greatly reduce the risk of fire. (O’Brien developed and patented the concept with Eric Udren, an executive adviser at Quanta Technology, a consultancy based in Raleigh, N.C.)

As of last month, the system had been installed in what the utility expects will be its final form on six circuits emanating from three substations in the fire-prone territory east of San Diego. The utility has 18 more substation build-outs planned and expects to ultimately deploy the system across its entire grid.

This system for detecting and disarming broken lines marks the first deployment of PMU-based automation on a distribution system. But a few utilities elsewhere have already integrated synchrophasor-based controls into their high-voltage transmission grids. One of the first installations, initially completed in Iceland in 2014 and substantially upgraded last year, tunes the island nation’s 50-hertz AC frequency.

Iceland has a relatively small grid whose supply and demand can easily be thrown out of balance when power plants, transmission lines, or big factories unexpectedly go off line. For years, the resulting AC frequency fluctuations regularly caused the grid’s eastern and western zones to split into electrical islands, which often led to power outages.

A wide-area PMU network and added controls, provided by GE’s grid solutions business, enabled Iceland’s grid operator, Landsnet, to rapidly locate power imbalances and automatically fix them by tweaking demand from aluminum smelters and other big consumers. The June 2017 updates have cut the magnitude of Iceland’s AC frequency deviations roughly in half, according to GE senior power systems engineer Sean Norris. “Events that we previously would have expected to cause splits in the system have occurred, and the system has remained intact,” says Norris.

Emerging frequency challenges for Great Britain’s much-larger grid have prompted a three-year research effort directed by London-based National Grid. England and Scotland’s many fossil-fueled power plants and the inertia in their heavy rotating generators currently hold the United Kingdom’s AC frequency steady. But that frequency-stabilizing inertia is disappearing as coal and gas plants shutter.

Simulations conducted earlier this year at the University of Strathclyde, in Glasgow, showed that synchrophasor-driven controls, running on an expanded version of GE’s technology, could keep the U.K. grid stable with fewer inertia-rich generators. By early next year, the research team hopes to begin testing its control platforms at National Grid substations.

Ultimately such real-time controls will take over grid operation, according to Patrick Lee, president of control developer PXiSE Energy Solutions (another Sempra Energy subsidiary). As renewable generation grows, industrial control systems aided by human operators watching PMU readings will no longer suffice. According to Lee, “As the system gets more renewable integration and becomes more dynamic, you have less time to respond. If you don’t have this high-speed synchrophasor-based technology, you really will have no chance.”

—PETER FAIRLEY

Synchrophasors could sense a power line break before gravity pulls the loose ends to the ground

MACHINE VISION TO CURB PIG PUGNACITY

3D cameras can help predict when pigs are about to nip each other’s tails

Pig farmers want human diners to bite into the delicious pork they produce, not for swine to bite each other. (Yes, it happens.) Now, using 3D cameras and machine-vision algorithms, scientists are developing a way to automatically detect when a pig might be about to chomp down on another pig.

Pigs have an unfortunate habit of biting one another’s tails. Infections from these bites can render up to 30 percent of a pig farm’s swine unfit for human consumption. Docking, or cutting, pig tails can reduce such biting but does not eliminate it, and the routine use of docking is banned in the European Union. There are a wide range of potential triggers for outbreaks of tail biting—among them genetics, diet, overcrowding, temperature variations, insufficient ventilation and lighting, disease, and even the season—so it’s an unpredictable problem. “Tail biting is a very frustrating challenge,” says John Deen, a veterinarian and epidemiologist at the University of Minnesota. “Controlling it has not always been that effective.”

To predict and potentially prevent tail biting, researchers in Scotland monitored 667 undocked pigs on a farm using both time-of-flight and regular video cameras that recorded continuously for 52 days. The pigs were checked at least twice a day for evidence of biting.
This research was part of a £160 million push by the United Kingdom to support innovative farming technology through its Agri-Tech Catalyst program. Agriculture and food already help generate more than £108 billion annually and support 3.9 million employees. A recent industry-led review suggested that incorporating digital technologies such as robotics and autonomous systems into food manufacturing could add £58 billion to the U.K. economy over the next 13 years.

A three-year project called TailTech is now furthering the development of this early warning system with up to £676,000 in funding from Innovate UK, a government agency. The aim is to test a prototype system on more than 16,000 pigs at nine farms throughout Europe for roughly 18 months, with each time-of-flight camera capable of monitoring up to 300 pigs, D’Eath says.

TailTech will compare the system’s efficacy for different types of pig farms, including ones with docked and undocked pigs, with and without straw on their floors, and with pigs of varying genetics, diet, and group sizes. The project will analyze what fraction of pigs hold their tails low, and for how long, before scientists are sure a tail-biting outbreak will occur. And it will assess how predictors vary between farms. The researchers also aim to improve the accuracy of their system. “In practice, though, 73.9 percent is good enough for the system to work well,” D’Eath says.

The ultimate aim is to have an early warning system “that reads out continually on a screen and also sends alerts to the farmer’s smartphone,” he adds. “No technical expertise will be needed once the system is installed.” The software will compute trends to give farmers a better idea of their herds’ current level of risk, D’Eath says.

A farmer might not buy technology designed solely to detect tail biting, but D’Eath notes that this system is being developed as an add-on to a camera-based automatic pig-weighing system called Qscan that Innovent already produces to help farms meet contractual weight targets. Deen, the veterinarian and epidemiologist, thinks this strategy could make all the difference. As he says, “If Qscan is already in place, I think farmers can quite easily justify adding this system at little cost.” —CHARLES Q. CHO

**TASTY TAILS:** In extreme tail-biting outbreaks, up to 30 percent of pigs raised together may be affected by bites so severe that their carcasses are no longer fit for human consumption.

Each time-of-flight camera emitted pulses of infrared light from LEDs 25 times a second, and recorded the amount of time needed to detect reflected pulses. This data allowed scientists to track each pig’s position and posture. Machine-vision algorithms from farm-technology company Innovent Technology, in Aberdeenshire, Scotland, then determined which activities might serve as possible early warning signs of tail biting.

The scientists found that before outbreaks of biting, pigs increasingly held their tails down against their bodies. Moreover, the software could detect when these changes in tail posture occurred with 73.9 percent accuracy. “It looks like good technology, and I’m very interested in how it could be applied on a farm,” says Deen, who did not take part in this project.

If farmers think a biting outbreak is likely to happen in a pigpen, they could deploy distractions such as straw, knotted ropes, or shredded cardboard, which tap into the pigs’ instincts to root and chew. “Another thing that people try to apply bad-tasting stuff such as Stockholm Tar to tails,” says Richard D’Eath, an animal behavior scientist at Scotland’s Rural College, in Edinburgh, who worked on this research. An early warning system could help farmers use such remedies only when needed, which would save money.

**PIG VISION:** The TailTech system monitors pigs with cameras that produce 3D images. Each pixel is created by measuring the reflection of infrared pulses as an indicator of the distance from objects. Software then represents the distances with colors.