# CHAPTER 3

# MICROGRIDS AND ASYMMETRICAL INFRASTRUCTURE

## MARINE CORPS AIR STATION MIRAMAR

When Governor Jerry Brown held the state's highest office the first time in the 1970s, he was a nontraditional leader whose environmental focus went beyond much of the political establishment's. In his second go at the governorship, which ends in 2019, Brown is still out front: He's pushed a climate change agenda for the state that is among the nation's most visionary, and he's led an unofficial group representing states, cities, businesses, and universities to climate talks in Bonn, Germany, where he pledged to abide by the Paris Agreement—even as the Trump administration's official US delegation arrived to promote fossil fuel use.

Brown takes the climate-action fight where it leads him and looks for allies where he can—including the Department of Defense, which is one of California's largest employers. At a meeting with military brass in 2017, Brown thanked them for supporting his climate change initiatives, saying their efforts on military installations around California were making both the state and the military more resilient. Then he asked for more.

Challenging them to jump the ruts of status-quo thinking, Governor Brown said: "We know we have to innovate, and innovation means not doing the same old thing."

The sense of urgency is well founded. In California, climate change is turning up the frequency dial on wildfires, record-breaking temperatures, and extreme weather events; and the California Department of Water Resources warns that climate change is having a "profound" impact on California water resources.

Marine Corps Air Station Miramar didn't need the governor's challenge; it's already ahead of the game and is building what will be the Defense Department's most ambitious and greenest installation-wide microgrid to date. Slated for completion in 2019, the Miramar microgrid will be powered mostly by renewable energy and, at the very least, be able to disconnect, or "island," from the shaky national electrical grid and operate autonomously when necessary. What's more, the air station is building this microgrid while at the same time helping the area quench severe water-scarcity problems. "Energy security" is the buzz phrase these days, but for Miramar it's the energy-and-water-security nexus that matters—a holistic attitude that acknowledges the environmental realities of the region and state. Not bad for a peewee-size air station best known until now as the place where *Top Gun*'s derring-do flight scenes were shot.

At 23,000 acres and constrained on all sides from future expansion by greater San Diego, Miramar is a relatively compact installation. The mission of the Third Marine Aircraft Wing, which is located on the base, is to provide well-trained combat-ready aviation forces capable of short-notice worldwide deployment. Twenty percent of the 9,300 marines and sailors assigned to the air station are deployed at any given time. One

recent deployment to Puerto Rico, to deliver 60,000 pounds of food and supplies after Hurricane Maria ravaged the island, occurred just a few days after the air station broke ground on its installation-wide microgrid. Among other things, the microgrid will help Miramar defend against modern contingencies like extreme weather—to name one menace—while also mitigating the installation's contribution to the greenhouse gases known to factor into climate change.

In the quest to ensure a sustainable future for Miramar and therefore its mission, the air station has managed to transform encroachment and proximity to a large urban municipality—downtown San Diego is just 13 miles south—into an asset, venturing beyond the fence line to partner with the City of San Diego on these renewable-energy and water reclamation projects. While the American Society of Civil Engineers gave the nation's energy infrastructure, drinking water system, and wastewater treatment varying degrees of a D grade overall in its 2017 annual Infrastructure Report Card, the Marine Corps and the City of San Diego have embarked on visionary, large-scale public works that break from the underachieving pack. Acknowledging this, in 2017 the US Environmental Protection Agency ranked San Diego eighth in the nation in clean power production. In recognizing Miramar's role in the ranking, the city's assistant director of public utilities, John Helminski, told me that Miramar has been "an excellent partner" to work with.

It's not always easy being Miramar's neighbor. The air station gets a half dozen noise complaints a day about its jets, which fly from 7:30 a.m. until midnight most days. Popular cycling trails that pass through the base have been restricted, and marines have been known to confiscate the bikes of those who don't heed the signs. But the air station's partnership with San Diego

is breaking new ground—not just on the infrastructure projects themselves but more broadly by showing how the military can work with communities as a good neighbor to help the region cope with environmental threats.

