

Wind Bust

How an airborne blade exposed broader problems at PGE's flagship wind farm

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In the waning days of January, a worker delivering fertilizer to a wheat farm in the rolling hills of Sherman County found some broken, industrial-size bolts on the ground near one of Portland General Electric's towering wind turbines.

He was puzzled because it stood to reason the bolts fell from the machine. But he didn't know if there was a problem or, if so, who to tell. So he picked up one, sent a snapshot to his co-worker, Kevin Massie, and used it as a paperweight while he documented the delivery.

Massie arrived a day or two afterward to tow a delivery driver whose vehicle got stuck in the mud near the same turbine at Biglow Canyon. It was dark and windy. Nothing seemed out of the ordinary.

Hours later, at 2:11 a.m. Feb. 1, one of the turbine's three spinning blades launched into the night.



A broken blade bolt found under a wind turbine at Biglow Canyon wind farm by a worker delivering fertilizer in late January. A day or two later, the turbine threw an eight-ton blade into a nearby field. (Courtesy Kevin Massie)

No one saw it. No one heard it. But it was evidently a violent affair.

The skinny blade, as tall as an 11-story building and weighing more than four Toyota Camrys, soared the full length of a football field. It plowed a furrow 4-feet deep in the wheat stubble where it eventually landed.

Heavy-duty bolts that once kept the blade fastened to the tower scattered around the turbine base like shrapnel, some spiked deep into the soil.



Broken blade bolts were scattered around turbine 71 at Portland General Electric's Biglow Canyon wind farm after the turbine threw a blade in the early hours of Feb. 1. Hours before the blade throw, a driver delivering fertilizer became stuck in close proximity to the turbine and had to be towed out. (Courtesy Kevin Massie)

“Someone could have been killed or badly injured,” said Kathryn McCullough, whose husband, Kevin, farms under about half of Biglow Canyon’s turbines – including the one that lost its blade.

The broken bolts preceding the incident weren’t the only warning signs of problems at PGE’s flagship wind facility, which opened 15 years ago amid a push to expand green energy technology in Oregon and nationally. But it took the so-called “blade liberation” for PGE to take urgent action at Biglow Canyon, one of Oregon’s largest wind farms, shutting down all 217 turbines for testing and keeping some out of service for at least four months.

The dramatic episode in the rural landscape of the Columbia River Gorge represents a revealing, if concerning, inflection point in Oregon’s two-decade history with the ubiquitous turbines that help fuel clean energy.



On Feb 1, turbine 71 at Portland General Electric's Biglow Canyon wind farm threw an eight-ton blade 100 yards into a nearby field, plowing a deep furrow in the ground where it landed. (Left, Dave Killen, right courtesy Kathryn McCullough)

Industry groups insist that wind farms are very safe and major malfunctions, such as blades flying off the turbines, are exceedingly rare. But as wind farms grow older and the underlying components age, regular and proactive maintenance become far more important.

[MORE: Why accident, safety data is hard to come by for wind industry](#) 

Yet landowners have been raising concerns to PGE for the last decade about maintenance issues at Biglow Canyon and their impact on energy production at the facility. And an investigation by The Oregonian/OregonLive has found that the seemingly isolated blade incident is part of a wider set of maintenance problems and equipment failures that are now undercutting electricity generation at Biglow Canyon, shortchanging ratepayers and landowners, and putting those who cultivate crops under the turbines – and potentially their farmland itself – at risk.

Among the findings:

- PGE has failed to report public safety incidents at Biglow Canyon, in potential violation of its operating agreement with the state. The utility hasn't disclosed incidents where hatches, metal disks and blade bolts have fallen off turbines from a height of about 265 feet. PGE has questioned whether such incidents meet the reporting threshold, but regulators insist even small objects may be a hazard to anyone near a turbine because they can reach almost 90 mph when falling.
- PGE knowingly operated at least four turbines at Biglow Canyon with broken blade bolts, in one case for nearly a year, maintenance records show. Those bolts clamp blades to the rotor and bear the stress of wind and motion. Research indicates that broken bolts, while not uncommon, can become a

serious problem leading to catastrophic blade failures like the one in February.

- Oil leaks from Biglow Canyon’s wind turbines and transformers are environmental and fire hazards. The turbines have been plagued by leaks of oil and lubricants that coat towers and blades and spit on to their gravel pads and surrounding fields. Transformers have ruptured regularly, causing two fires and spilling about 3,000 gallons of mineral oil into surrounding soil that prompted expensive cleanups.
- The number of problems PGE has disclosed to regulators is out of line with other wind farms. Since 2010, PGE has reported more than a dozen oil spills and other incidents at Biglow Canyon with the potential to affect public safety — about three times more than any other wind farm regulated by the state. But state officials only recently began pressing PGE to explain those troubles.
- Biglow Canyon has generated far less power than PGE originally projected. The availability of its Vestas wind turbines to produce energy has abruptly declined in recent years, and the project’s rate of energy production is less than neighboring wind farms of comparable age.
- Ratepayers may end up footing the bill for assets that are no longer useful. The project’s 76 turbines manufactured by Vestas are halfway through their projected life but PGE is already considering replacing them. If that happens by the end of 2023, ratepayers would be stuck covering \$156 million in remaining costs.



Kathryn McCullough, a Sherman County landowner, examines a bolt off the blade that was thrown from a turbine at PGE’s Biglow Canyon wind farm on Feb. 1. “Someone could have been killed or badly injured,” she said.

