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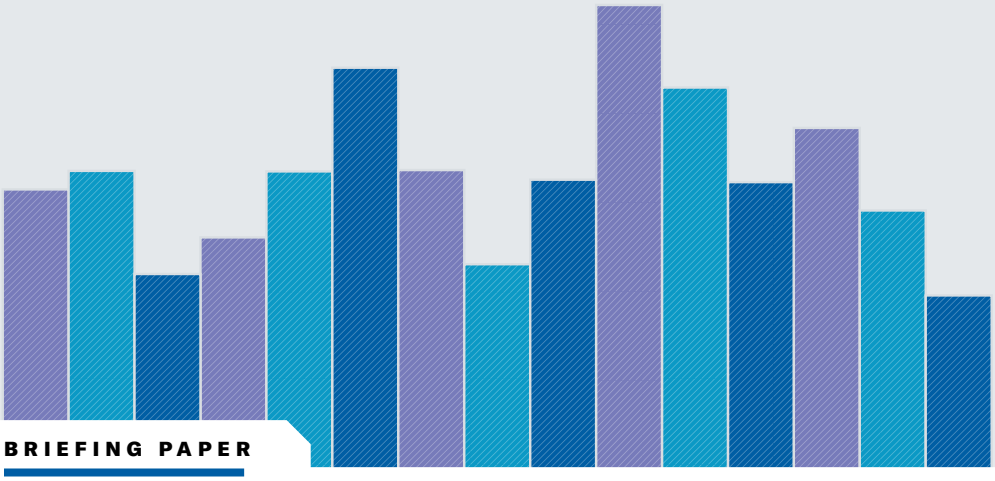

BRIEFING PAPER

Using Software and Other Technologies to Make Renewable Energy a Cost-Effective Reality

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Global markets are at a crossroads, the outcome of which will determine whether “alternative energy” becomes just “energy” and the ecological burden of fossil fuels becomes a thing of the past.

Leading the charge are firms that deploy critical infrastructure to support the demand of consumer energy needs. Yet these firms often face a false narrative designed to impede the adoption and propagation of clean energy: the “big green premium.”

As you’ll read in this report, the big green premium may at one time have been a legitimate concern, but that is no longer the case. Improvements to alternative energy asset hardware have made solar, wind, and other renewable energy economically viable. Sitetracker is on a mission to prove that the software powering the deployment, operation, and maintenance of renewable energy assets creates a commercially advantageous opportunity for the providers of this distributed infrastructure.

With a 94% adoption rate, Sitetracker is purpose-built to empower rapid scaling of alternative energy infrastructure. Our software provides automated, end-to-end workflows designed around the best practices of the electric vehicle charging and solar industries while real-time data seamlessly flows across the platform and between systems, unifying mission-critical business operations under a single source of truth. The end result is 20% faster project turnaround times and compounding portfolio growth for our customers, leading to greater availability and proliferation of alternative energy to consumers.

Innovation has always been driven by the market but led by the firms putting it into action. And while each has its own role to play in creating a more sustainable future, Sitetracker is committed to empowering these companies to successfully realize the green dream.

Randy Reynolds
VP of Marketing
Sitetracker

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Using Software and Other Technologies to Make Renewable Energy a Cost-Effective Reality

New Columbia Solar is based in Washington, D.C., but the key to the solar energy provider's growth strategy is mechanical, not political. The company's projects involve solar solutions for commercial operations and nonprofit organizations in an urban setting, and it typically has to manage 10 smaller jobs for every single big one its larger rivals have in another market. Creating a greener world for the company in the nation's capital didn't require more lobbyists but a way to make its operations and infrastructure builds more efficient.

For New Columbia Solar, the answer was software. According to the chief operations officer, Nicole Marandino, the software system the company now has allows for quick data entry, automation of complicated workflows, and seamless, real-time reporting of field operations. The system facilitates the use of a common language for all team members, and the database is available 24/7 to everyone, from the CEO to individual crew members.

