CASESTUDYSERIES

EXTREME WEATHER

Winter storms | Italy | 2018

This case study is part of an extreme weather impact project, in partnership with Swiss RE Corporate Solutions and Marsh & McLennan Companies, which aims to identify and share best practice within the energy sector to enable more agile and adaptive response to extreme weather and natural hazard impacts on energy systems and supplies.

CASE STUDY AT GLANCE

WEATHER EVENT
Strong winds and wet

ORGANISATION
Terna (Italian

INDUSTRY SUB-SECTOR
Transmission & Distribution

RESILIENCE RESPONSE
Physical: defence plans technological adaptation (e.g. information systems)

RESILIENCE BENEFITS
Improved preparedness; timely response

Over the past 5 - 6 years, Italy has been experiencing more frequent and severe winter storms, including hurricane-force winds and heavy snowfall. One of the associated impacts of this extreme weather has been wet snow ice accretion on overhead powerlines and associated poles and towers. These events often cause significant damage and disruption to power transmission and distribution, which is expensive to repair.

For example, in October 2018, a 'tornado-like' phenomenon occurred in the northern Italian areas of Veneto, Trentino and Friuli Venezia Giulia. For three days, hurricane-force winds knocked over 14 million trees, which damaged T&D infrastructure, causing over 90 major blackouts. More than 5000 MW remained shut. In order to help maintain energy supply to customers, TERNA, the Italian TSO, had to use back-up diesel generation, while repair works were being carried out.

Prevention is key to Terna's resilience strategy. By using an innovative numerical weather and ice accretion forecasting tool, Terna can identify where wet snow accretion has a high probability of occurrence, estimate the load of an ice sleeve and its hazard and decide upon the most effective mitigation measures. Furthermore, a multi-stakeholder coordinated response protocol combined with regular disaster scenario training and emergency recovery drills, helps Terna to keep an edge over extreme weather. This case study explores the context of the power outages and the critical role of preparedness and multi-stakeholder response processes in addressing dynamic system resilience.

CONTEXT

ORGANISATIONAL PROFILE: TERNA

- Main transmission system operator (TSO) in Italy and second largest in Europe
- Manages 72,000km of transmission lines, 873 substations, 781 transformers, 25 interconnections and 320TW energy

WINTER STORM OCTOBER 2018

- Hurricane-force winds with average speeds of 90km/h and gusts of 200km/h.
- 50,000 hectares of forest were destroyed with around 14 million pine trees and red spruces razed from the ground[1]

ENERGY IMPACTS

5000MW gap in electricity supply;
90 blackouts.

Disruption to business activity including industrial clients (e.g. paper and iron) as 132 kV power lines were damaged.

Millions of Euros spent on repair work.

[1] Italy Magazine, 2018

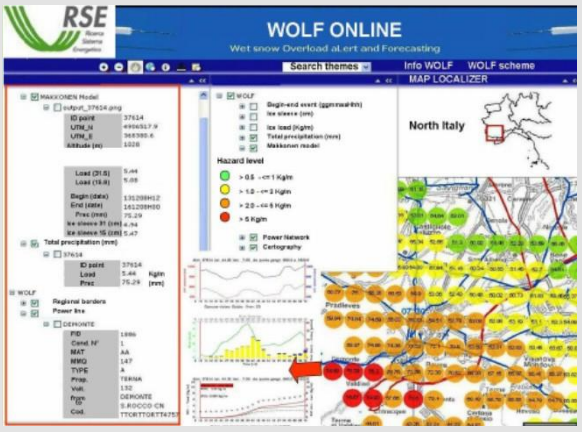
Ice accretion occurs particularly during January and March when the surface air temperature is close to freezing point (0-2C). Snowflakes settle on conductors and lines accumulating into ice layers that can reach 20cm in diameter. The added mechanical stress can lead lines and poles to break, and towers to collapse. Ice accretion can also contribute to conductor galloping in high winds, sometimes leading to short circuits and outages. In addition to disrupting power transmission, the damage to power lines can cause serious risk to people and property on the ground.

RESILIENCE: PREVENTION AND IMMEDIATE RESPONSE

Preventive measures form an essential part of Terna extreme weather defence strategy. One such measure is the weather forecasting tool called Wet Snow Overload Alert and Forecast (or WOLF). This application is used to analyse and predict icing hazards across the country, and to provide in turn, guidelines on how to manage the grid through preventive dispatch for de-icing. WOLF is fed data from over 60 automatic weather stations installed on transmission pylons, which record wind speed and direction, and the pressure, temperature and humidity of the air. It uses an interactive, user-friendly, online platform that can be operated by non-experts. The system is continuously upgraded and the learnings from tackling extreme weather events provide useful inputs to improving the tool's forecasting capabilities.