The Biglow Canyon turbine that launched its blade is one of about 72,000 machines nationwide, including some 2,300 turbines in Oregon, which has more production capacity than all but nine other states. Yet there is no effective national, state or county reporting requirement or database tracking safety or operational incidents at wind farms, and only 13 of the largest of Oregon's 48 wind farms are regulated by the state, numbers that include multiple phases of some projects.

PGE launched an investigation into this winter's blade throw and is filing written updates to regulators. But it has asked the Oregon Department of Energy to keep those confidential until the end of the year because of the possibility of litigation.

Seven months into that review, PGE told The Oregonian/OregonLive that preliminary results suggest the connection between the turbine blade and its hub was "not well clamped," a problem likely caused by "bolts becoming loose and experiencing fatigue damage over time."

PGE said it took the blade failure "very seriously as a safety incident" and is working to fully understand the cause, rectify it and make any other necessary adjustments to improve operations.

But PGE defended its overarching maintenance efforts. It said that state regulators have not issued any violations for failing to report safety incidents; only two of the incidents it did report were actually related to public health and safety; leaking oil posed only a low environmental or fire risk; and lost service time is likely the result of grid constraints beyond its control. The issues at Biglow Canyon, it said, are consistent with those experienced by other utilities with similarly aged equipment.

"PGE entered into a long-term maintenance contract with the maker of the turbines, a wind sector leader, Vestas," PGE spokesperson Melissa Havel said in response to written questions. "This was a prudent and industry standard action on the part of PGE. We challenge your categorization of the volume of troubles. Since coming online, Biglow Canyon wind farm has generated more than 13,000,000 MWh of clean electricity, which translates to powering 120,000 homes per year."

Even so, PGE said it has now taken a more active role monitoring the turbines at Biglow Canyon, analyzing incoming data for anomalies or patterns that may indicate performance or safety issues. PGE officials said the utility could also end up suing Vestas, which maintains all the turbines there and manufactured the one that launched the blade. PGE said it has streamlined Vestas' scope of work so the company can focus more on preventative maintenance.

Problems at PGE wind farm frustrate land owners



Vestas said it completed its own investigation into the blade failure but could not share results because they contain proprietary information. Vestas, which has its North American headquarters in Portland, said there was no evidence to suggest that inadequate maintenance has shortened the lifespan of turbines at Biglow Canyon, and that the project continues to operate at or above industry standards.

Most of the turbines at Biglow Canyon have now returned to service.

“We wouldn’t run it if it wasn’t safe,” said Jesus Carrera, PGE’s manager of wind operations.

Maintenance issues at Biglow Canyon matter broadly because PGE – Oregon’s largest electricity provider, serving some 900,000 homes and businesses in Oregon – plans to transition to 100% carbon-free energy by 2045. And its customers will be paying the bill.

To eliminate all its greenhouse emissions, PGE would need to supersize its fleet of renewable energy resources and manage them for longevity, maximizing production for decades to come. Yet the economics of wind power are heavily dependent on federal subsidies, and some experts suggest those subsidies are structured in a way that incentivizes operators to skimp on maintenance for older equipment that is no longer eligible.

PGE’s operations and maintenance expenses at Biglow Canyon have declined precipitously, federal records show. In 2021, PGE spent 40% less than it did eight years earlier, and it told economic regulators that spending would be even lower this year.

PGE said it has consistently invested in Biglow Canyon’s operations while also striving to maintain competitive rates and balancing customer cost implications. “We expect to remain consistent with our investments this year until we determine the best future course of investment,” Havel added.



The blade thrown from a turbine at PGE's Biglow Canyon wind farm on Feb 1. An outbuilding next to the McCullough's residence is shown in the background.

Meanwhile, Biglow Canyon landowners who believe in the promise of green energy have been left frustrated, not only by a perceived lack of transparency from PGE, but also because they feel financially shortchanged by excessive turbine downtime, as payments to them are based on energy production.

Don Godier, a retired air force colonel who lives in Florida, said it's always been a team effort to scratch a modest living out of the farm his great grandparents established. The family was fired up by the prospect of "harvesting the wind" by placing turbines on their land. But the resulting payments from PGE, which he said he uses to support his mother's long-term care, haven't met expectations.

"We were a little naïve and trusting," he said, "but those days are over."

Landowners recently hired a Portland lawyer to investigate potential remedies.

The McCulloughs, whose house and farm are surrounded by turbines, have been particularly vocal. They've regularly complained to PGE and recently provided documentation about maintenance concerns to the office of U.S. Sen. Ron Wyden, Oregon's senior senator and a member of the Senate Energy and Natural Resources Committee.

"If you think about it, any of those things could come down at any time," said Kathryn McCullough, a retired 747 airline captain. "If we maintained our equipment like that, we wouldn't be farming for long."





Kathryn McCullough, a Sherman County landowner, examines the blade that was thrown from a turbine at PGE's Biglow Canyon wind farm on Feb. 1. Her husband, Kevin McCullough, farms wheat under about half the wind farm's 217 turbines, including the one that threw the blade. Thirteen of the wind farm's turbines are on their land.

'What's not to like?'

When a wind prospecting outfit first approached Sherman County residents in 2001 about leasing out portions of their cropland to a wind farm operator, the McCulloughs were immediately intrigued.

