SAFETY FIRST

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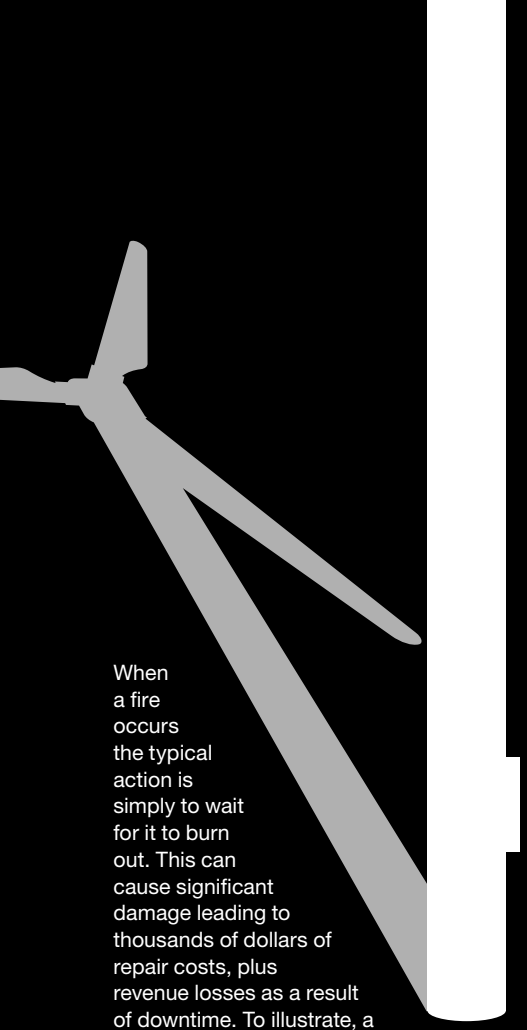
Wind turbine fire protection: investing to protect the bottom line. Fire is the second leading cause of accidents in wind turbines after blade failure[1], with the average overall cost of a wind turbine fire being around $4.5m[2]. Given that $112.5bn was ploughed in to wind power globally in 2016[3], wouldn't it be prudent to invest a little more of that in fire suppression?

1 2014 report by Imperial College London, Edinburgh University and SP Technical Research Institute of Sweden, published in Fire Safety Science
2 Renewable Energy Loss Adjusters
3 BNEF



When a fire occurs the typical action is simply to wait for it to burn out. This can cause significant damage leading to thousands of dollars of repair costs, plus revenue losses as a result of downtime. To illustrate, a single 2.5-3MW commercial scale wind turbine is valued at approximately $3-$4m[1], with the value of the output averaging $2,800[2] per day. It's clear, therefore, that the financial impact of even a minor fire, which can still cause weeks of downtime, can be significant - the average total cost of a wind turbine fire is $4.5m[3].

1 2014 report by Imperial College London, Edinburgh University and SP Technical Research Institute of Sweden, published in Fire Safety Science

2 2014 report by Imperial College London, Edinburgh University and SP Technical Research Institute of Sweden, published in Fire Safety Science

3 GCube report 2015: Towering Inferno – Global Trends in Wind Turbine Downtime Events

Causes

There are generally three main causes of wind turbine fires: mechanical failure, electrical malfunction and lightning strikes.

A small fire can accelerate quickly in a nacelle that comprises highly flammable resin fiberglass. Internal insulation in the nacelle, which can become contaminated by oil deposits, further adds to the fuel load. Lightning strikes also pose a uniquely high- risk due to both the turbines' exposed locations and their height; turbines are now being built in excess of 450ft.

Reporting

Despite the high fire risk in wind turbines, there are relatively few widely reported incidents in the industry. But from discussions with wind farm owners, turbine manufacturers and insurers, it's certain the losses from fire are much more frequent than publicly documented.

A 2014 report published for the International Association of Fire Safety Science set out to quantify the true number of wind turbine fires and their impact. In the UK, where the report was published, the findings attracted attention-grabbing headlines in major newspapers such as 'wind turbine fires ten times more common than thought', and 'wind turbine fires are hidden peril.'

Since 2011 there have been 36 large wind turbine fire incidents reported in the mainstream media. One of the worst recorded incidents in recent times took place in California in 2012. More than 100 firefighters were required to put out a wild land fire that spread across 367 acres, which could have been far worse if not for a witness. The final report indicated equipment failure, specifically an arch flash, was to blame for the fire.

And just this September in Wyoming in the US, a wind turbine caught fire and caused a wild fire that burned out nearly 1,600 acres. The cause of this particular incident isn't yet known, but dramatic cases such as these always hit the front page.

In the social media era news travels fast, with traditional media attention amplified by witnesses sharing news online; often videos of burning wind turbines taken on their camera phones. All this has resulted in increased public awareness of wind turbine fires.

