

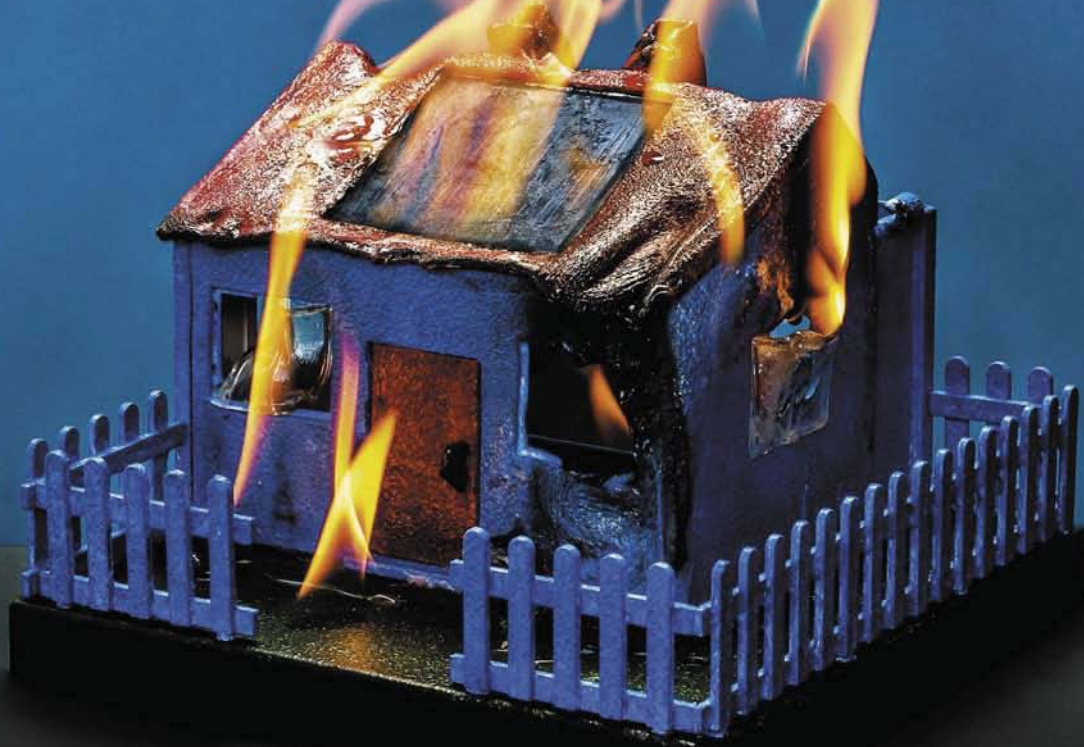
# Photon

The Photovoltaic Magazine

## IT'S TOO LATE NOW

What you should have asked about solar insurance

An iPad for your thoughts – our first readers' survey



**YOU LOOKIN' AT ME?** Good. A Brooklyn developer's plan for urban PV  
**ESCAPE FROM ALCATRAZ** Solar prevents carbon from fleeing »The Rock«  
**ROCKY COAST, ROCKY MARKET** Maine could use some policy help



## Alcatraz



Visited by 5,000 tourists daily, protected as a historic landmark and now serving as a seabird sanctuary, Alcatraz is now home to an off-grid PV system – one that has faced numerous challenges. Once the system is permanently online, it should cut the run time of the island's generators by 60 percent. But technicians are still struggling to make it work.

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Solar panels and batteries are intended to someday replace diesel generators on Alcatraz Island

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The photographs on these pages are a challenge even for experts



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**Cover:**

We all purchase insurance as protection against disasters, such as fires. But if you want to be sure that your PV system is covered, ask lots of questions.

**Photo:** Dirk Eusterbrock / photon-pictures.com

## Massachusetts



Governor Deval Patrick recently signed a package of energy-related measures into law. For Massachusetts' growing solar industry, the decisions to raise the net-metering cap and to exempt small PV systems from it were warmly greeted – except by the utilities. Despite the changes, some question whether more policy adjustments will be needed soon.

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## Solarcity



As the nation's largest residential solar integrator, Solarcity does a lot of hiring. And as an organization offering solar training to ex-cons and former gang members who have turned their lives around, Homeboy Industries in Los Angeles has plenty of people looking for work. So how is it that Solarcity nearly found itself the target of a Homeboy-led boycott?