The nation's wind energy boom was just getting off the ground. California was adopting rules requiring utilities to invest in green power, soon to be followed by Oregon and Washington. And the Columbia River Gorge, with solid winds and existing transmission lines established to carry hydropower around the west, would soon become a hotbed of wind farm development and eventually become one of the top ten wind energy producers in the nation.

The big-talking wind prospector was spinning tales of the Learjets landowners would soon own, the McCulloughs remember.

It seemed like a no-brainer.

And while state and county regulations limit public access to the land under wind farms, there are virtually no off-limit areas for farming. That meant farmers could continue to cultivate nearly right up to the base of the turbines, harvesting crops from the ground and a regular stream of lease payments from overhead machines.

The McCulloughs and their neighbors soon became big backers, expressing support for the Biglow Canyon project at various forums as other groups raised concerns about its visual and noise impacts, bird mortality and operations of a nearby airport. Kevin McCullough even appeared in a [promotional video for the project](#).

It took several years, but the project gained momentum, first steered by Orion Energy, then PGE.



The first 76 Vestas turbines under construction at Biglow Canyon wind farm in 2007. Kevin McCullough, right, looked on enthusiastically at the time. He farms under about half of the wind farm's 217 turbines today and earns lease payments based on electricity production from the 13 turbines on land he and his wife own there. (File photos by Ross William Hamilton)

By 2007, the first 76 turbines manufactured by Vestas were up and spinning on the McCulloughs' and neighboring farms. They were followed by 141 Siemens machines by 2010, in what was then the largest wind farm on the Columbia Plateau. PGE said costs from the \$1 billion project would raise ratepayers' monthly bills by a total of 4.5% while producing the equivalent amount of energy used by 125,000 homes in a year.

PGE's Biglow Canyon wind farm was a reality. The electricity – and the dollars – began to flow.

“We were ecstatic,” Kathryn McCullough said of the 13 turbines on their land. “What’s not to like? When these things are turning, we’re making \$100,000 a year. How do you shake a stick at that?”



‘Just pure carelessness’

Long before the blade flew into the night at Biglow Canyon, landowners say they had concerns about substances spewing from PGE's turbines.

Problems began more than a decade ago. The McCulloughs said they expressed concern to PGE that the Vestas turbines, then only three years old, were leaking oil and lubricants from the nacelles, the box atop the turbine tower that houses its gearbox and other major components.

It's a condition that persists today. Many of the once-pristine white Vestas turbines are visibly soiled by oil, blackening the towers, the blades, the gravel pads and spitting into the fields below. The McCulloughs snapped photos of the problem as recently as early August showing their truck spattered in oil after just 30 minutes parked near a turbine, and the ground darkened with oil spots.

The leaks likely fall below the threshold for reporting oil spills to the Department of Environmental Quality, which requires disclosure only for discharges to the ground over 42 gallons in any 24-hour period. And officials at the Department of Energy said the problem had not been brought to their attention by a member of the public, during annual inspections or by PGE, so they haven't looked into it.



Kevin McCullough parked his truck near one of Biglow Canyon's Vestas wind turbines for about 30 minutes during wheat harvest in early August. When he returned, he said it was spattered in oil leaking from the top of the turbine. At right, oil spots on the ground nearby the same turbine. Landowners worry that regular leaks of oil and lubricants from Vestas turbines, which PGE says is a fixable problem if it chooses to make the investment, could be contaminating their cropland. (Courtesy Kathryn McCullough)

Godier, the property owner paying for his mother's care, said he's driven cross country twice in the past few years and made it a point to check conditions at other wind farms.

"I didn't see a single one with the amount of oil and grease we have on ours," he said, while speculating that it could be seeping into the water table. "It's on the ground. Someone needs to hold these folks liable for what we're going to find in 50 years."

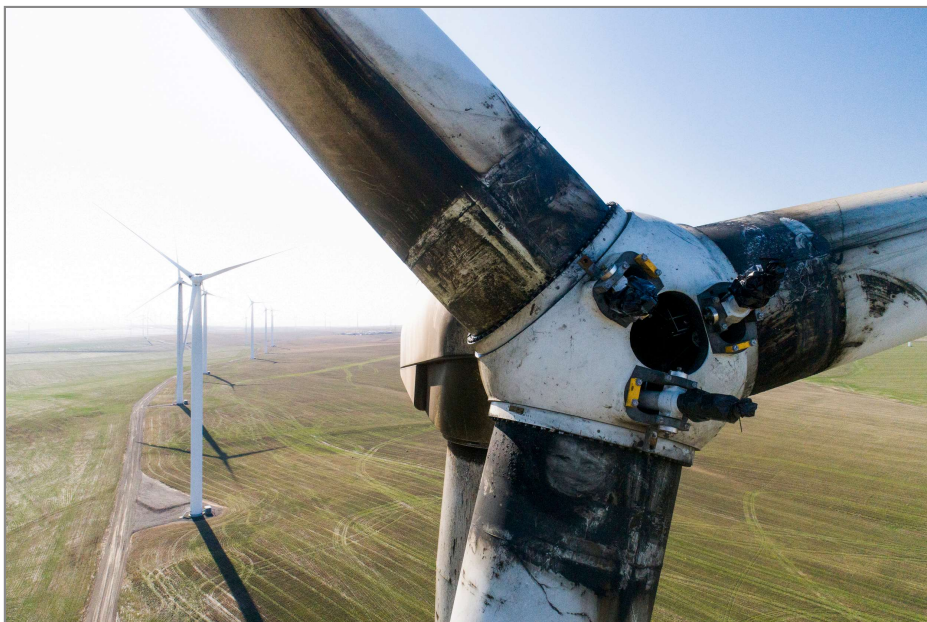


Residents who own land under PGE's Biglow Canyon wind farm worry that regular leaks of oil and lubricants from turbines pose fire and environmental hazards.