Risk prevention

Redesigning the turbines to reduce the fuel load inside the nacelle is one step to reduce fire risk. Measures including avoiding the use of combustible insulating materials and hydraulic or lubricant oils, as well as installing lightning protecting systems and a radiant barrier to protect combustible materials, could be considered.

To reduce fire risk further, any maintenance and repair activities that involve 'hot work' inside the nacelle could be avoided. It has also been suggested that condition monitoring systems should be implemented and maintenance checks completed regularly.

Fire suppression

As a final step, many owners and manufacturers are incorporating automatic fire detection and suppression systems alongside these methods to further protect the nacelle. The wind turbine nacelle presents a unique challenge for fire detection and suppression: dust, vibration and temperature fluctuations can all interfere with reliable operation. An effective system has to cope with the environmental challenges within the nacelle. One has to consider both the detection method and the agent when selecting an automatic fire suppression system.

There are several types of fire detection available. One approach is to use smoke detection or air sampling systems. While these systems can be effective at detecting the early stages of a fire, the air flows and environment can present a challenge to their effectiveness. Alternatively, traditional

linear heat detection systems and fusible link detection systems aren't affected by air and dust but are potentially electrically conductive. All of these types of detection have power and control requirements, which means that the system will fail if the external power or battery backup fails.

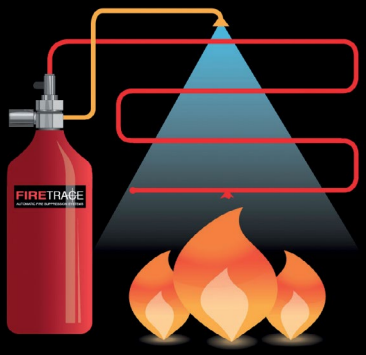
Then there are the fire suppression agents. Compressed air foam systems and water mist have both been proposed solutions, but concerns about the effectiveness on energised electrical components, as well as potential corrosion hazards, have limited their implementation.

Carbon dioxide systems have been used but aren't ideal because, due to the CO_2 displacing the oxygen in the event of a discharge, the fire suppression system has to be 'locked out' any time personnel are present in the nacelle. In a working at height situation this is a significant safety concern and therefore this agent should only be considered if others aren't available.

The weight of these technologies and the space required to store them can also pose a problem in the cramped environment within the nacelle.

The most common solution today overcomes the above drawbacks by providing component-level automatic systems that offer both fire detection and suppression in a single package. They can be designed to detect a small fire in or around a critical component, dramatically improving the response time and reliability while reducing the size of the system required.

These systems use clean agent fire suppression technology involving a non-conductive gas, which leaves no residue following a discharge, requires no clean up, and in small volumes doesn't present a hazard to personnel.



The presence of an automatic fire detection and suppression system offers 24/7 reliability and unsupervised protection to quickly address a growing fire and limit its damage, both in terms of financial impact and costs to the image of the wind energy industry.

And yet, despite the availability of affordable fire suppression methods, thousands of wind turbines are still being installed without adequate fire protection, and entirely preventable wind turbine fires continue to occur.

Legislature

There's been increasing momentum over the past few years for local authorities to protect their resources by requiring fire suppression on new wind farms.

For example, The Nation's council in eastern Ontario last year voted in favour of passing a bylaw requiring fire suppression be installed in turbines under construction at the Eastern Fields Wind Farm. Furthermore, there is some unique regulation in Canada that has enabled local authorities to take it a stage further and insist that fire suppression systems must be retrofitted to existing sites.

And this isn't simply a Canadian phenomenon. A growing list of authorities in Germany, and a number of both local and state governments in the US, are acknowledging that fire suppression is a prudent step to safeguard assets in the event of a fire in a wind turbine.

This is a welcome trend given that the design of a wind turbine, which places the mechanical portion of the turbine nearly 300ft off the ground at the top in the nacelle, means there is no practical way to respond to a fire in these units.

Designing in fixed fire suppression, which can contain the blaze within the micro-environment of the nacelle, is a sensible move to help prevent large-scale fires.

www.firetrace.com/wind

Case study: preventing fire-related damage at a California wind farm

Location: Palm Springs

Owner: Whitewater Energy Corporation

Number of wind turbines: 6 x 1.5MW

Fire suppression: Firetrace's automatic fire suppression system was installed in all six turbine converter cabinets in late 2009 following an earlier fire that caused more than $243,000 in damaged equipment and downtime.

The issue: A fire started in a wind turbine converter cabinet.

The solution: The Firetrace automatic fire suppression system, comprising unique linear pneumatic detection tubing routed throughout the equipment, activated immediately on detecting the fire. It released its suppression agent directly on the heat source to contain the fire and limit damage to the eruption point.

The result: No damage to the cabinet or internal components, other than the failed component.

Downtime: Firetrace was able to quickly deliver a replacement system, enabling the turbine to be up and running the next day. This was a considerable improvement on the average downtime following a wind turbine fire of approximately nine months.

7 GCube report 2015: Towering Inferno – Global Trends in Wind Turbine Downtime Events