"I could easily see it saving us thousands of man-hours a year," says Marandino. "[The software is] just so flexible that we can configure it however we want. [It] takes the guesswork out of how our employees should organize their day and shows them where the critical paths are to be most effective in their roles."

In addition, Marandino believes that other efficiencies and large cost savings could also be realized in legal fees, thanks to New Columbia Solar's affiliation with a SaaS (software-as-a-service) provider helping with the configuration of the software. She sees the standard legal costs of roughly $20,000 per project closing eventually being cut in half and potentially dropping to as

HIGHLIGHTS

Thanks to the **operational efficiency that software and other tools can now bring to wind, solar, and other renewable energy infrastructure,** the cost of going green isn't as steep as it was before.

Software and other technologies can create such efficiency when it comes to how solar panels or windmills work that **the idea of a big green premium is anachronistic.**

Just because there are now software and other technologies that can make renewable energy more cost-effective and operationally more sufficient **doesn't mean such a transition is easy.**

According to New Columbia Solar's chief operations officer, Nicole Marandino, the software system the company now allows for quick data entry, automation of complicated workflows, and seamless, real-time reporting of field operations.

low as $2,000 because the SaaS's solution can streamline back-end processes used in due diligence.

Thanks to the operational efficiency that software and other tools can now bring to wind, solar, and other renewable energy infrastructure, the cost of going green isn't as steep as it was before. Software can help renewable energy providers deploy infrastructure faster, manage more projects and assets with fewer people, and improve operational efficiency overall.

More organizations in the renewable energy sector, however, still must come to the same realization New Columbia Solar did. It starts with a solid upfront strategy, which includes tailored and purpose-built software for infrastructure that allows the energy solutions providers to efficiently deliver what a customer wants. These consumer wants could include solar panels connected to a huge grid, strategically placed charging stations for electric vehicles (EVs), or windmill farms that keep the lights on at home and at work.

"Digitization, including appropriate software tailored to the project, allows renewable energy facilities and projects to be managed remotely in a standardized way. This allows them to be built and operated more efficiently and cheaply, with fewer delays and stoppages," says Mika Obayashi, director of the Renewable Energy Institute, based in Tokyo.

This report examines what may be thwarting the foundational development of the renewable energy infrastructure. It also explores how software and other tools can be used to provide the operational efficiency needed for such foundational infrastructure to work. Finally, it examines how the so-called big green premium—or the extra costs associated with adopting cleaner technologies or energy sources— is now less and less a factor as costs have come down due to software innovations, among other things, and how the thinking of the stakeholders needed to move wind, solar, and other renewable energy sources forward is changing.

Debunking the Big Green Premium

Renewable energy infrastructure is now operating at scale throughout the world. Norway has installed 16,000 charging stations for some 400,000 EVs and plug-in hybrid cars. China has gone even further, erecting more than 309,000 charging stations over the past decade. Colchin, India, runs the world's first solar-powered airport, which even gives energy back to the power grid and grows and sells vegetables. The London Array, the world's sixth-largest wind farm, sits in the Thames Estuary and has a capacity of 630 megawatts; on the edge of the Gobi Desert in China is the world's largest such farm, with 7,000 turbines—enough to power a small country.

Much of this infrastructure runs on customized software and depends on efficient, miniaturized mechanisms, as well as batteries, which are easy to use, cost-effective, and accessible. In the U.S., demand for such solar, wind, and other renewable energy infrastructure, and its efficient operation, is only likely to grow.