Brett Gray, who farms under PGE's turbines, said the Vestas turbines seem the worst, but the Siemens machines at Biglow Canyon leak, too. He also farms under turbines at another wind farm to the south, Klondike, and regularly passes by others.

"It's not the norm for the projects I've been around," he said of the oil, adding that PGE told landowners there's "no way to fix" the Vestas turbines. "But that's hard to believe."

PGE's spokesperson said Vestas has identified a solution and could install retrofit kits to equipment that is prone to leaking. But PGE hasn't decided whether to make those fixes, saying it must first choose between enhanced maintenance of existing turbines or replacing them.



A metal frame and pieces of fiberglass fell from the spinner cone of this Vestas turbine into a field below at Biglow Canyon wind farm in April 2021. PGE didn't report the incident to regulators until this summer. Wind

technicians later lowered the turbine's nose cone and spinner frame onto the turbine pad, where the pieces remained for a year. The nose cone blew into a nearby gully, and remained there earlier this month.

Mark Haller, a wind industry consultant who spent 40 years managing and developing wind farms across the globe until retiring last year, said that if the turbines continue to leak oil, "it's because someone isn't spending the money to fix them."

"Those machines should not be puking oil all over the place, other than just pure carelessness," he said.

The same model of Vestas turbines used at Biglow Canyon, officially known as the V82 1.65mw, are in operation at the Echo wind farm about 50 miles to the east. They were commissioned in 2009, two years after those at Biglow Canyon, and are partially owned by a group of farmers.

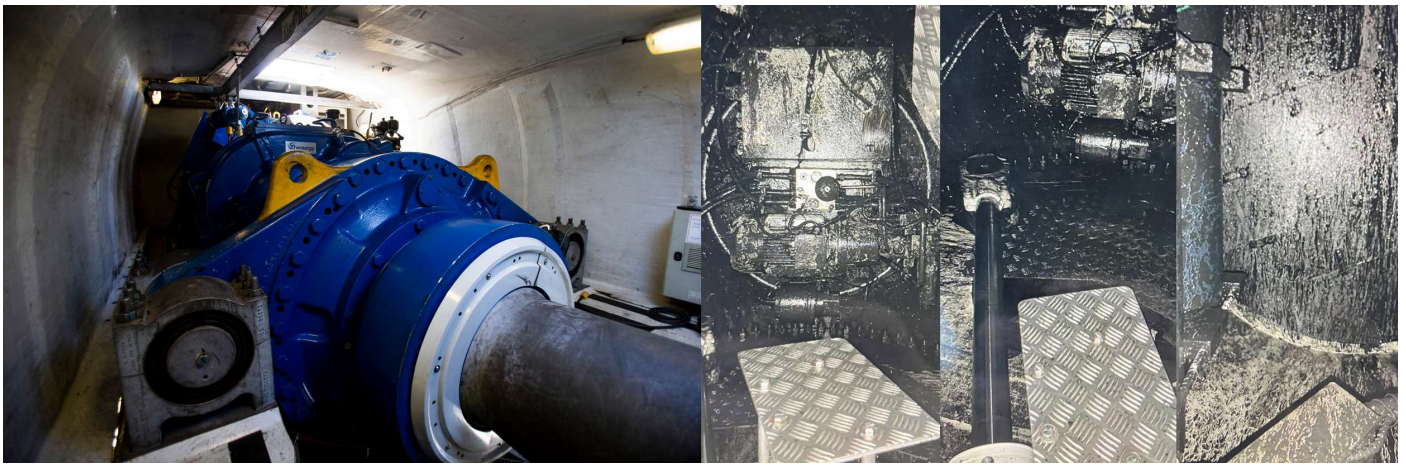
Kent Madison, one of the farmers there, said he's seen an occasional leak from the gears in several turbines, but they've been promptly fixed, cleaned and look nothing like the machines at Biglow.

"Ours have run like a fine watch," he said. "We have not had any issues over the years."

Brad Jenkins, PGE's vice president of utility operations, this summer led a reporter on a guided tour of Biglow Canyon that didn't include any of the soiled turbines. Jenkins downplayed the potential environmental issues, saying the oil leaks were confined to the machines, and said PGE would never run a turbine with a fire risk.

Biglow Canyon has never experienced a turbine fire. But they do happen in the industry, with a 2,000-acre blaze in Gilliam County four years ago linked to a turbine operated by a different company, according to compliance reports submitted to the state.

"Just because an asset is dirty doesn't mean it's not running well," Jenkins said. "We're more concerned with what's on the inside."



Portland General Electric provided a look inside the spotless nacelle of a Vestas turbines (left) at Biglow Canyon wind farm during a tour in late June. Kathryn McCullough sent the pictures at right to U.S. Sen. Ron Wyden, which she said shows the oil-coated nacelle of a Vestas turbine this spring at Biglow Canyon. (Photos courtesy PGE, left, and Courtesy Kathryn McCullough, right)

The guided tour included showing off the inside of a spotless turbine. But Kathryn McCullough recently emailed Oregon’s senior senator photos she said she obtained from a contractor showing the inside of a turbine at Biglow Canyon this spring.