What is now Marine Corps Air Station Miramar had its roots in the army, which established a National Guard training center on the property in 1917. It became an aviation way station for the navy and Marine Corps in the 1930s. Although Miramar today is home to sixteen flying squadrons and more than two hundred fixed and rotary-wing aircraft, the aviation iteration of the base had a tragic start due to human error and no small amount of technological hubris.

Crossing the Dust Bowl region of West Texas in 1932 from its home base in New Jersey, the USS *Akron*, a helium-filled US Navy rigid airship and the largest ever built, was pummeled by a massive dust storm and forced to stop for repairs at Miramar en route to a scouting assignment in the Pacific. Only nine months before, the *Akron*—also known as the Queen of the Skies—had been christened by first lady Lou Henry Hoover to tremendous fanfare. These were hard times in America and the Great Depression was in full swing. Millions of farmers in the Plains states, displaced by drought and destructive federal agricultural policies, were migrating west toward the promise of California; homeless camps along the route and elsewhere in America were derisively called Hoovervilles; and President Herbert Hoover was about to lose the election to Franklin D. Roosevelt in a landslide. People needed something big and bold to celebrate, and they came out by the thousands for the christening. When Mrs. Hoover pulled the ceremonial cord, a compartment opened in the blimp's belly and a flock of silvery doves flew out.

The *Akron* was two and a half football fields in length and

could carry five Curtiss Sparrowhawk fighter planes in its hold. It was new to the world, and certainly to the Miramar ground crew that greeted it when it landed. No one expected or was prepared when the hot California sun caused the airship's helium load to expand. When the airship came unmoored and began to rise, four young sailors tried to hold it to the ground with ropes dangling from its underside. Like Icarus, the men were taken up into the sky. One sailor let go of the rope quickly and only broke an arm in the fall; two hung on too long and died after they lost their grip and plummeted to earth; the fourth was lucky to find a toggle to slip a boot into, and he was able to stand, hugging the rope to his chest for two hours, until crew members on board could reel him in.

By the time the *Akron* crashed into the sea off the East Coast six months later, killing seventy-three of its seventy-six crewmen, Roosevelt was president and his New Deal administration was signing off on massive public works projects to promote economic recovery. Many of those infrastructure projects were designed to last sixty years and are today antiquated, obsolete, and inefficient. A part of that frayed infrastructure is, in short, what the Miramar Energy Project, as it is known, is reimagining. Less hubristic than pragmatically human-scale and collaborative, the air station's contributions to the project are grounded in the realities of technology and cost and driven by a man on a mission.

**Mick Wasco had a** newly minted undergraduate degree from UC San Diego in structural engineering when he started work at Miramar as an engineering technician in 2010. Two years later he was promoted to energy program manager. His title is some-

what of a misnomer, given that he's the manager of a team of one. As he said when I first met him in 2016, "Energy isn't even a department here; it's just a thing."

Wasco, who has the distracted air of someone with too much to do and too little time to do it, readily admits that luck played a role in his energy innovations. A joint initiative between the Department of Defense and the Department of Energy in 2008 identified ways to reduce energy demand and increase renewable energy use on military installations. As the largest energy consumer in the US government, the Department of Defense had concluded that its use patterns and dependence on nonrenewable fossil fuels were impacting its mission at home and abroad. The Department of Energy then tasked its National Renewable Energy Laboratory (NREL) with devising specific approaches to attaining those goals, and NREL, in turn, chose Miramar as a case study.

When I first reference the lab in conversation with Wasco, I use its acronym but pronounce it NARAL, as in the National Abortion and Reproductive Rights Action League. We were sitting across the table from each other, and when I saw the look of amusement on his face I immediately realized my mistake. I blushed and blurted, "Jeez! That's the abortion rights organization. Not what I meant."