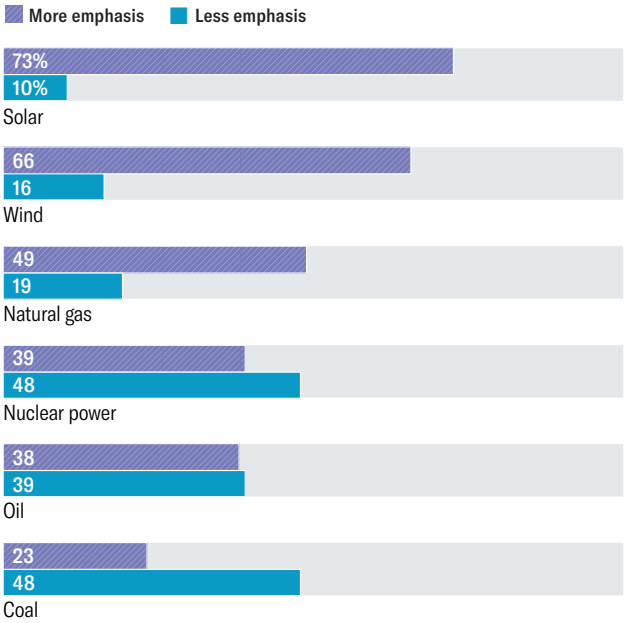
According to a March 2021 survey by Gallup of 1,000 adults living in the U.S., 73% want the government to emphasize producing more solar energy, whereas dwindling percentages—23%, 38%, and 39%—favor pushing for more

FIGURE 1

Solar Has the Brightest Future

Oil and coal rank at bottom

Do you think that, as a country, the United States should put more emphasis or less emphasis as it does now on producing domestic energy from each of the following sources?



Source: Gallup survey, March 2021

"Digitization, including appropriate software tailored to the project, allows renewable energy facilities and projects to be managed remotely in a standardized way," says Mika Obayashi, director of the Renewable Energy Institute, based in Tokyo.

coal, oil, and nuclear energy, respectively. **FIGURE 1** Wind power ranked second to solar at 66%, while natural gas came in at 49%.

Despite increasing public support for conversion to renewable energy sources, the specter of the big green premium haunts the actual execution of a strategy to create the infrastructure for them. Simply put, the big green premium represents the extra cost associated with selecting a clean technology over one that releases a larger amount of greenhouse gases, which pollute the environment and contribute to global climate change.

The reality, however, is that the use of software and other technologies, such as those that model the performance of wind and solar integrated power systems, can reduce energy costs. Software and other technologies can create such efficiency when it comes to how solar panels or windmills work that the idea of the big green premium is anachronistic.

Mark Z. Jacobson, a professor of civil and environmental engineering at Stanford University and the director of the school's atmosphere/energy program as well as author of *100% Clean, Renewable Energy and Storage for Everything*, goes a step further when discussing the big green premium. "Green energy results in lower energy and climate costs and better health than fossil energy, so there is no such thing as a green premium," Jacobson says. "[The big green premium] is made up by people claiming green energy is more expensive."

Getting It Done With Software

Just because there are now software and other technologies that can make renewable energy more cost-effective and operationally more efficient doesn't mean such a transition is easy. As Marandino tells it, New Columbia Solar filed through a lot of duds in its search for the right match.

As a rule, she says, software is generally not produced to address the intricacies of the solar industry, and software companies can come and go quickly, leaving those that bought the product with no tech support. She found that some software is geared to engineering or procurement or construction management, but no company offers a product that combines all those functions and the others her company needs.

New Columbia Solar's current solution is head and shoulders above what was previously available, namely hit-and-miss solutions to challenges that could only be addressed by individual software programs. The only result from these standard software programs was sluggish operation that was neither cost-effective nor efficient enough to drive down costs significantly, couldn't help beat deadlines, and failed to help renewable energy providers win more contracts.

Off-the-shelf, commercially offered software programs aren't "enough to create real change and the difference we need to drive those costs down," Marandino asserts. "If you have [a software program like the SaaS solution we use] that's connected and creates that visibility across the disciplines, you can move much, much faster. Communication is everything, and so is getting the right information to the right people quickly. If you have to wait for each one of those pieces to move, the amount of time it takes can drag out. And time is money."