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**Lead article**



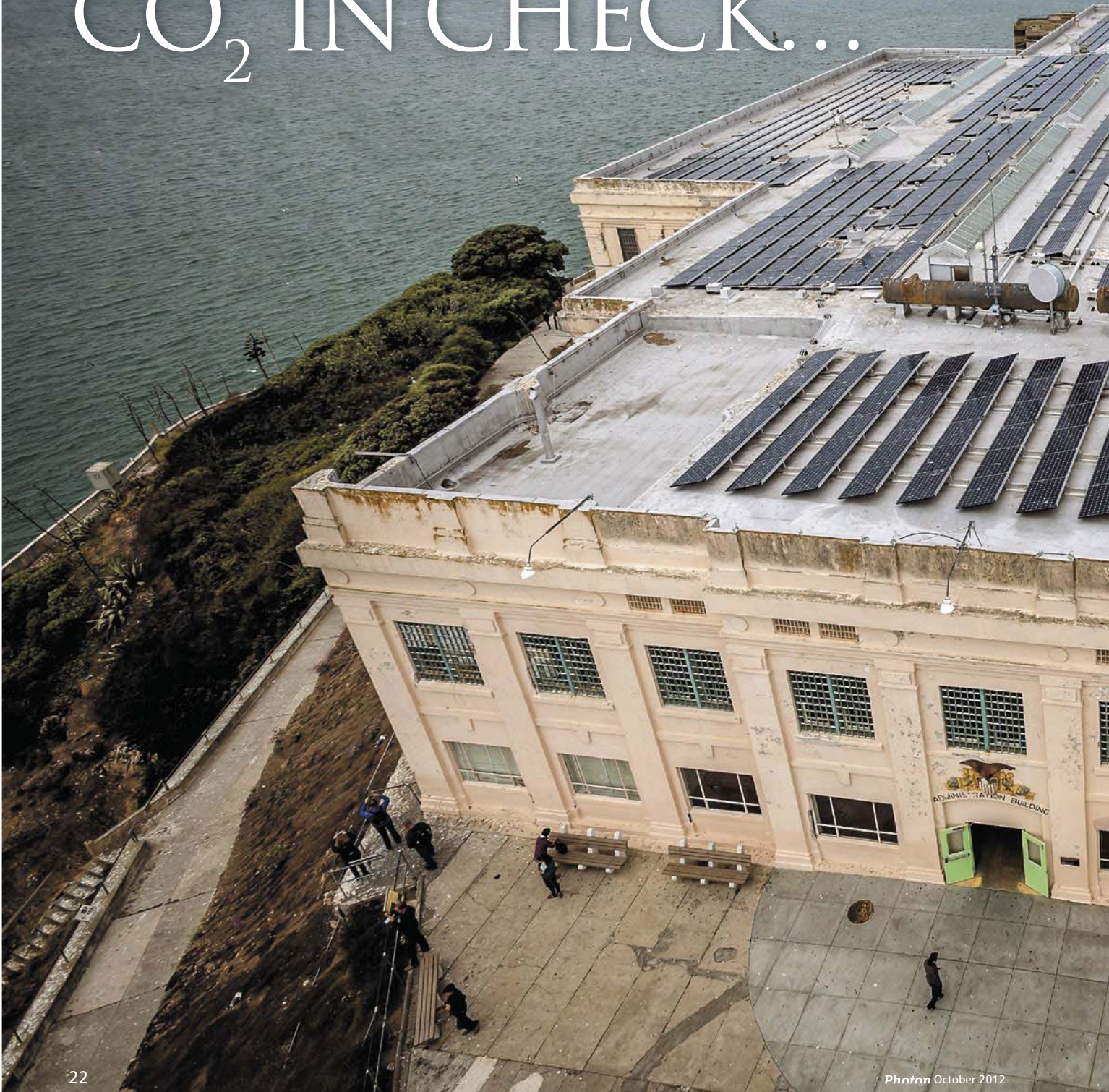
**additional pictures:**

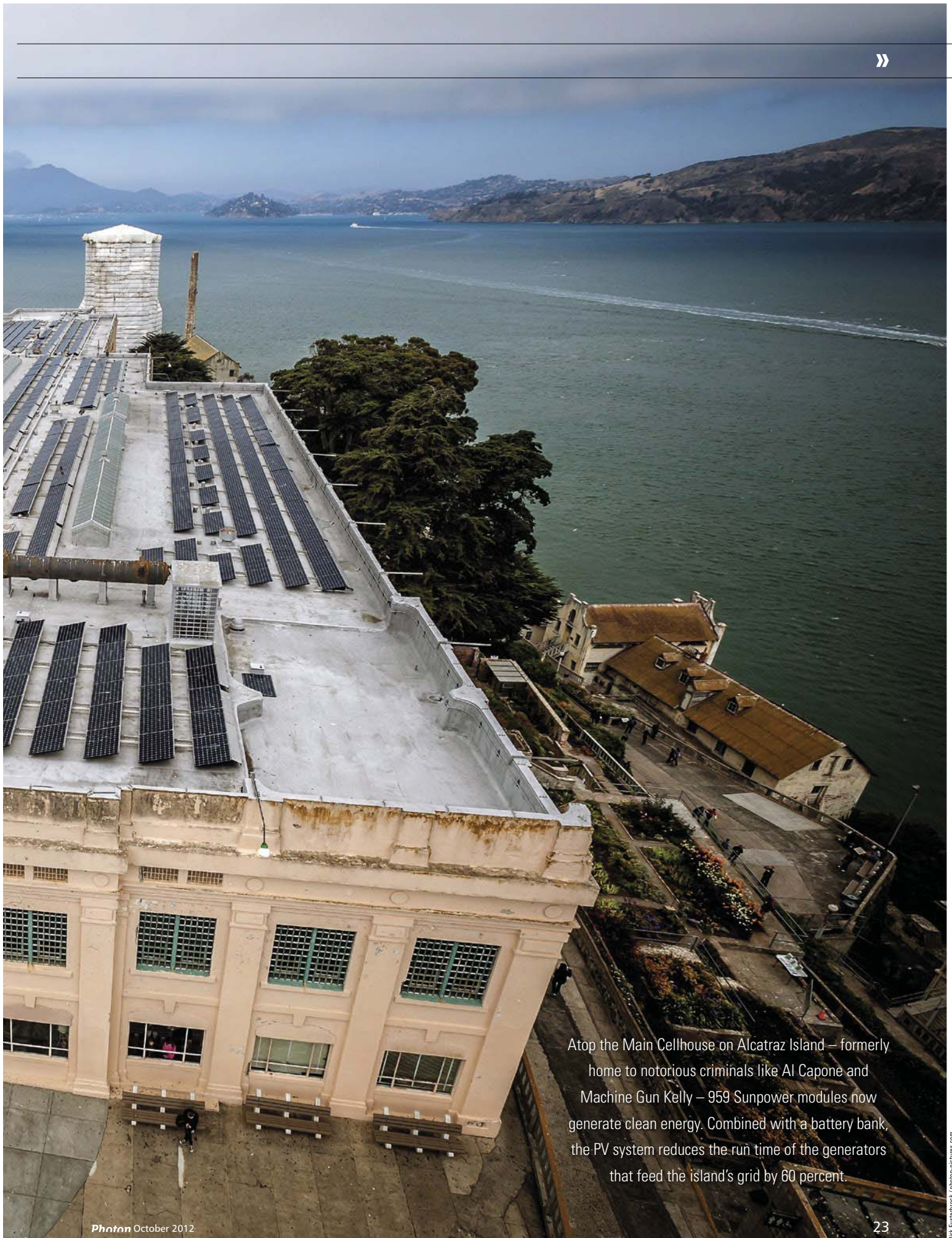
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# HOW TO KEEP CO<sub>2</sub> IN CHECK...





Atop the Main Cellhouse on Alcatraz Island – formerly home to notorious criminals like Al Capone and Machine Gun Kelly – 959 Sunpower modules now generate clean energy. Combined with a battery bank, the PV system reduces the run time of the generators that feed the island's grid by 60 percent.