For future reference, NREL is pronounced with the emphasis on the letter N, followed immediately by the first part of "relationship," as in "N-rel." Federal agencies, and the military in particular, employ far too many acronyms as a general rule. But NREL I like because every time I use it now I think about relationships and how things are connected—the matrix of biota, habitats, climates, and basically all of life. If I have a bias with regard to NREL, and I most assuredly do, it is that I consider the

lab a sleeper cell in the contemporary political battle for good science, good government, and good stewardship; and it's fighting on the right side. It is the United States' premier research laboratory for renewable energy and energy efficiency but also takes the lead on cost-effective technology development, commercialization, and deployment. In other words, it walks its talk and works with federal agencies to transform the way energy is made and used.

Miramar was chosen as one of NREL's Net Zero Energy on Installations projects. Generally speaking, "net zero" means energy self-sufficiency based both on reduced demand and on use of local renewable-energy resources. NREL's refined definition of net-zero energy for military installations requires that each one "produce as much energy on-site from renewable-energy generation, or through the on-site use of renewable fuels, as it consumes in its buildings, facilities, and fleet vehicles." NREL's net-zero project for military installations does not yet include tactical aviation fuel in its calculations, but if the R&D efforts of people like Ben Harvey at Naval Air Weapons Station China Lake pan out to create high-performing commercially available renewable jet fuel, installation net-zero energy will take on an even more impressive meaning.

As NREL was winding up its analysis of Miramar in 2011, the region-wide electrical-grid failure knocked out power to Miramar and all the other military installations in the area. Training missions stopped at Miramar. "A lot of our security systems were compromised, and marines had to guard ordnance," Wasco said.

"It wasn't theoretical anymore, it was actual," said Sam Booth, senior project leader at NREL and the point person on Miramar, referring to the blackout and its real-world consequences. "A lot

of folks were able to see the impacts. It went from, 'Hey, we're going to design you a system and its backup power if the grid goes down, or if there's an attack or something,' to people really understanding the need."

NREL's resulting reports, titled, *Valuing Energy Security* and *Targeting Net Zero Energy at MCAS Miramar*, focused on practical recommendations—many tailor-made for Miramar. Among the most resonant were the steps needed for the air station to be able to delink from the nation's electrical grid and not depend on utility providers to power its mission-critical functions, which include the seamless operation of the hundred or so buildings along the installations flight line next to its airfield.

As Wasco recalls, his initial impetus for reaching toward net zero had been to build renewable on-site energy-generation systems that would be cleaner and cut costs, both worthy goals in their own right. But the power outage "marked the moment of change in energy management" for him. "I'm now realizing that we could use those [renewable-energy] assets to provide us with resiliency and security and mission capability. It's not just something to do to make the bugs and bunnies happy, it's to become more effective at our mission."

Unlike environmental programs, driven as they are by decades of federal law and accompanied by budgets, energy programs like Wasco's are comparatively new. For example, there are approximately twenty employees in Miramar's environmental department. Wasco is a one-man band. The air station secured $20 million from Congress in 2014 for the installation-wide microgrid, but that doesn't cover the rest of Wasco's master plan. He's had to get creative to find additional funding, capitalizing on public-private partnerships; leveraging budget-neutral Energy Savings Performance Contracts that allow federal

agencies to upgrade or initiate efficiency and renewable-energy projects with no up-front cost; and using sheer scrappiness to move his energy projects forward. "Mick is a kind of visionary in the Marine Corps," said NREL's Booth. "Having worked with a lot of people in his position across the Department of Defense, Mick has the willingness to be innovative, to work hard, to take risks. He goes above and beyond in a way that a lot of others don't. He wants to push the envelope."

Wasco's first big foray into energy resiliency came in 2012 when he was approached by the Raytheon Company, which had secured funding from the Defense Department's Environmental Security Technology Certification Program, to become a military host site for testing cutting-edge battery technology. The holy grail of power management is batteries. It's one thing to generate power from renewables, but intermittency makes renewables fickle. Reliable and plentiful battery storage could help transform an unreliable source of electricity into one that could radically transform how power is made, who makes it, and how it's distributed. Miramar signed up.