The machinery appeared filthy, heavily coated in oil, the photos show.

PGE declined to comment, saying the photos had no metadata attached so it couldn’t confirm where or when they were taken.

Oil has also leaked from Biglow Canyon’s on-site transformers, which sit at the base of each turbine and are used to regulate electrical current.

Ten transformers have failed at Biglow since 2010, three times more than reported by any other facility regulated by the state, according to Department of Energy records. Nine transformers under both Vestas and Siemens turbines and one in a substation spilled some 3,400 gallons of mineral oil — 90% of it to the ground around the turbines, prompting excavation and soil replacement.

“Ten transformer failures?” said Haller, the industry consultant. “That’s bad.”

PGE’s Jenkins said oil used in transformers is essentially vegetable oil, and poses minimal environmental or fire hazard. But the mineral oil used in transformers is flammable, and transformers have caught fire at Biglow Canyon in 2011 and 2013.

After nine transformer ruptures and related oil spills since 2010, state regulators this year pressed PGE for answers about the problems. But after hearing from a utility official in January, they took no further action.



PGE has experienced 10 transformer failures at Biglow Canyon that have collectively leaked 3,000 gallons of mineral oil to the ground surrounding turbines and caused two fires. Pictured above, pad-mount transformers sit in cabinets below each turbine at Biglow Canyon.

Lenna Cope, a project specialist at PGE, told regulators during a public meeting transformer failures are an industry-wide problem and PGE was replacing them with transformers with different specifications when they failed. She said the demand on turbine transformers is unique because it rises and falls with rapid changes in the wind, and resulting temperature changes can degrade transformer oil and insulators, leading to the buildup of combustible gasses. The gas accumulation can over pressurize a tank, cause a rupture or, if there's an electrical arc, flash off and cause an explosion.

“PGE has a program to sample each transformer for dissolved gasses, but there are no industry standards to compare the results for decision making and accurately predict pending failures,” Cope said. “PGE does our best to make prudent choices.”

After watching PGE's presentation online at The Oregonian/OregonLive's request, Tony Sleva, the president of Prescient Transmission Systems, said it appeared to be tailored for an audience with limited knowledge of electrical equipment, and a panel of electrical engineers would have been more skeptical. Sleva, whose expertise includes forensic analysis of aging and failed electrical equipment, told the newsroom that testing gas in oil is an effective method to predict remaining transformer life, the methodology is well understood, and the science simple.



Screen shots of a ruptured transformer and the required cleanup of a transformer oil spill from a presentation that PGE made to state regulators in January about transformer problems at the wind farm.

“PGE needs to obtain the service of a forensics lab,” he said in a statement, adding that without intervention the number of failures would likely climb.

Two weeks after Cope’s comments to regulators, another transformer failed at Biglow Canyon, leaking 166 gallons of mineral oil to the surrounding ground.



‘They’d hurt you’

Pieces of turbine equipment are now falling into landowners’ fields with some regularity.

PGE has not reported those incidents to the state promptly, or in some cases at all. That’s a potential violation of state administrative rules governing wind farms, as well as the conditions in Biglow Canyon’s operating permit with the state.

Take the metal frame and pieces of fiberglass that fell off the damaged nose cone of a Vestas turbine in April 2021. PGE didn’t report it until June of this year, and only after a reporter asked why it hadn’t been disclosed to regulators.

State rules require wind farm owners to operate the facility in a way that prevents structural failures of the tower or blades that could endanger public safety, and PGE’s operating permit requires a report within 72 hours of any incident with the potential to impact public safety.



Pieces from a damaged Vestas V82 wind turbine at Biglow Canyon. PGE told regulators a metal frame and pieces of fiberglass fell off the turbine in April 2021. Wind technicians later lowered the turbine’s nose cone and spinner frame to the ground, where they were left for a year.

After PGE questioned whether such an incident was reportable, the Department of Energy made it clear to PGE that it was, noting that even a small item falling from about 265 feet could reach 130 feet per second, the equivalent of almost 90

miles per hour.

At “those speeds, even a small object may present a hazard and raises questions with both the adequacy of and compliance with the requirements of PGE’s Operational Safety-Monitoring Program,” Wally Adams, an analyst at the department, wrote to the utility.

Using that standard, it appears PGE should have been reporting a lot more public safety incidents, based on what landowners say happens.

Kevin McCullough said that over the years, he has found 10 to 12 hatch doors, most of them beaten up and coated in oil, that have broken off the top of the Vestas turbines and fallen into the fields he farms. Each measures 25 inches by 29 inches and weighs about 10 pounds. He picks them up so his combine doesn’t, and either sits them against the base of the turbines or delivers them to PGE’s office.

Gray, one of the neighboring farmers, confirmed the same. “The Vestas turbines, they lose doors all the time and you’ll see them laying in the field. They’d hurt you. My neighbors won’t park by them.”

Likewise, the McCulloughs’ son, Colton, said he’s found several metal disks with a Siemens label attached, of about the same size and weight as the Vestas hatches, that have fallen off the Siemens turbines.