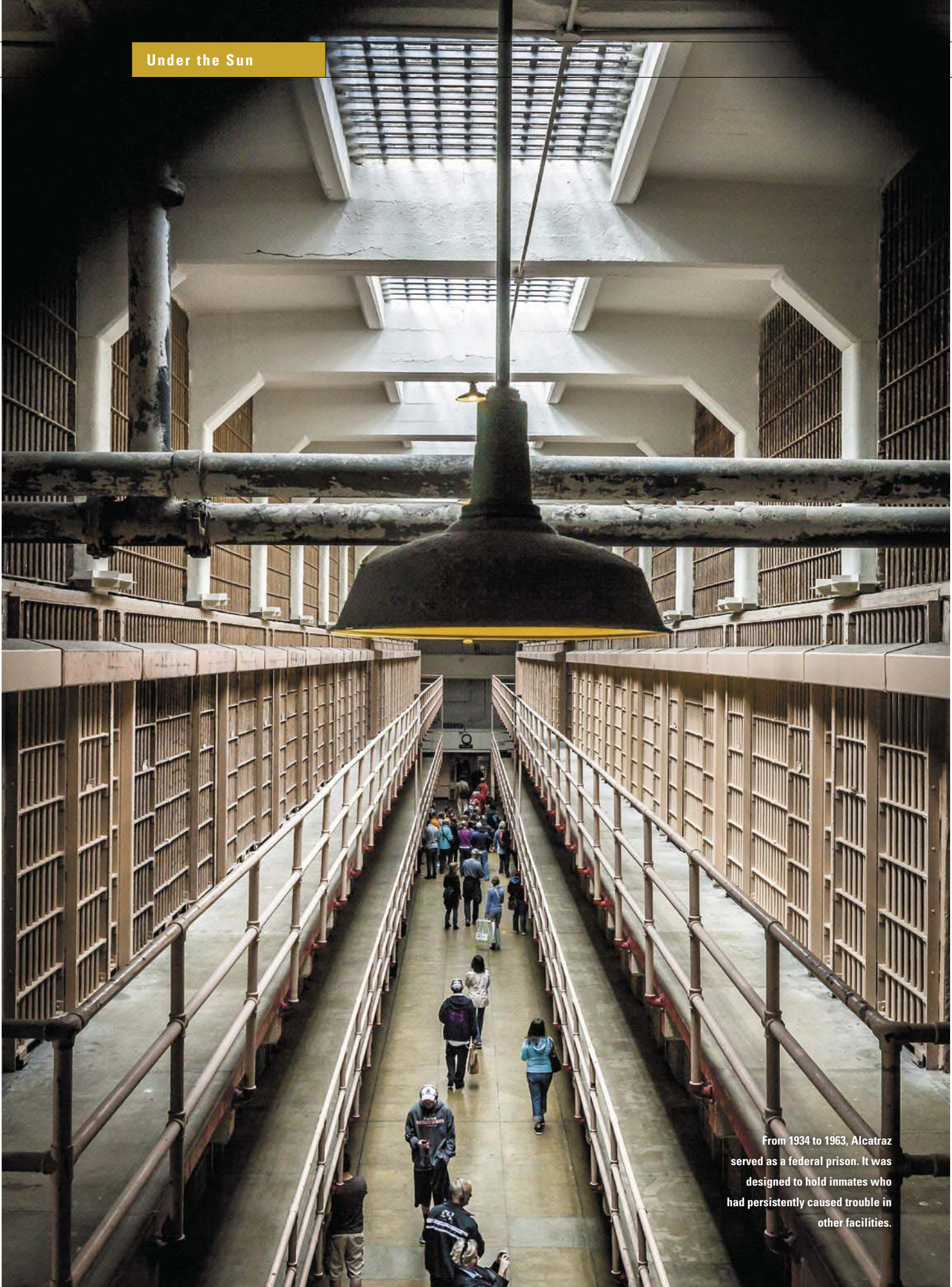
...AND STILL  
ILLUMINATE  
»THE ROCK«



Light must always shine on Alcatraz Island. For one, it houses the oldest lighthouse on the US West Coast, which guides ships into San Francisco Bay.

But »The Rock« is also a signature element of the city's skyline and turning off lights would mean altering it, a no-no for any historic landmark.

Under the Sun



From 1934 to 1963, Alcatraz served as a federal prison. It was designed to hold inmates who had persistently caused trouble in other facilities.