Wasco worked with NREL and Raytheon engineers to design a building-capacity microgrid that could keep electricity flowing by combining renewable energy from the base's 200-kilowatt solar array with battery storage. Primus Power was chosen to supply the storage: a zinc-bromide flow battery that utilized titanium and a unique design that prolonged battery life. "We thought the technology deserved development," says Wasco. "We could have just bought a bunch of car batteries linked together to make it work, but that didn't have the value I see with the DoD's program to test new technologies." The goal of the DoD's environmental security program is to go beyond standard off-the-shelf commercial projects while avoiding woo-woo

super wacky ones. According to Booth, the program's "pre-commercial sweet spot is where a project or two has been completed but there's not yet a really big track record and operating history." That's just where the zinc-bromide flow battery fit.

In 2016 Wasco deliberately knocked out power to Miramar's public works building to demonstrate how his mini microgrid could work. "Basically, we simulated an outage. Everybody in the building saw the power go out." Importantly, his building-capacity microgrid was capable of what's called a black start. Imagine that everything is on and working fine and then there's a sudden power outage. You need to be able to restart things and pick up the building's electrical load equal to what it was just before the power was cut, or have a control system in place that can manage and prioritize what comes on line when. That's a black start, and solar generation alone can't do that. You can't just flood the electrical system with solar power. For want of a better word, solar power alone is not "intelligent" enough to know the load requirement and carry that power where it needs to go, which is why a battery and a smart power system are required.

After the black start, the electricity flowed and the lights came on. Impressively, the test achieved 80 percent solar penetration, meaning that 80 percent of the energy used during the exercise came directly from the solar panels to provide for the building's electricity needs and only 20 percent came from the battery. Computers powered up. "A sign of success!" Wasco says. There were also lessons learned. The goal was to be able to "island," meaning that the building could power up and operate independently from the grid. "We wanted to be able to island the building for seventy-two hours—sustain ourselves for multiple days. But in reality, we faced some limitations with the technology."

To be fully operational, the building required 100 kilowatts of electricity. Even though the base had plenty of solar panels, the battery could not accept that power while providing power to the building. In other words, the battery couldn't charge and discharge at the same time. With those constraints, the Primus zinc-bromide flow battery could provide only eight hours of backup power.

**The base has added** photovoltaic arrays on rooftops and carports so it can now generate a total of 1.5 megawatts of power from solar. The second generation of the Primus battery will be part of the installation-wide microgrid as well, thanks to funding from the California Energy Commission. The commission is also funding a $3 million vehicle-to-grid (V2G) lithium-ion fuel-cell demonstration project on base: Three electric cargo vans and three electric pedestrian vans will provide green transportation. When they aren't in demand they will plug into the microgrid to provide power. "I spend a lot of hours trying to figure out how to use other people's money," Wasco says. "I've been getting involved with California state initiatives. When it comes to clean energy, there are so many opportunities it's crazy!"

The biggest power boost for Miramar doesn't come from the sun or from V2G technology, however, but from garbage—which has helped power the air station since 2012. Unlike Fort Irwin, Miramar has a happy story to tell about trash.

The City of San Diego has leased land on air station property for a landfill for more than half a century; today it's at 1,500 acres. One can see the air station's landing field and hangars from the dump. Each year, more than 900,000 tons of trash come through Miramar Landfill's gates. A huge recycling facility is just inside

the fence line, but notices and bins along the main dirt road alert drivers that they have another chance to deposit recyclables before they reach the actual tipping point for trash. Along the route there's a turn-off for the Miramar Greenery, where curbside clippings destined for the waste stream have been diverted and transformed into mulch, compost, and wood chips. San Diego residents can drive in and take up to 2 cubic yards of the stuff for free, while landscapers and other commercial outfits pay a nominal fee.

At the active landfill cell, where commercial trucks actually dump the trash, high moveable backstops keep floaty plastic bags from blowing off site, and employees with bright orange vests and hard hats orchestrate the traffic flow. The city runs a tight ship on the air station's land. There's a lot of beeping, the automatic warning that a dump truck is backing up. As soon as trash is dumped, a tricked-out earthmover starts compacting it. By closing time each day, the garbage has either been covered with dirt or a temporary tarp material. The effort keeps down the accumulation of ravens and seagulls, which could get sucked into jet engines and pose a threat. The bird control program is part of the longstanding contract between the city and the Department of the Navy.

