Crawford®

FACT SHEET

Common causes of loss

Considering the challenges faced in the successful operation of renewable energy resources

Lightning damage to wind turbines

Wind turbines are at risk of lightning damage due to their height and exposure to stormy weather.

Potential lightning risks include:

- **Direct strikes:** Wind turbines can be directly hit by lightning strikes, which can cause damage to the blades, generator, and other components.
- **Indirect strikes:** Even if a wind turbine is not directly hit by lightning, it can still be affected by the electromagnetic field generated by a nearby strike. This can cause voltage surges that can damage sensitive electronics and control systems.
- **Fire:** Lightning strikes can also cause fires in wind turbines, which can lead to catastrophic damage and, in worst cases, the loss of the entire nacelle.

Lightning risk mitigation

To mitigate these risks, wind turbines are typically designed with lightning protection systems (LPS) that include lightning rods, grounding systems, and surge protectors. Regular maintenance and inspection of these systems is necessary to ensure they are functioning properly and are able to protect the wind turbine from lightning damage.

A lightning strike to a wind turbine can be detected by several means, including:

- **Visual observation:** If someone is physically present at the wind turbine site during a thunderstorm, they may be able to see or hear the lightning strike. They may notice a bright flash or a loud noise, which could indicate that the wind turbine has been struck by lightning.
- **Monitoring systems:** Wind turbines are often equipped with sensors and monitoring systems that can detect and record lightning strikes. These systems can measure the current and voltage of a lightning strike, the location of the strike, and the time of occurrence. This information can be used to assess the potential damage to the wind turbine and to help with maintenance and repair efforts.
- **Weather detection companies:** A number of specialist weather data companies offer services that predict strike probability from approaching weather systems and alerts Owners when a strike occurs directly or locally.
- **Data analysis:** The same companies record data that can be analysed to identify patterns or trends in lightning strikes over time. This can help wind turbine operators to identify areas of the turbine that are more vulnerable to lightning strikes and to develop strategies for lightning protection and mitigation.

It is important to note that lightning strikes can still occur even with the best lightning protection systems in place. Regular inspection and maintenance of wind turbines is necessary to ensure that they are safe and operational, especially after a lightning storm.

Fig 01 – Catastrophic lightning damage to blade

Latest observations using 3D mapping technology

The first set of observations shows that under certain thunderstorm conditions, wind turbine blades produce electric discharges at regular intervals of ~3 s in relation to its rotation, over periods of time that range from a few minutes up to hours.

This periodic effect has not been observed in static towers, indicating that the effect of rotation is playing a critical role.

The repeated discharges can occur tens of km away from electrically active thunderstorm areas and may or may not precede a fully developed upward lightning discharge from the turbine. Similar to rockets used for triggering lightning, the fast movement of the blade tip plays an important role on the initiation of the discharge. The movement of the rotor blades allows the tip to “runaway” from the generated corona charge.

The second observation is an uncommon upward/downward flash triggered by a wind turbine. In that flash, a negative upward leader was initiated from a wind turbine without preceding lightning activity. The flash produced a negative cloud-to-ground stroke several km from the initiation point.

The third observation corresponds to a high-speed video showing simultaneous upward positive leaders from a group of wind turbines triggered by a preceding intracloud flash. The fact that multiple leaders develop simultaneously indicates a poor shielding effect among them. All these observations provide some special features on the initiation of lightning by non-static and complex tall structures.

Key Points

- Periodic discharges are emitted by rotating wind turbines
- Rotating blades are less shielded by corona
- Rotation favours occurrence of discharges compared to stationary tall objects