Marandino adds that New Columbia Solar chose not to go the route of creating its own software, like larger solar providers do, because the cost would have been prohibitive. In addition, she says, software development is not her company's area of expertise, and they wanted to partner with a technology vendor that knew how to take New Columbia Solar's vision and turn it into a reality. That's especially true because stand-alone software programs she reviewed didn't fulfill New Columbia Solar's needs and because with the volatility of the high-tech industry, its vendors can't be relied upon to stay in business and provide tech support later on. So, Marandino concluded that the very best plan for her company was to work with a SaaS partner for a tailored solution.

Using Tech in a Public EV Charging Network

Software has also changed the narrative when it comes to EVs and charging stations. Four years ago, the state of Michigan had no active, publicly available direct-current (DC) fast chargers for EVs, or electric vehicles. Today, Michigan, the home of Detroit, the car capital of the U.S. and the epicenter of internal combustion engine manufacturing, offers 480

The idea behind the tool used for the project, according to the University of Michigan's Ghamami, "is ensuring all the EV trips are feasible, minimizing investment cost while minimizing users' waiting, detour, and charging time."

publicly accessible charging stations featuring nearly 1,400 charging outlets as well as 146 private charging stations.

That change came about thanks to funds from the Michigan Department of Energy, Great Lakes and Environment (EGLE) Energy Services. It was money from EGLE Energy Services that was earmarked for a study overseen by Mehrnaz Ghamami, Michigan State University assistant professor of civil and environmental engineering. She began the multiphase project with a half-dozen graduate and doctoral students in 2018. Ghamami's project, the Optimized EV Charger Placement Plan, is administered by EGLE Energy Services and has resulted in recommended charger placement throughout the state. The plan tracks intercity, intracity, and urban traveling patterns and trips taken by residents and tourists and has contributed to the design of the Charge Up Michigan program, which involves a partnership among site hosts, utilities, and the state to build a network of DC fast-charging stations that make all EV long-distance trips feasible within Michigan and to neighboring states and nearby Canada.

With federal funds supplementing those from the state, the team studied eight major urban areas in Michigan, including Detroit and Grand Rapids, and nine of its smaller cities, including Menominee and Sault Ste. Marie. Among the stipulations of Ghamami's project are that her team develop its own software and that the program be offered to other states and planning agencies to help them set up their own network of charging stations. The idea behind the tool used for the project, according to Ghamami, "is ensuring all the EV trips are feasible, minimizing investment cost while minimizing users' waiting, detour, and charging time."

As for creating the software, there was no comparable tool available for what the team needed, namely data evaluation and project tracking and planning, says Ghamami, echoing Marandino's experience. So, the project team worked within the university's mainframe system to create a bespoke solution. "For modeling purposes, we developed our models and solution algorithms (i.e., metaheuristic algorithms) and then coded everything in a multiparadigm programming language or used other programming languages," she explains. "We also used a commercial solver as an optimization tool for small-scale problems and to validate our solution algorithm. To simulate the trips, we incorporated a traffic-analysis tool using the statewide travel-demand model provided by the Michigan Department of Transportation."

Among the results of the project are cost savings when it comes to the build-out of the charger network. In the optimization model, the team found ways to lower the expense of the infrastructure, chargers, and electricity, as well as the cost to drivers. The team also discovered that because intercity dwellers don't always have charging stations at home, they cannot charge their vehicles overnight and need access to public stations.

Finally, having the optimal wattage for the charging stations factored into the network's success, too. For example, 50-kilowatt charging stations take longer to charge a battery than most drivers have the time or patience for. By either upgrading those to 150-kilowatt stations, which can easily be done by attaching a more powerful component, or installing 150-kilowatt stations at the outset, the battery's charging time is shortened, which also helps prevent bottlenecks at public charging stations. All this simulation was done through a traffic-analysis tool.