Throughout the landfill, one can spy pipes jutting from the ground: The Miramar Energy Project, a joint venture between the air station, the city, and an energy development company, captures methane from the landfill with this pipe system—the pipes act like little vacuums that suck up the methane—and transforms it into energy. Methane—straight out of the ground, produced by decomposing organic landfill waste; or straight out the backsides of livestock, produced as one would imagine—is a potent greenhouse gas. According to the Intergovernmental Panel on Climate Change, while the better-known carbon diox-

ide ($CO_2$) persists in the atmosphere for centuries to warm the planet, methane does much worse damage in much shorter time: methane has twenty-eight times the heat-trapping power as $CO_2$ over a hundred-year period. When methane is captured, refined into natural gas, and burned, however, it enters the atmosphere as $CO_2$—still a greenhouse gas but far less potent. In a climate-changing world with no silver bullets on the horizon, prettified methane from leaky landfills is a lesser evil compared to coal and other fossil fuels.

Not only did the initial phase of the project drastically reduce the amount of raw methane emissions escaping from the landfill, a refinery and power plant built there currently produces 15 megawatts of renewable energy. Of that amount, 3.2 megawatts go directly to the air station through dedicated infrastructure to supply 37 percent of its average electricity needs. The rest goes to power City of San Diego public works, like its demonstration wastewater reclamation plant, which produces 1 million gallons a day of reclaimed water. The air station satisfies around 30 percent of its water needs by using some of that reclaimed water for landscaping, for street sweeping, and in toilets. Landfill gas also powers San Diego's Metro Biosolids Center, which processes sludge at the landfill.

The Miramar Energy Project is a matrix that excludes the area's investor-owned utility, San Diego Gas & Electric. The City of San Diego contracted with Fortistar to build the landfill power plant and pay for the pipes that run the gas to its facilities, and build other necessary infrastructure as well. The air station has done much the same for its infrastructure. According to one energy expert I spoke to, the fact that the air station and the city's water agency—both historically large consumers of utility-provided power—are finding ways to break free of

what has essentially been a regulated monopoly is of great concern to SDG&E. As well it should be: These kinds of changes to business as usual threaten to disrupt the traditional power-generation-and-provision paradigm, opening the possibility of a new energy frontier where those suffering bureaucratic inertia are left in the dust.

The population in San Diego County is one of the fastest growing in the nation and is expected to reach nearly four million by 2050. Not only does that put a stress on the electrical grid, it also increases the demand for water: Currently, the county imports 85 percent of its supply, and costs have grown exponentially. In 2000, water was $400 an acre-foot; by 2016, it was $1,200 and continues to rise, according to San Diego's assistant director of public utilities John Helminski.

Since water conservation efforts began in San Diego in 2007, the city has been able to reduce its water use by 17 percent even as the population has grown. But with population trends ever upward, and Western drought part of the new normal thanks to climate change, in 2014 the city launched the $3 billion Pure Water project to help ensure that San Diego can continue to thrive both economically and environmentally. The air station is part of this project, as Pure Water will be powered by the landfill in its Phase 1 iteration. This is what twenty-first-century sustainability infrastructure looks like, and though the particulars aren't necessarily pretty the sum of the parts is impressive, even elegant. Here's how it will work:

The landfill, which currently captures 50 percent of its methane emissions to provide 15 megawatts of power, will add capacity so that it can capture nearly all the emissions. As part of its installation-wide microgrid project, the air station will get a piece of that action, adding another 1.6 megawatts to what it already

utilizes from the landfill. When approached about getting the additional power, "Of course the city said yes," Helminski told me, adding somewhat tongue in cheek, "seeing as how we being good neighbors and they being our leaseholder we are more than willing to do that." The rest of the new landfill power, upwards of an additional 15 megawatts, will provide the electricity needed for the upgrade and expansion of San Diego's North City Water Reclamation Plant just northwest of the air base.

