Insuring wind power in China against typhoons and earthquakes

Renewable wind power is one of the fastest growing sectors in China, where installed capacity is set to almost quadruple by 2030. But wind-rich areas in China are exposed to earthquakes and typhoons with extreme wind gusts. So how to build reliable energy supplies for China’s future?
To achieve economies of scale, wind parks often comprise several dozen wind turbines. If they are located in areas exposed to earthquakes or peak gusts from severe typhoons, there is a chance that they are damaged or snapped in two in extreme cases.

For wind farm owners and operators, damage from natural catastrophes is likely to bring reconstruction costs and loss of revenue, as such events can affect not just one but many units.

Still, revenue streams and wind farms can be protected against even the most severe events. If disaster strikes, we can stabilise your balance sheet with our insurance products and our insurance payouts provide the funding to rebuild your turbines.

This publication gives you a brief overview of where the hazards are, how big the potential reconstruction bill could be and how you can protect yourself.

China needs clean power to continue its journey of economic success. We are here to help you achieve this goal with our more than 150 years of experience in insuring technical installations. Contact us to find out how we can serve you with our know-how.
Investments at risk

Renewable energy and especially wind power are a growth story in China. The main drivers are the rising energy needs of the growing economy, the increase in air pollution in recent years and the need to mitigate climate change – an area in which China has committed to play a leading role in the Paris agreement.

Wind power today

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<th>Moderate scenario GWEA</th>
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Over the last decade, installed capacity has reached over 145MW, and it is expected to almost double by 2020. By 2030, capacity will have grown more than 3.5 fold. This represents a huge financial investment, much of which is exposed to the risk of natural catastrophes.

Swiss Re estimates that the current total sum insured of China’s offshore and onshore wind facilities is approx. CNY 1 195bn (USD 176bn), a figure that is set to increase to CNY 4 230bn (USD 622bn) by 2030.
A significant share of the growth will take place in areas at risk from earthquakes and typhoons. This is new for the wind power industry, as not many wind farms are currently located in such areas.

As the earthquake hazards map shows, a large number of planned developments are in earthquake-prone areas in China. The installed capacity equals investments at risk. If an earthquake damages installations, both the replacement cost and the loss of revenue are at risk. Business interruption in the industry can be an additional burden.

Typhoons also represent a severe hazard for this industry because of their high peak gust speeds and rapidly changing wind directions. Blades and installations in current wind farms are known to be susceptible to damage. These hazards need to be considered going forward for wind farms in China.
Moving to dangerous grounds

Many easily accessible areas for wind power plants have already been developed, so that many of the new facilities will need to be built in less convenient areas. The large urban centres have the greatest need for energy, and power supplies should ideally be close by. Fortunately, many of these cities in China are in areas where wind is available. The downside is that many are also located where earthquakes are common and peak gusts – which push hardest against the wind turbines – are severe.

Modelling the earthquake and peak gust exposure in China

Over its more than 150-year history, Swiss Re has insured and paid out for losses in exposed areas all over the world gaining large amounts of knowledge in loss prevention in this process. To complement our own knowledge of windstorm and earthquake exposures, we used the expertise of the Danish Technical University to model loss estimates for China today and for the future up to 2030.¹

¹ See also Swiss Re’s publication: Moving on dangerous grounds - wind power and earthquake exposures in China, www.swissre.com/library
Where the exposures are

The map shows how we expect wind farms to spread across China in the next few years up to 2030. Major new developments will take place both onshore and offshore in areas exposed to earthquakes and peak gusts.

Seriously affected wind farms could trigger severe business interruption in the fast growing economies of the entire region. And the costs to repair or replace damaged turbines would also need to be covered. Just how high could the bill be?

Harvesting model outcomes for more resilient wind farms

By 2030, a 200-year typhoon event could trigger a market loss over CNY 56.8bn (USD 8.4bn) depending on where and how often it strikes. A 50-year event could also easily breach the USD billion threshold by 2030.

We modelled the exposures based on the data and expertise we have acquired over the years. The calculations show that future exposures will be huge. So what can be done to make our energy supplies more resilient?

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Managing risks pro-actively

Swiss Re’s publication “Wind farms: harvesting energy on shaky grounds and in stormy seas” offers an in-depth review of the current design challenges. Key outcomes of the risk assessment there are listed below:

To enable wind parks to keep on running even in severe events, the following should be considered in the planning and design phase:

- Which natural hazards are present at the selected site? Swiss Re’s CatNet®, which is accessible via our website, gives you an initial indication.

- Current design criteria (e.g., International Electrotechnical Commission (IEC) design standards) oversimplify hurricane and earthquake conditions. An update and extension is planned and will improve the design basis for wind turbines in exposed areas in the future. We strongly support these efforts. They could address the following items, for example:
  - During the passage of a tropical cyclone, wind speeds and wind directions can change very rapidly. However, yaw system control mechanisms usually only consider 10-minute averages of measured wind speeds and directions. As such, they are not flexible enough to react to the sudden changes during a storm.  
  - Cracks and delamination between the junction faces of the cover layer caused by long-term wind effects are not yet properly considered in design guidelines.

