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How Tech From Australia Could Prevent California Wildfires and PG&E Blackouts

Technology developed to combat Australia's deadly bushfires could slash California's fire risk and reduce the need for PG&E's "public safety power shutoffs"

By **Peter Fairley**

Photo: Philip Pacheco/AFP/Getty Images

Firefighters battle to save structures on a farm in Windsor, California during October's Kincade fire, which was driven by wind but ignited by a PG&E power line.

California utility Pacific Gas & Electric (PG&E) delivered a bitter pill last month when it said that deliberate blackouts to keep its lines from sparking wildfires could be the new normal for millions of customers for the next decade—a dangerous disruption to power-dependent communities that California governor Gavin Newsom says "no state in the 21st Century should experience." Grid experts say Newsom is right, because technology available today can slash the risk of grid-induced fires, reducing or eliminating the need for PG&E's "public safety power shutoffs."

Equipment to slash grid-related fire risk isn't cheap or problem-free, but could be preferable to the most commonly-advanced solutions: putting lines underground or equipping California with thousands of "microgrids" to reduce reliance on big lines. Widespread undergrounding and microgrids will be costly. And the latter could create inequalities and weaken investment in the big grids as communities with means isolate themselves from power shutoffs with solar systems and batteries.

Some of the most innovative fire-beating grid technologies are the products of an R&D program funded by the state of Victoria in Australia, prompted by deadly grid-sparked bushfires there 10 years ago. Early this year, utilities in Victoria began a massive rollout of one solution: power diverters that are expected to protect all of the substations serving the state's high fire risk areas by 2024.

"It's not cheap to put one in but once you do it, you've got 1,000 kilometers of network that's suddenly a lot safer," says Monash University professor Tony Marxsen, former chair of the Australian Energy Market Operator, Australia's power grid regulator, and chairman of Melbourne-based grid equipment developer IND Technology.

The power diverters—known as Rapid Earth Fault Current Limiters (REFCLs)—react to the surge of current unleashed when a power line strikes the ground or is struck by a tree. When this happens on one of Victoria's 22-kilovolt distribution circuits, the REFCL instantly begins collapsing the faulted line's voltage toward 100 volts, and can get there in as few as 40 milliseconds (ms). "If it can do it within 85 ms, you won't get fires," he says.

REFCLs exploit a phenomenon discovered in 1914 by German engineer Waldemar Petersen, who showed that a charged coil could neutralize the current in a network if the former's magnetic field resonated at the right frequency relative to the latter's electric field. REFCLs employ a resonating coil to neutralize all but a few amps of the current in a faulty line, then use power electronics to squelch the rest.

"These lines are the backbone of our electric grid. It's ridiculous, frankly, that they're not monitored."

—Hudson Gilmer, CEO of LineVision

The beauty of the REFCL is that squelching a faulty line does not cause a widespread blackout. Victoria's 22-kV distribution circuits consist of three parallel lines. While voltage is collapsing on a faulted line, the REFCL temporarily diverts its power to the circuit's other two lines. The customer never knows there has been a fault.

REFCL producer Swedish Neutral originally developed the device to maintain throughput in underground power lines, where faults can be hard to fully quench. Through Victoria's R&D program, they adapted REFCLs for overhead circuits and faster operation.

Credit: Powerline Bushfire Safety Program, Government of Victoria

22,000 volts pulsing through these cables can easily ignite a fire (top panel). Ignition is prevented, however, by adding a REFCL power diverter to the circuit (lower panel). The REFCL collapses the voltage to squelch arcing in less than 1/20th of a second.

Marxsen says 20 to 30 percent of the distribution circuits in PG&E's territory have the appropriate three-phase design for REFCLs, as do a similar proportion of circuits in the territory of Southern California Edison (which is also grappling with grid-sparked wildfires). "It would certainly offer the option of not shutting down the networks when there's high fire risk," he says.

Another technology fostered by Victoria's program is already being tested by PG&E, according to Marxsen, who is leading its commercialization through IND Technology. The hypersensitive detection system combines electromagnetic frequency sensors, which track 1-megahertz to 130-mhz signals, and algorithms that match signal patterns to the condition of the lines. With sensors placed every 4.8 kilometers on distribution lines, the system is so sensitive that it can detect vegetation within 80 millimeters of a line, and so precise that it can locate trouble spots with 10-meter accuracy.

Marxsen says the idea is to identify problems such as weakened lines and faulty transformers so they can be fixed before they cause sparks. Victoria utilities recently completed pilot tests on 250 kilometers of distribution circuit, and he says the results have convinced several to begin rolling out IND's early fault detectors on some circuits. He expects even better results from the technology in California, based on early data from the PG&E pilot test that began in June.

None of these solutions is a silver bullet that will completely eliminate fire risk from power grids.

Home-grown analogs to Australia's devices are also coming to the fore. San Diego Gas & Electric is already deploying a rapid fault detection and line shutoff system that can beat gravity, squelching current in broken distribution lines before they hit the ground.

Somerville, MA-based LineVision, meanwhile, says one California utility is considering a test of LineVision's continuous monitoring system, which tracks the condition of more powerful *transmission* lines. A broken PG&E transmission line sparked the massive Kincade fire that forced 200,000 Sonoma County residents to evacuate last month.

Photo: LineVision

LineVision's tech uses a combination of lidar and electromagnetic field detectors to spot transmission conductors that are overheating and sagging toward vegetation, or being swayed violently by winds and clashing. It could spot weather-driven line damage, thus preventing some incidents, and also enable utilities to limit forced shutoffs to network segments posing high risk at a given moment, according to LineVision CEO Hudson Gilmer. "PG&E has a plan that includes better weather forecasting and risk analysis, grid hardening, clearing of vegetation. What we find is a missing link is to actually monitor the asset that is causing the problem," says Gilmer. "These lines are the backbone of our electric grid. It's ridiculous, frankly, that they're not monitored," he says.

LineVision uses LIDAR and EMF sensors plus digital twinning analytics to spot power line movement and damage that could ignite wildfires.

None of these solutions is a silver bullet that will completely eliminate fire risk from power grids. REFCLs, for example, are proving hard to configure and less effective on certain Victoria circuits.

And none of this equipment comes cheap. Victoria's REFCL rollout could ultimately cost AUS $700 million (US $500 million), according to *The Age*, a Melbourne-based newspaper.

That's a hefty cost that ultimately will be borne by ratepayers. But it pales in comparison to the devastation wrought in the weekend of bushfires in Victoria in 2009. What came to be known as the "Black Saturday" fires killed 173 people and caused an estimated AUS $4 billion in damage. More than half of the major Black Saturday fires and 159 of those deaths traced back to power lines.

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