don't, it's essentially "mobility on demand," like streaming your favorite movie. And when you're not committed to a single vehicle (the one you own in your garage today, perhaps) then the mobility-as-a-service perspective opens up all sorts of possibilities to you—walking, biking, Ubering, Lyfting, a self-driving car, buses, trains. The new mobility gets you where you want, when you want, how you want.

Underlying mobility as a service is using the right vehicle for the right job. Forget giant SUVs with third-row seats shuttling a single person. The vehicles of the future—a future that will take shape in

the next five to ten years, the RMI team says—will be a diverse lot, built for diverse needs. Comfy one-seaters could carry commuters between their homes and bus or train stations, finally cracking the infamous "last-mile" problem that has long vexed transit planners. SUVs might carry people to the mountains or the beach, pickup trucks to Home Depot and back. Minibuses might make sense where big buses now trundle along mostly empty (and thus costing up to 90 cents a passenger mile in many municipalities, says Jonathan Walker, a manager in RMI's mobility practice).

The vehicles of this future will also be electrified. Why? In a high-utilization mobility future—where fewer vehicles are driving more miles and more hours of the day—operating costs dominate their total cost. That's one place where electric vehicles (EVs), with an average 120 MPGe, have a huge leg up over gasoline-burning cars, because their drastically lower "fuel" cost more than offsets their higher purchase price. And, since EVs also have far fewer moving parts, Weiland says they can go 300,000 or maybe even 500,000 miles, compared to 150,000 miles on the average late

IMAGES: Traffic closeup image copyright Thinkstock / Rafal Olikis. Seattle image courtesy of car2go North America.



“In the new mobility, much higher utilization rates mean we’ll need far fewer cars to move more people more efficiently in less traffic with less cost and less climate impact.”

model car. The combination of robustness and low maintenance costs makes EVs ideal for high-volume shared services. That includes corporate fleets, where EVs can seriously trim a company’s operating costs and carbon footprint.

Then there are the aforementioned self-driving vehicles. At first blush, self-driving capability might sound like another cool feature. For maybe \$10,000—the Boston Consulting Group’s estimate for the added cost of that capability and the actual price of California startup Cruise Automation’s Audi self-driving add-on—you can let your car drive you. Catch up on the news, read a book, do some work, take a nap. But think about it: if the car can drive you, why have it just park itself and wait all day for you? Why not share it, let it transport others rather than sit parked waiting for you? Self-driving vehicles thus only further support mobility as a service provided through ubiquitous retail fleets, instead of individually-owned cars.

Finally, there’s mobility-friendly cities, says Greg Rucks, a principal in RMI’s mobility practice. Today’s urban landscapes are built around the automobile: streets clogged with traffic; drivers circling city blocks

searching for parking; curbside, garage, and underground parking. Mobility-friendly cities, on the other hand, can trade excess road capacity and parking for more parks... or homes or shops or anything other than catering to the almighty automobile.

THE JOURNEY OF A THOUSAND MILES...

There are currently about 253 million registered cars and light-duty trucks on the road in the U.S. With a 2014 population of 319 million, that’s almost one car per person! That won’t be the case in the new mobility, where much higher utilization rates mean we’ll need far fewer cars to move more people more efficiently in less traffic with less cost and less climate impact. Of course, arriving at such a mobility Shangri-La won’t happen overnight, and it won’t be easy.

Weiland, Rucks, Walker, and the rest of the team believe we can reduce the number of urban/suburban vehicles on the road by up to 90 percent. Along the way, we will redefine cities and, probably, American life, just as the horseless carriage once did. The barriers will be formidable. Automakers, insurance companies, and other incumbents won’t be excited to cede 90 percent of a

market, Weiland says, and would need to develop completely new business models to stay competitive—just as today’s electric utilities are facing with the rise of rooftop solar.

Psychology may prove a bigger hurdle than technology. People like the idea of being able to spontaneously take off somewhere in their own wheels, whether they do it very often or not. Plus, consumers may be slow to trust self-driving technology and reluctant to cede the steering wheel to a computer “brain” under the hood that’s wirelessly connected to the mobility world around it—even though self-driving cars are already safer than cars with human drivers. Data privacy could be a concern, too, though Rucks says the data at the heart of the new mobility would be anonymized. It’s not your personal secrets that matter, he adds, but rather “the aggregation of data in and across systems.”

“We have to devise a solution that’s 100-percent failsafe,” Weiland says. “The new mobility has to offer people a complete answer, not a partial one. Otherwise you’re not going to get rid of your car.” Or at least one of them as a starting point.

Nobody, the RMI team included, knows where exactly this all might go, and that’s not the point, Walker says. “We want to whet the appetite of businesses to go attack these trillion bucks,” he says. The road ahead looks very different from the one behind. But the question now is who will chart the course, who will come along for the ride, and who will be left standing on the side of the road.

Todd Neff is a freelance writer who specializes in covering energy and climate. He wrote about retail electricity pricing in the Summer 2014 issue of Solutions Journal.

+ WEB EXTRA

For more information on this topic visit: rmi.org/transportation

THE FUTURE OF PERSONAL MOBILITY

AN URBAN TRANSFORMATION FOR THE UNITED STATES

TODAY
ANNUAL STATS

VEHICLE COSTS



VEHICLE USE



PERSONAL EXPENSES

~\$15,000/YR = \$0.59/MILE (More than average food and leisure expenses combined per year)
* 2-car household

FUTURE

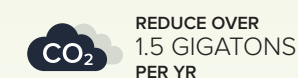
REDUCE OIL CONSUMPTION



REDUCE OWNER COSTS



REDUCE EMISSIONS



HOW DO WE GET THERE

01 MOBILITY AS A SERVICE

Multimodal transportation seamlessly connected to mobility on demand



02 MOBILITY-FRIENDLY CITIES

More walkways & bike paths while reducing roads & parking lots



03 THE RIGHT VEHICLE FOR THE RIGHT JOB

Vehicle size, type, and features matched to the specific need of the moment



04 SELF-DRIVING VEHICLES

Safer, more-efficient “robot cars” that let passengers spend time on activities other than driving




IMAGE: Traffic congestion image copyright Thinkstock/ alexandragit.





2317 Snowmass Creek Road
Snowmass, Colorado 81654
(970) 927-3851



Your support is crucial for Creating a clean, prosperous, and secure energy future™

JOIN THE NATIONAL SOLUTIONS COUNCIL

We are extremely thankful for our National Solutions Council members who are committed to supporting and promoting RMI's work. With a minimum contribution of \$1,500 per year you help transform ideas to solutions and network with others who share the same goal: a vibrant future rich with abundant, clean energy.



WWW.RMI.ORG/NSC
NSC@RMI.ORG

JOIN THE LEGACY SOCIETY

Let your vision for a clean, prosperous, and secure energy future live on. Name RMI in your will with a bequest or a charitable trust and support RMI's work in perpetuity.

Contact us at **303-567-8716**
Or ENGAGE@RMI.ORG

About *Solutions Journal*

Solutions Journal is published, both in print and electronically, by Rocky Mountain Institute. Back issues of *Solutions Journal* and all RMI publications are available online at <http://www.rmi.org>.

About Rocky Mountain Institute

Rocky Mountain Institute (RMI) is an independent, nonpartisan, 501(c)(3) nonprofit organization. RMI transforms global energy use to create a clean, prosperous, and secure future.

Contact Us

2317 Snowmass Creek Road
Snowmass, Colorado 81654
(970) 927-3851

1820 Folsom Street
Boulder, Colorado 80302
(303) 245-1003

solutionsjournal@rmi.org | <http://www.rmi.org>