# A BATTLE STILL TO BE WON

SOLAR PANELS AND BATTERIES ARE INTENDED  
TO SOMEDAY REPLACE DIESEL GENERATORS ON  
ALCATRAZ ISLAND

**It took more than 15 years and a big chunk of federal change to install an off-grid PV system on the island that was once an infamous prison. Visited by 5,000 tourists daily, protected as a historic landmark and now serving as a seabird sanctuary, Alcatraz's solar project has faced numerous challenges. Once the system is permanently online, it should cut the run time of the island's generators by 60 percent. But technicians are still struggling to make it work as planned.**

If the thought of a boat ride through the freezing, unpredictable waters of San Francisco Bay to one of the most infamous prisons in American history doesn't send chills down your spine, then reading the green banners at Pier 33 probably will. At the start of the voyage to the former home for some of the country's most hardened convicts, placards and pictures hint at what it was like to do time in such a miserable place. One sign recounts what Army Lieutenant Alvin Sydenham declared in 1895, when Alcatraz was still a military prison: »Any convict who escapes, or who attempts to escape, when recaptured is obliged to wear a ball and chain for three months.« From another sign, visitors learn that half a decade later mobster Al Capone, inmate #85, conceded: »It looks like Alcatraz has got me licked.«

Capone's defeatism has a somewhat familiar ring to the two women who are about to board the boat to the island. With their stiff-brimmed brown hats, hunter green uniforms and gold badges, they can hardly be mistaken for the tourists who otherwise crowd the pier. Alexandra Picavet and Laura Castellini are on their way to check on one of the latest projects of the Golden Gate National Recreation Area (GGNRA): a 305 kW off-grid photovoltaic (PV) system on Alcatraz. It is the most significant attempt to reduce the carbon footprint of the GGNRA, the government agency that manages not only Alcatraz, but also seven different ecological zones, spread over a 60-mile swath of coastal lands around San Francisco. Thirteen million people visit the recreation areas each year, and their vehicles travel some 73 million miles to and from the parks.





Lead acid battery cells – 480 of them – are put together in two strings and provide 1.9 MWh of storage capacity.

All this travel accounts for about 88 percent of the emissions in the area. Of the remaining 12 percent, half the emissions are released from a single source: the generators necessary to keep the lights illuminated, the computers working and the pumps running on Alcatraz Island.

Ever since a ship's anchor ruptured the power line linking the island to San Francisco in the 1950s, electricity has been provided by burning dirty fuels like diesel, coal or, at one point, even wood. It was never cheap to keep Alcatraz operating, be it as a federal prison until 1963, when it was finally deemed too expensive at \$10 per inmate daily, or as the historic landmark and tourist attraction that it is today. Everything must be brought in by boat: the fuel, the food, the water. And everything has to be taken out the same way, be it wastewater, garbage or the staff who run the island. Even with the two new MTU 250 kW generators from Valley Power Systems Inc., which were installed in 2009, a tanker has to deliver at least 15,000 L of diesel to the island each week. »Right

now we are paying \$1,500 a day for diesel,« says Alexandra Picavet, who is a public affairs officer with the National Park Service (NPS), which administers GGNRA. »Alcatraz is very, very expensive to operate.«

#### Important sanctuary

The idea of lowering maintenance costs and emissions by tapping the power of the sun dates back to 1995, when the National Renewable Energy Laboratory (NREL) was commissioned to monitor the irradiation on the famously foggy island and provide a mock-up for a PV system to be reviewed by the NPS's Advisory Council of Historic Preservation.

The project came to a standstill, however, when a historic landmark group protested that the modules would be too visible. They were planned to be mounted on the New Industries Building, where Capone once worked a sewing machine and kidnapper Machine Gun Kelly did laundry. But that was not the only problem.

Ever since the island's birds ceased to be the preferred target of trigger-

happy prison guards, their population on the island has exploded. These days Alcatraz is an important seabird sanctuary, hosting 42 different species that benefit from special protection during nesting season. From Feb. 15 to Sept. 15 each year, up to 75 percent of the island is closed to the public to assure that the birds can raise their offspring undisturbed.

»That also means that we can't enter certain areas for maintenance,« says Laura Castellini, who serves as sustainability coordinator for the GGNRA.

As it turned out, the best place to put the panels was the Main Cellhouse, the building that was deemed the most significant landmark of all structures on the island. It was here that the inmates spent most of their days behind bars, locked up in tiny quarters with few creature comforts and little hope. As long as the modules would be mounted relatively flat on the roof at an angle of roughly 10 degrees, they would stay out of the public's sight.