Landowners say they find hatch doors (left) from the Vestas turbines at Biglow Canyon and metal disks (center) from the Siemens turbines that break off and fall into their fields from a height of about 265 feet. State regulators say even small objects falling from that height can reach speeds of nearly 90 mph and could endanger anyone below. (Courtesy Kathryn McCullough)

PGE has also discovered at least one instance of broken blade bolts falling from the turbines. Last year, the company discovered broken bolts on four of its Siemens turbines, maintenance reports obtained by The Oregonian/OregonLive

show. In three cases, those were identified during annual inspections or during repairs, while broken blade bolts were found under one of the turbines in the fourth instance.

It's not clear how many blade bolts were broken or missing on each turbine. But PGE did not report the bolts, or the fallen hatches or disks, to the state.

Havel said PGE has reported "consistent with our understanding" of state rules and "in alignment with other wind operators' reporting patterns" but will "continue to evaluate our practice to ensure we are meeting" the state's expectations. PGE told regulators in July that it would hold meetings with staff and contractors to review the types of events that trigger reporting requirements.

The Department of Energy told the newsroom it would require reporting of a broken blade bolt found below a turbine but wouldn't say if the obligation would apply to other items, without having more details from the wind farm operator or a member of the public.

"We will investigate if it's reported to us," said Todd Cornett, assistant director of the Department of Energy siting division.

What is clear is that PGE kept its four Siemens turbines with broken blade bolts running for months while awaiting spare parts. In one case, according to the maintenance reports, PGE left a turbine in service with broken bolts for nearly a year.

Jenkins, the PGE manager, defended the decision. He said both Siemens and Vestas specify how many bolts attaching a blade to the rotor hub can be loose or broken and have the turbine remain operational. He declined to say what those specifications are, saying PGE is under a non-disclosure agreement.



Flags marking debris in a wheat field after a Vestas V82 wind turbine at Biglow Canyon threw one of its eight-ton blades the length of a football field on Feb. 1.

Andrew Luther, a spokesperson for Siemens Gamesa, said in a statement that it provides focused recommendations for Siemens turbines with broken blade bolts, but that “as every wind farm has a unique combination of location, wind conditions, equipment, age, and maintenance schedules, we do not have the necessary information to comment on this situation.” He also declined to comment on falling equipment or oil leaks because the company is not responsible for maintaining turbines at Biglow Canyon.

Vestas said most oil leaks are contained within the turbine structure, don’t affect performance and have a low risk of migrating to surrounding areas.

In the “rare instance” that objects fall to the ground, it is the responsibility of the wind turbine owner to make any required report to regulators, it said.

“Vestas investigates and repairs issues provided the failure falls within Vestas’s agreed upon scope with the wind turbine owner.”

The company said that when broken blade bolts are found, engineers make the determination on a case-by-case basis.

“Under certain circumstances and with the necessary engineering assessment, Vestas’ guidelines may allow for temporary wind turbine operation with additional guidelines,” it said in response to written questions. Those might include extra inspections and replacing additional bolts around the broken bolt during repair.

PGE said it had not identified broken bolts on Vestas turbine No. 71 or any of the other Vestas machines before this winter’s blade throw. But it found broken bolts and other problems on other machines afterward — including a cracked blade bearing, a steel ring that connects the blade to the rotor hub and controls the blade angle to the wind. PGE had to replace both the bearing and the attached blade as a result.

“A cracked blade bearing is a biggie,” said Haller, the retired industry consultant.

PGE told regulators its inspections this year included hiring a contractor to check the torque on “a representative sample” of more than 10,000 blade bolts at Biglow Canyon, and it submitted 50 of the failed blade bolts from the thrown blade for specialized metal testing.

Project maintenance reports obtained by The Oregonian/OregonLive show broken blade bolts were found on four more Siemens turbines and two more Vestas machines. The reports show those machines were taken offline by PGE.

Jenkins told the newsroom that if a certain percentage of blade bolts on a given turbine were not within specifications, it planned to replace all bolts on that blade. Havel later said that it replaced all the bolts on four Vestas turbines but, after testing the metal, concluded full bolt replacement was unnecessary on additional turbines.

The failure of blade bolts due to stress and metal fatigue is cited as a frequent cause of turbine failure, according to a recent study published in the academic journal *Engineering Failure Analysis*, which presented a methodology to predict the remaining life of in-service wind turbine bolts.

Metal blade bolts do have some ability to stretch and deform without breaking. But over time, they begin to lose that elasticity, and corrosion or cracking can cause them to snap under severe loads.



Workers replacing the blades on a Vestas V82 wind turbine at Portland General Electric's Biglow Canyon wind farm in late June. The turbine threw one of its blades into a wheat field on Feb. 1. PGE blamed "a loss of clamping force."

When a fatigue failure occurs, the paper said, it's difficult to pinpoint the origin after the fact, which complicates the decision on whether to replace bolts on every turbine or just the one with failed bolts. "It is of paramount importance to know whether the fatigue-damaged bolts are in general throughout the whole farm/park, only of one turbine or only those of one connection."

One of the paper's authors, Daniel Garcia Vallejo, a professor of mechanical engineering at the University of Seville in Spain, said in an email that catastrophic failures typically result from a cascading set of events.

"Usually, the first bolt will break due to fatigue, and after a number of other bolt breakages the rest will break due to overload," he wrote.

Asked if it was considered safe, under any circumstance, to run a turbine with broken blade bolts, he replied, "I don't think so. When one bolt breakage is detected it should be analyzed and repaired."



'It could produce so much more'

Amid the problems, landowners say Biglow Canyon's turbines often resemble giant lawn ornaments, sometimes sitting idle for months at a time.