The North City facility was built as a demonstration project in 2011. To date it has performed more than 28,000 water-quality tests on the 1 million gallons of purified (though still non-potable) water it produces each day from—okay, let's just say it—sewage. In the next phase of Pure Water, expected to be completed by 2021, North City will build a LEED-certified advanced water treatment plant across the street, add several additional and critical steps to the treatment process to bring it up to state and federal drinking standards, add additional generation capacity so it can transform the landfill gas into power on site, and produce 30 million gallons per day of high-quality drinking water. When Phase 3 is completed, in 2035, San Diego will be producing 83 million gallons of potable water a day, one-third of its drinking-water demand.

The Pure Water process is complicated and energy intensive—and kind of gross-seeming until one realizes that much of San Diego's pricey and imported water, drawn from the Colorado River and the canal that conveys water from Northern California to San Diego, is also wastewater that has been treated and then put back into the system. Still, the Pure Water concept takes some getting used to. Like I said, it ain't pretty and I admit to balking at first when Helminski offered me a glass of water produced by the advanced five-step treatment process.

(It tasted far better than Los Angeles tap water.) Pure Water is a level-headed yet forward-thinking endeavor that will help the City of San Diego slake its thirst, upgrade its infrastructure, and better control its destiny. Mick Wasco is riding that wave at Miramar.

**While working to bring** the building-capacity microgrid on line, Wasco was simultaneously working with NREL on the installation-wide microgrid project. During peak-load demand, Miramar requires 14 megawatts of electricity to power the base. The average load is 7 megawatts and the minimum is around 5 megawatts. If it works as planned, the installation-wide microgrid will utilize a mix of renewables, battery storage, and diesel and natural gas to generate reliable power on base, ensuring energy security at all mission-critical buildings along the flight line.

"You hear that construction?" Wasco asks as we sit in the public works building. Beyond the wall, sounds of hammering and sawing can be heard. It's been a year since our first meeting and little over a year since the building-capacity microgrid proved itself, and Wasco is finally getting a dedicated energy office and control room as part of the larger installation-wide microgrid. He's obviously pleased, though no less harried.

NREL had run the numbers for the air base; it had calculated costs and taken a deep dive into the relative benefits of using particular energy sources to achieve energy security. According to Wasco, the air station currently uses 40 percent renewable energy—3 percent photovoltaic and 37 percent landfill gas. When the installation-wide microgrid powers up, it will use 60 percent renewables due to the increased power coming from the landfill.

Wasco underscores that, while operating, the microgrid will

likely use a high percentage of renewables, but a certain amount of conventional generation may be required for reliability and surety. Landfill gas, like any other renewable, is not consistent, he says. "Sometimes the quality changes and it causes generators to trip off line." So, in addition to the 1.3 megawatts of solar and the 4.8 megawatts of landfill-gas power, the air station will build a $13 million plant powered by 4 megawatts of diesel and 3 megawatts of refined natural gas supplied by SDG&E. The air station's on-site plant will provide backup when landfill-gas generation lapses, but during low demand almost all energy needs can and will be met by landfill gas and solar, he says.

Wasco, ever the engineer and realist, is resigned to this conventional and renewable mix. "When you have to think about operating your own grid, reliability and power quality are big deals." He's looking to the future as well, though, and turning to his alma mater, UC San Diego, for an assist. They've partnered and are on the trail of another grant from the California Energy Commission, this one to provide funding for battery storage large enough to deal with the inconsistencies inherent in large-scale landfill-gas use. This, in addition to Wasco's other battery storage projects, "would mean we could use it alongside landfill power and mitigate having to use diesel," he says. "The benefit to the state in our grant proposal is that we would not be burning diesel but instead be replacing it with energy storage—assuming that it works. This is another demonstration project! But that's what California wants to invest in," i.e., ways to make dirty fossil fuels obsolete, Wasco says.