But the headaches didn't stop there. Everything on the roof that was con-

sidered historically significant had to remain untouched. This included the old salt water tanks that were once needed to flush the toilets but are now rusted with fist-sized holes and serve no purpose other than casting shadows on the modules. And it also included the famous vent hole that had to be restored after the roof was reinforced to support the extra weight of the modules. In the words of Picavet: »We need to maintain the historic fabric.«

The vent hole's claim to fame is as the escape route for inmates Frank Morris, John Anglin and Clarence Anglin, on Jun. 11, 1962, an episode recreated a decade later in Don Siegel's film »Escape from Alcatraz,« starring Clint Eastwood. It was one of two escape attempts that did not immediately fail. But because the escapees in these attempts – the other took place in 1937 – never reappeared, the Federal Bureau of Prisons, which ran Alcatraz, simply

declared that they drowned in the frigid waters of the San Francisco Bay. So the assertion stands that no one ever escaped »The Rock« alive.

It did not require these additional challenges to make the PV project on Alcatraz Island unique. Initially the NPS had planned to commission a grid-tied system, but as it turned out, that would have been nearly three times as costly as an off-grid photovoltaic system with battery backup, given the need to connect with the mainland.

»It became obvious that the undersea cable would be prohibitively expensive,« says Castellini.

According to her, plans for the grid-tied system suffered its final blow when the local utility Pacific Gas & Electric Company requested that a second cable also be put in, in order for them to provide service. The tide finally turned when the American Recovery and Re-



»We might be disappointed, but we are not surprised« says Alexandra Picavet, a park service public affairs officer. The off-grid PV system has encountered many problems.



Two MTU 250 kW diesel generators (right) and eight Princeton Power Systems inverters share a room in the old Power House.

investment Act was passed in 2009 and the project received \$8.7 million in funding. It also did not hurt that at about the same time, module manufacturer Sunpower Corp. had introduced its new 318 W panels. Their increased efficiency allowed the NPS to have a system on the Main Cellhouse powerful enough to reduce the run time of the generators by 60 percent over the course of a year.

### Big challenges

Contractor Hal Hays Construction Inc. began installing the 959 Sunpower E19 318 W modules in October of last year. The battery bank featuring two strings of 240 valve-regulated lead acid gel cells – each from East Penn Manufacturing Co. Inc. – was finished in February. Then eight 100 kW inverters – four for the batteries and four for the solar system – from Princeton Power Systems Inc. were installed.

Again, though, nothing comes easy on Alcatraz Island. In the old Power House, four outdated and heavily rusted generators had to be preserved as witnesses of their time, which made it a challenge to find enough room for all the new cables, devices, switches and controlling units that had to be put in. Running cables from the Main Cellhouse atop a hill a dozen stories above the Power House, which is near sea level, was a major undertaking. While there were many trenches for pipes and cables already in place, they were also

- 1) Not much room to spare: Alcatraz featured 312 cells.
- 2) Plastic falcons are used to scare away other birds and reduce the volume of droppings on the modules – but that's a lost cause.
- 3) NPS saves energy from its installation of efficient new light bulbs, but they need to look like historic lamps.
- 4) What used to be the prison church now serves as the pathway to the PV system on the roof of the Main Cellhouse.
- 5) The fuel for the generators has to be brought in by ship each week.
- 6) The red cross marks a vent hole used in the 1962 escape attempt, which was later portrayed in a Clint Eastwood movie.