- For areas exposed to earthquakes

  Time history analysis is the preferable method to predict the non-linear dynamic response of wind turbines subjected to concurrent loads (wind, wave and earthquake).
  - The analyses should also include the different states of operation, such as normal operation, parked or emergency shutdown. This should be considered in modelling the forces affecting the turbine.
  - Due consideration should be given to the selection of seismic motions that are used in the time history analyses, because the selection of ground motions may strongly affect the results of the vulnerability study.
  - Special attention should be given to soil structure interaction, as the soil may significantly change the dynamic response of the wind turbine.
  - Additional effects, such as scouring and liquefaction, also need to be considered.
  - Deterioration due to fatigue and corrosion and the effects of maintenance need to be considered.

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3 [http://www.swissre.com/clients/client_tools/about_catnet.html](http://www.swissre.com/clients/client_tools/about_catnet.html)
4 [Rochelle Hurricane gusts can exceed offshore wind turbine design loads.pdf](http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50724/abstract)
5 [Assessment of the ASCAT wind error characteristics by global dropwindsonde observations](http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50724/abstract)
6 [See also Swiss Re’s publication: Moving on dangerous grounds – wind power and earthquake exposures in China, www.swissre.com/library](http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50724/abstract)
If wind farms in exposed areas are designed bearing in mind the above considerations, the probability that they will withstand a severe event is high. In addition, enabling infrastructure like cables, substations and access roads must be designed accordingly.

Even then, a residual risk remains, and for this, there is insurance.

**Safeguarding properties and revenues via insurance**

The insurance offerings available to wind farm operators cover the entire value chain.

Planning and construction: Swiss Re’s engineering policies insure your facility during the construction phase. Depending on the cover you choose, it insures only property and/or loss of revenue due to delayed start-up.

Operation: index-based “lack of wind” coverage is available. It will pay out if a certain pre-defined threshold is met, protecting the revenue streams of corporate and reinsurance clients in long windless periods or if you have to shut down due to a storm.

Natural catastrophe coverage protects your farm against damage resulting from storms, floods, earthquakes or wildfires. Depending on the cover you choose, it can be limited to property and/or loss of revenue due to delayed start-up.

**The road ahead to a clean energy future**

The transition to renewable energy supplies has begun in China, as exponential growth rates show.

Wind will be one of the key components of the new mix of energy supplies. The process is advancing rapidly and technological developments in this field will accelerate even more. As a case in point, the first floating wind turbines were installed off the coast of Scotland in 2017. This is just one example of a technological leap which will bring new opportunities but also new risks – just think of the cables and substations for a floating wind farm far offshore.

For investors to buy into this new technology, they need the assurance that their investments are safe and revenue streams are ensured. Part of this assurance comes with the design, and for the rest, the insurance industry can provide the coverage investors are looking for.

Dealing with technological change is part of the DNA of the insurance industry. Swiss Re has more than 150 years of experience in insuring technological innovation. Let’s work together in applying it to wind power to ensure our future energy supplies are reliable and resilient.

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7 [https://corporatesolutions.swissre.com/innovative_risk/weather/](https://corporatesolutions.swissre.com/innovative_risk/weather/)
Annex

We have a long history of developing, maintaining and advancing our own proprietary, state-of-the-art risk assessment models. A risk assessment model is nothing more than a simplified representation of reality. Natural hazard models use the virtual world of computers in an attempt to simulate natural catastrophe losses expected in reality. These virtual worlds consist of four different basic sets of data:

**Hazard**

The hazard component contains the physical footprints of realistic catastrophe scenarios. This can be, for example, the maximum peak gusts during a tropical cyclone or the peak ground acceleration during an earthquake. It allows to assess where, how often and how severe potential events can be. Because the historical record is usually not enough to assess that question in a consistent and robust way, natural scientists simulate hundreds of thousands of artificial but still realistic (so-called probabilistic) events. For the study presented here, we produced footprints for more than 400,000 events covering the North Atlantic, Europe and the West Pacific.

**Vulnerability**

The vulnerability component describes the damage (or loss) ratios as a function of the physical intensity (e.g., peak gust, ground acceleration). Generally, the loss ratio at a given intensity depends heavily on the risk characteristics. In the case of a wind turbine, factors such as the design standard, age, safety mechanisms and the foundation play a major role. This becomes evident from both loss experience and engineering considerations. In addition to the expected loss ratio, the spread/uncertainty is also taken into account.

**Value distribution**

The exact location and the type of an insured object (e.g., a wind farm) are very important factors determining both hazard and vulnerability. In order to be able to put an absolute amount on the loss, the value of the insured objects also needs to be known. In addition, the value distribution determines how far the expected losses of the risks in a given portfolio correlate for a given natural peril: risks located along typical storm tracks are likely to suffer damage from one and the same cyclone. If the value distribution is tracked over time, this also allows for accumulation control.

**Insurance conditions**

Insurance conditions, including deductibles and limits, are important tools allowing the re/insurer to keep its share of any loss within reasonable limits. These conditions may apply to an individual insurance cover or to several insured interests in the same location. Obviously, such conditions must be taken into account when computing absolute expected loss amounts.