And that is what they find most exasperating, and something they contend should also concern utility ratepayers and regulators, who aren't getting the carbon-free energy production they are paying for and expect.

"It's a good rent, but I'm complaining because it could produce so much more electricity," said John Scharf, who has 26 of the project's turbines on his land.

Where the turbines are

The U.S. Geological Survey maintains a database of more than 72,000 onshore and offshore wind turbine locations in the United States. [Zoom to Biglow Canyon wind farm](#)



Oregon wind farms

Oregon has about 2,300 turbines across 48 wind farms, mostly concentrated near the Columbia River Gorge.

Search:

Farm	County	Turbines	Model	Operator	Distributor
Benson Creek Wind Farm	Baker	5	GE 2.0	DE Shaw Renewable Investment / Oregon Wind Farms	Idaho Power
Biglow Canyon Phase 1	Sherman	76	Vestas V82 1.65	PGE / Orion Energy	PGE
Biglow Canyon Phase 2	Sherman	65	Siemens SWT 2.3	PGE	PGE
Biglow Canyon Phase 3	Sherman	76	Siemens SWT 2.3	PGE	PGE
Combine Hills	Umatilla	41	Mitsubishi MWT 1000	Eurus	PacifiCorp / Energy Trust of Oregon
Combine Hills II	Umatilla	63	Mitsubishi MWT 1000	Eurus	PacifiCorp
Condon (Phase I)	Gilliam	41	Mitsubishi MWT 600	ALLETE / AES / SeaWest	BPA
Condon (Phase II)	Gilliam	42	Mitsubishi MWT 600	ALLETE / AES / SeaWest	BPA

Biglow Canyon has been a disappointment from the start.

In 2008, when PGE first asked the Oregon Public Utility Commission to approve a rate increase to cover the cost of the first phase of Biglow Canyon, it told commissioners it expected the Vestas turbines would generate, on average, about 37% of their rated capacity of 125.4 megawatts.

That number is known as a turbine's "capacity factor," which accounts for the fact that wind doesn't blow all the time. It's an important contributor to wind farm economics, as it tells you not only how much power they'll generate but how many federal subsidy dollars are likely to flow to the project.

The project's capacity factor has never hit 37%. In their first five years of operation, compliance reports filed with the state show the Vestas turbines had an average capacity factor of 31%, meaning the project widely missed its initial projections.



A Vestas V82 turbine, missing a hatch door, at PGE's Biglow Canyon wind farm this summer. Farmers say the hatches fall into their fields from a height of 265 feet. (Courtesy Kathryn McCullough)

"Phase one was clearly not very good," said Bob Jenks, a ratepayer advocate for the Citizens' Utility Board of Oregon. "They'd probably argue that it was new technology and they were learning how to operate it. But they asked us to pay for output, not a learning experience."

By the time the last turbines were finished in 2010, PGE said publicly that the entire project's capacity factor was expected to be about 33%. Instead, it's averaged 27.6% – again, well below projections.

PGE said its estimates were based on assumptions and history of wind at the location, and that as the industry matures and it collects more weather pattern data, it can now more accurately assess wind farms capacity factors.

Nearby facilities are performing better.

The Patu wind farm, a six-turbine operation owned by a neighboring landowner that opened in 2010 and sits directly adjacent to some of Biglow's turbines, has had an average capacity factor of 36%. Klondike III, a large, neighboring wind farm of comparable age, has maintained consistently higher capacity factors than Biglow, averaging 29.2%, which over the years adds up to a lot of extra generated electricity.

Gray said he has four Biglow Canyon turbines on his land to the north and west of the Patu wind farm. He said he seldom sees any of the neighboring turbines down.

"He's not on any exceptional ridge," Gray said of the Patu operator. "When they built Biglow, they built on the best wind resource available."

PGE said different environmental factors and plant features affect the capacity factors of each, and that "these wind farms are not directly comparable."

State regulators separately require wind farm operators under their jurisdiction to report how often equipment is available to generate power, regardless of whether the wind is blowing.

On-shore wind turbines tend to be very reliable, typically available more than 95% of the time, according to James Manwell, a professor in the Department of Mechanical and Industrial Engineering at the University of Massachusetts who studies wind energy.



Farmers cultivate wheat right up to the base of wind turbines at Portland General Electric's Biglow Canyon wind farm (left). An aerial shot (right) of a Vestas turbine on Feb. 22, after it threw a blade 100 yards into a field below.

Among wind farms under state jurisdiction that have been operational for at least 10 years, all have hit that mark, on average, including Biglow Canyon. But the Vestas machines at Biglow have failed to achieve that target in half the years they've operated, plummeting to 88.5% in 2020 and 86.5% in 2021.

This year's performance could be worse, as many of the Vestas turbines were down three or four months after the blade separation.

Doug Medler, a Portland resident who sold his land to the McCulloughs three years ago but retained the wind rights, said his payment for the second quarter of this year was about \$5,250, compared to about \$17,850 in the same quarter last year, a 71% reduction.

"It's a significant hit," he said. "It's a big source of income, but not one that affects my ability to put food on the table or pay the utility bill."

During the past five years, PGE has offered landowners various reasons for the turbine downtime: low wind; plant curtailments by the Bonneville Power Administration when the region's hydroelectric dams are producing too much energy; and more recently, aging equipment and a lack of parts due to disruptions in the global supply chain. PGE has also said it's sometimes advantageous to ratepayers to run its other wind plants that are still within the 10-year eligibility window for federal production tax credits, and shut down Biglow Canyon, which is no longer eligible for the subsidies.