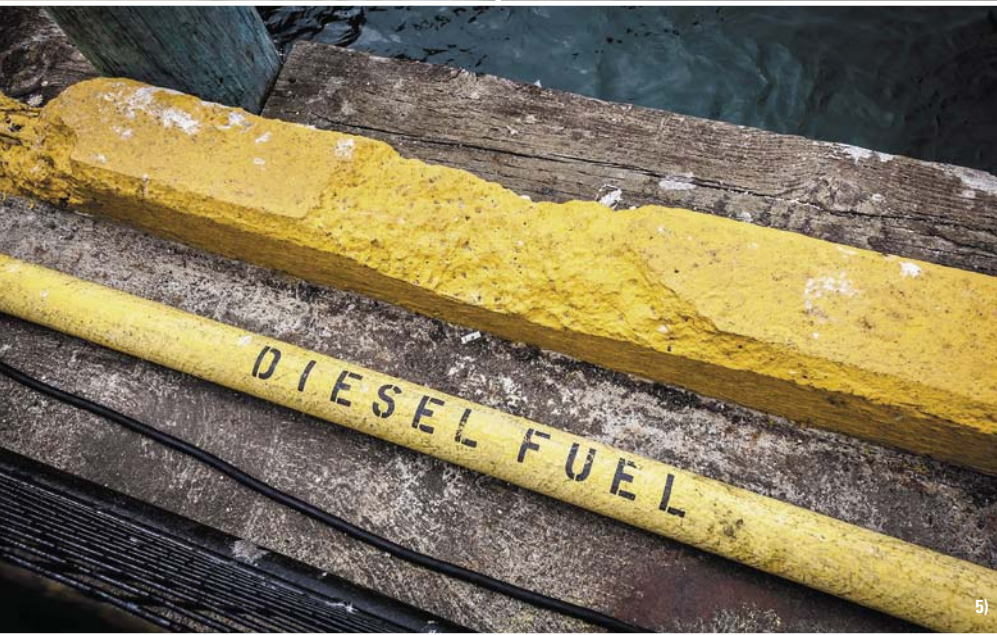




3)



4)



5)



6)

## The Alcatraz microgrid

### Modules

Manufacturer: Sunpower Corp.  
 Model: E19 / 318 (318 W each)  
 Design: 959 modules in series  
 Total capacity: 305 kW  
 Expected yearly yield: 400,000 kWh

### Mounting system

Sunlink Corp.

### Inverters

Manufacturer: Princeton Power Systems Inc.  
 Model: GTIB 480-100 kW  
 Design: four solar inverters, four battery inverters

### Batteries

Manufacturer: East Penn Manufacturing Co. Inc.  
 Model: valve-regulated lead acid gel battery 2AVR125-33 IL Gel  
 Design: 480 cells in two strings of 240  
 System current: 480 V  
 Energy capacity: 1,900 kWh  
 Operating capacity: between 40 and 80 percent state of charge.

### Generators

Manufacturer: Valley Power Systems Inc.  
 Model: MTU Diesel 250 kW  
 Design: two redundant generators  
 Weekly fuel costs when powering the island 100 percent: \$1,600  
 Cost per kWh produced: \$0.60

**PV system costs:** \$8.5 million

**Funding:** American Recovery and Reinvestment Act

**First day of operation:** Feb. 15, 2012

**Expected reduction in generator run-time:** 100 percent in summer, 40 percent in winter; yearly average: 60 percent

**Expected emission savings:** 337,000 kg CO<sub>2</sub> per year



Dirk Eustenbrock / photo-pictures.com (7)

**Daily mopping:** Park service employee Ray Katsanes spot-cleans the modules every day to minimize the yield loss from bird droppings.

## »Growing pains«

### Princeton Power Systems co-founder Darren Hammell on the challenges of a solar microgrid

**PHOTON** What makes the microgrid on Alcatraz island special from your point of view?

**Darren Hammell** The system, with the solar array, the batteries and the diesel generator, is set up in a pretty unique way. Usually with a PV system of this size, you would charge the batteries with solar power first. But we feed the island with solar power directly, and we actually already had a number of days when Alcatraz was running solely on solar. That is just way more efficient than charging the batteries first, and it also expands their lifetime.

**PHOTON** When the PV system and the battery bank went online in the beginning of February 2012, there was an immediate problem and they went off-line again right away. What was the issue?

**Hammell** During the commissioning of a large and unique system like this, there are often »growing pains.« The basic issue is adapting to the specific loads on the island, which were unknown until the initial start-up. The NPS did not want to shut down the island since it is such a popular tourist attraction during the day and a popular filming location even at night. This gave our field engineers only small windows of time to start up and fully commission the system. But we have seen 20 to 30 days of operation at a stretch already and with proper maintenance, we expect the system to run stably for many years.

**PHOTON** Why have you had to tweak the firmware of the inverters already?

**Hammell** We maintain a schedule of releasing new firmware roughly every 6 weeks, which includes feature upgrades and other things. We try to update fielded systems as immediately as is practical. Also, software parameters in the inverters on Alcatraz



Princeton Power Systems, Inc.