After the analysis, the answer was to use a more expensive and more powerful charger whose efficiency would ultimately lower costs overall and create better traffic flow at stations. "Comparing the 50-kilowatt charger and 150-kilowatt charger, [the] 150-kilowatt charger is way faster, about three times faster, [but] it's more expensive," Ghamami explains. "Even though the 150-kilowatt chargers [cost] more per piece, we would need a lot [fewer] chargers because of the higher throughput that these chargers have. The overall cost of a network of charging stations along Michigan highways providing similar- or better-level service is less than that of 50-kilowatt chargers. With the 150-kilowatt chargers, vehicles [can] charge [faster] and leave [faster]."

In the project's third phase, which is now underway, the team is examining distributed energy resources, supporting the grid, and reducing the cost of electricity for the customers using distributed energy resources like battery storage and solar panels. Ghamami knows of no commercially available software system for infrastructure that mimics what her team and Michigan have achieved with their EV charging stations project.

Michigan is carrying on its renewable energy programs. For another project altogether, the state is in the project-solicitation phase to fund EVs to replace older, diesel-powered vehicles.

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Meanwhile, legacy companies, including oil producers Shell and BP and car manufacturers Mercedes-Benz and a partnership of Hyundai and Kia, are picking up the slack and setting up networks of charging stations to accommodate what they predict will be a strong demand for EVs. Other experts agree that more EVs are coming. "We think that within two decades, a majority of new automobiles sold in the U.S. will be electric," wrote John Paul MacDuffie and Sarah E. Light in "EV Turning Point: Momentum Builds for U.S. Electric Vehicle Transition," in the March 15, 2021 issue of *Yale Environment 360*.[1]

Driving Cost-Effectiveness Home

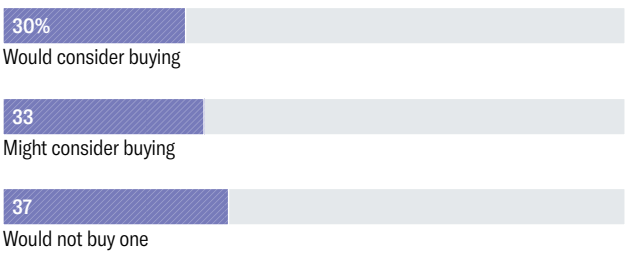
Projects like those in Michigan prove that the costs of operating renewable energy infrastructure can be driven down, yet pricing is always cited as a stumbling block for converting to renewable energy solutions. Because EVs are the renewable-energy products most accessible to most consumers, attitudes about their cost are the most often debated. According to a CBS News poll in April 2021, 63% think EVs are too expensive to buy, 61% think there aren't enough charging stations, and 60% believe that EVs don't have enough range before a recharge is needed. However, Americans are warming to the idea of EVs, in that of those respondents, 30% would consider and 33% might consider buying an EV. **FIGURE 2** For 37% of respondents, EVs are out of the question.

The acceptance rate of EVs in the United States has tripled since 2016. According to McKinsey & Co.'s report "Electrifying Insights: How Automakers Can Drive Electrified Vehicle Sales and Profitability," only 20% of Americans were open to buying an EV then. For the report, McKinsey conducted an online poll of 3,500 vehicle buyers in the United States, Germany, and Norway and an additional 3,500 in China.

FIGURE 2

Will More Americans Buy an EV?

The majority are leaning toward owning the new technology



Source: CBS News poll, April 2021

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But as the Michigan example shows, the cost myth when it comes to EVs and charging stations can be debunked. What seldom are discussed as part of the infrastructure of charging station builds and other renewable energy sources are the software and other actual technologies now available to make them more affordable. Stanford's Jacobson uses his personal experience as an example of savings that can be had by going the renewable route. "I haven't paid a natural gas, electric, or gasoline bill in four years," he says.