Even though Miramar's diesel engines are going to be certified Tier 4, the cleanest technology on the market, the injection of a fossil fuel into Miramar's resiliency plan is a bit of a buzz killer for me, so I ask NREL's Sam Booth if they couldn't

have found another way to make the microgrid hum without it. "There are other ways, but they're mostly cost prohibitive. The scale of batteries Miramar would need to ensure power for half the installation just isn't economically feasible. Technically feasible? Sure. No one would do it, but there's no technical reason you couldn't," he tells me.

I ask how long he thinks we will be stuck with a reliance on diesel. "I think about that a lot," he says, explaining that diesel generators are relatively cheap to buy but expensive to run, which makes them the go-to emergency choice when the grid goes down temporarily. "They have resiliency value and cost you less up front," he says. The more expensive (and cleanest) option would be photovoltaic power combined with a battery storage system. Though not cost effective and therefore not realistic yet, such a system "would have grid-connected and resiliency value," Booth says, meaning such a system could conceivably contribute to the region's power needs when those needs are highest, while serving the base's needs at all times.

The important word here is "conceivably." Regardless of whether the power is generated by diesel or clean, green renewables, Miramar and all other military installations in California are currently restricted by law and Public Utilities Commission regulations from exporting excess power back onto the grid. According to Wasco, there is even technology in place at the air station to make sure of this. The installations are also prohibited by the same PUC regulations from being paid for that power, even if they were able to put it on the grid. But what if Miramar were allowed to provide power to the grid when it was really needed, say, during peak electricity demand between 4:00 and 9:00 p.m. daily, and be paid a fair price for it in the form of what's called a feed-in tariff?

Sam Booth isn't the only one thinking about how to harness Miramar's microgrid potential. As the California state director of the US Marine Corps West's Office of Governmental and External Affairs, Ned McKinley's portfolio of duties includes working with lawmakers and others to help make the lives of military personnel in California better. That said, a "big chunk" of his time is taken up with installation energy issues related to cost, reliability, and security, he says. For McKinley, the Miramar microgrid presents a world of possibility that benefits not only the air station but the larger San Diego community as well.

McKinley imagines that Miramar's microgrid could become a pilot demonstration project: with a feed-in tariff, the air station could be incentivized to generate power for the state at peak times to prove its benefit to the surrounding community while also meeting the energy security needs of the Marine Corps. "We are putting in place state-of-the-art technology that produces renewable energy and can interact with the grid for everyone's benefit. That's valuable; that's worth something. If fairly compensated, Miramar could help pay for its microgrid 364 days out of the year by putting power on the grid. And on that one day when fires or something take out multiple transmission lines, the installation would have the ability to hold on to that power and go into island mode and still land and take off aircraft safely." The air station's location makes this idea even more practical, adds McKinley, because "it's right in an urban area near load centers."

It seems such a simple and straightforward idea. Wasco is on board with McKinley's pilot-project notion and in fact had floated a similar scenario when I first met with him. The problem is that one person's proof of concept is another's hit to the bottom line. "Utilities need to come up with a new business model

so that they are not an impediment to this interconnected grid of grids," McKinley says. SDG&E had a successful demonstration 4.6-megawatt microgrid project in Borrego Springs, which also utilized a combination of diesel, solar, and battery storage. The company is now working on connecting its microgrid to a nearby 26-megawatt solar field, but there's been no discernible interest yet in allowing military installations to produce and supply power in the way McKinley and Wasco suggest.

Miramar's microgrid is located at the four-way intersection of political will, technical reality, economic feasibility, and aspirational goal, and it therefore reflects the fundamental challenges to the widespread deployment of renewable energy. In California, forward-leaning renewable-energy targets and market-driven green incentives have jump-started a good deal of innovation and technology adoption, while market mechanisms and regulation have worked to disincentivize diesel and natural gas use. Miramar's microgrid could be the next step: Were it able to prove itself useful in achieving energy security for the air station and, at the same time, alleviate stress on the electrical grid and further California's climate-action goals, the state would be that much closer to building its much-needed twenty-first-century sustainable infrastructure. A greener future is dangling right in front of us; it would be a pity to not seize it.