**Harsh environment: Princeton Power Systems co-founder Darren Hammell describes the challenges on Alcatraz Island.**

were modified frequently over the course of commissioning, in order to tune the system to run the specific loads on the grid in all conditions, including solar start-up, shut-down and curtailment. This is normal for commissioning any microgrid.



**Double duty: The inverters can be set up either to convert the solar power or the battery power into grid-conforming AC power.**

**PHOTON** In August, the system was down for at least 2 weeks. What was the complication?

**Hammell** The system has periodically been taken down for maintenance and repairs since its commissioning several months ago. In this specific case, the initial issue was a failure in the battery string and a resulting ground fault detection, which the inverters sensed and tripped off-line. There was also a resulting component failure in an inverter that had sustained damage from water condensation inside the unit. Alcatraz is about as challenging an environment as you could imagine for electronics, given the difficulty of construction on the historical site and the positioning in the Bay.

**PHOTON** Are you not able to prevent the whole system from shutting down if just one component fails?

**Hammell** The system is actually uniquely able to continue working with one or several inverters, PV strings or battery strings off-line. Inverters can be »hot swapped« into and out of the microgrid while it is running, enabling easy maintenance without affecting island loads.

**PHOTON** The NPS was unhappy that it took so long to get the PV system back online. What is the story behind that?

**Hammell** The biggest issue is that when the PV system is not running, diesel generators are used to generate the power. This is both expensive and polluting. As described above, there had been environmental issues and issues with electronic components in the batteries and inverters. The technical fix was fairly easy and straightforward, but since Alcatraz is a National Historic Landmark, it is difficult to make modifications to buildings and structures that would normally be easier in a less scrutinized environment.

Interview: Matthias B. Krause



Dirk Esterbrecht / photon-pictures.com | 21

divided by solid concrete blocks originally put in place to prevent prisoners from crawling through them, which some inmates indeed tried.

And even before all the installers got down to work, it was tricky to figure out exactly what electrical loads the off-grid system would have to deal with. None of the buildings were equipped with meters, and the only way to determine how much power the island draws was to monitor the run times of the generators. »We calculated the loads by how much fuel they used,« says Castellini, »and we came up with 600,000 to 800,000 kWh a year.« That is as much as about 70 US households consume annually. But it is not only important to know how much is needed in total, but also how much electricity is required at any given time. And there are all kinds of different loads involved, says Herman Pinales, who is responsible for maintaining the system. For example, the old freight elevator, which is used to hoist merchandise into a storage room up on the hill and lower it back down to the shop at the dock several times a

day, runs on direct current. The pumps transporting diesel and water, however, draw energy on three phases as alternating current.

The PV system, the batteries and the generators are also set to work in a very specific order. Any energy the 305 kW solar array produces is fed into the island's grid first. Whatever is not consumed directly is used to charge the batteries, whose state of charge is set to fluctuate between 40 and 80 percent of their nominal capacity. The two generators only engage if the batteries are in danger of being discharged too deeply – or if the whole PV system is down.

### Companies pointing fingers

When Alexandra Picavet and Laura Castellini visited Alcatraz Island in August, the system had already been down for 2 weeks. One of the inverters was at fault then, they said, but even after a technician tried to solve the problem, the system still didn't work as designed at the time this issue went to print. And it was not the first time the project of making Al-

catraz Island greener had run into problems. Shortly after the whole off-grid system initially went online on Feb. 15, the batteries were found to be defective and had to be replaced. When the system came back on in June, the inverter started to cause trouble. At this point, it is not clear if unforeseen challenges are to blame, if some of the components don't work as advertised, or if they were installed incorrectly. An insider tells PHOTON that companies involved in the project have started to point fingers at each other. The NPS is somewhat tight-lipped about the issues as it tries to recover the additional costs it encountered as a result of the problems.

On the ferry back from Alcatraz Island to Pier 33, Alexandra Picavet tersely summed up the situation: »We might be disappointed, but we are not surprised.« After all, Alcatraz is too special a place to be conquered and settled easily. But Picavet remains optimistic that, unlike Al Capone, the off-grid PV project will not be defeated by »The Rock.«

Matthias B. Krause