Jacobson lives in a photovoltaic (PV) house he built in 2017, which is solely powered by renewable energy. It has solar panels on the roof and battery storage for the family's two Tesla EVs. The home's air-conditioning, heating, and hot-water tank are run by electric heat pumps. In the kitchen, the family cooks on an electric induction cooktop stove, and they use LED lights throughout. Jacobson says that software in the inverters controls whether the house uses solar PV or battery electricity and whether the PV is used to charge the battery, run the appliances in the house, or send power to the grid.

Jacobson remains more the exception than the rule when it comes to PV houses. Much needs to change for them to become more affordable to build. But while it cost more initially to build the family's PV house than a conventional one, Jacobson explains, he has made up the difference in the extra expenses within four years, plus he saved the $16,000 it would have cost for a natural gas hookup and related pipes. The icing on the cake is that the house produces 20% more energy than it needs, which he sells to the grid for $800 a year. Better yet, "the temperature in the house is always comfortable," he says. And because the house is off the electric grid, "If there's a blackout, we don't have one."

"In the case of my house, residential PV is more expensive upfront than utility PV, and batteries are not free, but all appliances were similar [in] cost [to] their fossil alternatives," says Jacobson. "Further, the energy costs of the main electric

New Columbia Solar's Marandino sees the standard legal costs of roughly $20,000 per project closing eventually being cut in half and potentially dropping to as low as $2,000 because [its software-as-a-service provider's] solution can streamline back-end processes used in due diligence.

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appliances [and other] machines (heat pumps, electric vehicles) are one-quarter those of their natural gas or gasoline counterparts."

Conclusion

Innovation is the calling card of technology. And pricing and cost-efficiency to make projects scalable are often what seal the deal.

With that in mind, the costs of renewable energy have continued to drop for hardware and software. "Since 2010, there has been a 64%, 69%, and 82% reduction in the cost of residential, commercial-rooftop, and utility-scale PV systems, respectively," according to the National Renewable Energy Laboratory's report "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020."[2]

Jenya Meydbray, the CEO of Berkeley, Calif.-based PV Evolution Labs, an independent lab that monitors the extended reliability and performance testing for solar PV and storage technology, confirmed this pattern in a company statement. "By the time PV Evolution Labs started testing at PVUSA [Photovoltaics for Utility-Scale Applications] in 2011, the cost of a PV module had dropped to just $1.39 per watt and more than 30 gigawatts of solar was installed worldwide. Over the past decade, the expansion of solar power has continued to skyrocket."[3]

Equipment expenses for wind energy have also dropped, while an evolving learning curve on how that equipment should be used has helped reduce costs further. "The analysis finds that changes in materials (copper, fiberglass, and iron), labor (employee productivity), legal and financial costs contributed over 30% to the cost reduction of wind turbine prices over the period 2005–2017.

"Moreover, learning-by-deployment was the most important innovation driver, being responsible for half of the cost reduction," wrote Alessia Elia and her coauthors of the article "Wind Turbine Cost Reduction: A Detailed Bottom-Up Analysis of Innovation Drivers," for *Energy Policy*.[4]

Governments are also boosting the renewable energy quest in the U.S. through policy advances in cities and states. Nearly two dozen U.S. cities have strong renewable energy programs, meaning they get at least 70% of their power from renewable power, notes the nonprofit charity CDP, which produces a global disclosure system for investors, companies, cities, states, and regions to manage their environmental impacts. According to the U.S. Energy Information Administration website, "As of the end of 2018, 29 states and the District of Columbia had renewable portfolio standards (RPS), or policies that require electricity suppliers to source a certain portion of their electricity from designated renewable resources or eligible technologies. Four states—New Mexico, Washington, Nevada, and Maryland—and the District of Columbia have updated their RPS since the start of 2019."

Although the Biden administration is aiming for progress in renewable energy nationwide through a legislative infrastructure package, its success is uncertain.

With so much going on, there is no time to waste, according to Jacobson. "Renewable deployment needs to increase by an order of magnitude over the next few years," he says. "We can't allow its deployment to slow down."

Endnotes

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