PGE told the newsroom substation and transmission outages initiated by the Bonneville Power Administration likely affected Biglow Canyon in 2020 and 2021. "There were no equipment failures or breakdowns that significantly impacted availability or capacity," PGE previously told regulators about those years.

Yet in emails to Kathryn McCullough about frustrations over downtime, a PGE official last year acknowledged the role of failing equipment.

Nick Loos, the director of dam safety and renewable energy, blamed increased downtime on wear and tear, "end of life issues" that were "rearing its ugly head" and the need for PGE to stay ahead of the "failure curve."

"The past maintenance strategy of replace as main components fail has worked in the past," he told her, "but with the increase in failures we need to mature our maintenance strategy. Work we are doing in the background is focused on preventative maintenance."



'Need to hold the utilities responsible'

The path forward for Biglow Canyon is uncertain.

Company officials have pledged to improve safety and performance, and Wyden, the senator, has vowed to keep watch.

“PGE is updating our office regularly with the inspection status, as well as committing to provide our office with a longer-term inspection and maintenance plan,” Hank Stern, a spokesperson, said in an email. “Sen. Wyden will keep watchdogging this issue to ensure PGE follows through on its commitment to him and the community.”

Financially, PGE appears to have two routes to address issues.

Jenkins, the utility’s vice president of operations, insists that PGE is managing the project – and the Vestas turbines – for longevity, focusing on preventive maintenance to keep small problems from turning into big ones. “I don’t know that with the age of these assets, the case can be made that they’re not performing,” he said.



Brad Jenkins, PGE's vice president of utility operations, watches as workers install new blades in late June on the Vestas turbine that threw a blade on Feb 1.

But keeping the turbines performing at a high level may require significant investments, and PGE’s filings with regulators don’t reflect that reality.

In fact, PGE's operations and maintenance expenses at Biglow Canyon have steadily declined, despite the aging equipment and acknowledged need for major repairs. PGE spent \$13 million last year, down 40% from 2013, according to figures filed with the Federal Energy Regulatory Commission. That's the lowest total since 2010.

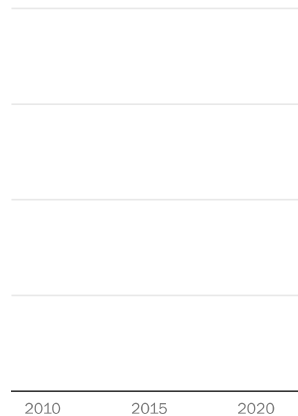
And in documents submitted to Oregon regulators, the company said it would spend even less this year: \$10 million.

If that seems strange, perhaps it shouldn't.

A 2020 study by researchers at Lawrence Berkeley National Lab found that wind plant performance in the United States declines suddenly after 10 years – far more abruptly than output dropped in Europe or Asia. One theory the authors offered: As plants aged out of the 10-year window for federal production subsidies, they don't warrant more intensive operations and maintenance activities to maximize production.

Biglow Canyon operation and maintenance expenses

PGE's operations and maintenance expenses at Biglow Canyon have declined 40% since 2013, despite aging equipment and inflation in the price of wind turbine components. The company projects spending even less this year - \$10 million – as it considers whether to "repower" the project's Vestas towers with new components or invest more heavily to keep the existing equipment running.



*2022 figure is an estimate
[Get the data](#)



A wind technician enters a Vestas turbine at PGE's Biglow Canyon wind farm. The project's 76 Vestas turbines are now 15 years old, about halfway through their depreciable life. PGE is already considering replacing them.

A related hypothesis cited by the research: regular maintenance that was deferred to maximize production while the wind farms were still eligible for the tax credits eventually comes home to roost in the form of increased breakdowns.

PGE's alternative to spending more on maintenance would be to repower the Vestas turbines, replacing most of their components, increasing their efficiency and output. It's not uncommon. And PGE is considering it.

If that happens, ratepayers could end up eating the remaining value tied to the existing machines. The Public Utility Commission said that was \$178 million at the end of last year and would decline to about \$156 million by the end of 2023.

The likelihood of repowering may have just gotten higher, as the Inflation Reduction Act passed by Congress this month renewed the federal production tax credit subsidy for another 10 years for wind and solar farms that begin construction prior to Jan. 1, 2025, including those repowering turbines.

Any decision to repower turbines at Biglow Canyon would be subject to a so-called "prudence review" by the Oregon Public Utility Commission to determine whether the investment is in the public interest. That decision would include all the costs involved, including the remaining costs of the turbines being repowered, the cost of the new equipment, and the available tax credits.

Jenks, the ratepayer advocate, said the review would also include an analysis of whether the current equipment has been properly maintained, and if not, what went wrong.

"If we're going to make a transition to clean energy," he said, "we need to hold the utilities responsible for managing these projects properly."

The landowners would like that same level of accountability.

"When we entered into the agreement, the objective of the company and the landowners leasing the land was to have the project work, and make money," said Cheryl Woods, a Biglow Canyon property owner and the accountant for the wind prospecting company that originally arranged the lease.

"But it doesn't seem to be exactly going that way. It just hasn't been managed well."



A Vestas wind turbine at PGE's Biglow Canyon wind farm.

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