THE WOLF SYSTEM[2]

The aim of WOLF is to forecast wet snow events and calculate maximum ice-load expected on conductors with different diameters in a target area. Every day, the ice-load hazard level is plotted on a map in order to supply a daily warning (Figure below). The system helps power network management dispatch load where needed. WOLF integrates an ice accretion model, an interface for the collection of forecasted meteorological data and a GIS display system. WOLF forecast outputs are reportedin a WEB-GIS Active Desktop that is easily-accessible by Terna's staff of Power Grid Maintenance Department.



Based on WOLF's predictions, Terna can choose to dispatch load in a way to increase flows through a particular line, raising the temperature of conductors to facilitate de-icing. This may involve connecting auxiliary power plants. Other short-term mitigation solutions include installing anti rotational devices to prevent the ice load twisting and damaging the cable.

In preparation for crisis situations, Terna carries out regular training and drills that consider different possible disaster scenarios (e.g. wet snow accretion, earthquakes etc.) and how to respond effectively. These tests are carried out with distribution partners and the Civil Protection Agency to increase preparedness to extreme weather events.

Emergency response planning enables strong coordination between electrical distribution operators, civil authority[3], local municipalities and other infrastructure companies (e.g. the highway and roads companies). These response plans include holistic approaches to grid maintenance, and the allocation and mobilisation of repair teams and resources across the country to address impacts across the network.

During blackout events, customers can call one of Terna's three regional control centres, via a 24/7 customer service helpline. If the extreme event afflicted a small portion of the grid, regional offices have some degree of autonomy to address the issue. However, if the event damaged a large section of the grid, coordination procedure between the different stakeholders and the central management is initiated. When necessary, the TSO can make use of helicopters to inspect damaged lines and facilitate swift repair.

TERNA'S DEVELOPMENT AND RESILIENCE PLANS

The Development Plan of the Italian National Transmission Grid is presented for approval each year to the Ministry of Economic Development. The plan indicates the projects that will be launched in the next ten years and the status of works implemented in the previous year. This plan takes into consideration the investments into resilience[4] (since 2018), security of supply, special protection schemes and other kind of extreme events. The resilience plans[5] need to indicate the areas and lines most at risk, the phenomena that may compromise service, and the measures to avoid or reduce the probability and extent of outages. Network operators must also indicate measures in coordination with other institutional stakeholders, including the Civil Protection Department, and local authorities, for restoring service if disruptions occur in conjunction with extreme events. These investment plans are paid by customers in the transmission tariff.

[2] Bonelli et al., 2011
[3] The Civil Protection Department is an association that delivers emergency alerts and develops forecasts before an extreme event.
[4] Terna, 2018
[5] EC Europa, 2018

> **ALL EVENTS THAT OCCUR TO THE GRID REQUIRE SOME RETROACTIVE RESPONSE – FOR EXAMPLE MOBILISING AND MONITORING MAINTENANCE TEAM ACROSS THE COUNTRY. IT IS HARD TO BE PROACTIVE SINCE EXTREME EVENTS ARE STILL QUITE RARE. HOWEVER, WE TEND TO RESPOND TO EXTREME WEATHER WITHIN A FEW HOURS**
>
> **- Terna -**

In the long-term, infrastructure upgrades are applied to vulnerable sections of the network, including meshing and reinforcing, and also diversifying the technologies used. This includes installing underground cables, apart from earthquake-prone regions such as Sicily and Calabria and the Apennine Mountains where overline cables remain the most resilient.

> **GLOBAL CLIMATE CHANGE IS A VERY COMPLEX PHENOMENON AND IT IS VERY DIFFICULT TO PREDICT THE NEXT EXTREME EVENT. LAST AUTUMN WE EXPECTED WET SNOW; NOBODY THOUGHT THAT A HURRICANE WILL AFFECT NORTHERN ITALY"**
>
> **- Terna -**

ANTICIPATION OF FUTURE RISKS

The overload of snow on power lines is the principal cause of major power outages during the winter season in Italy. However, sea salt pollution is also an issue as most of Terna's transmission infrastructure is located near the sea (southern Italy). When strong winds occur, there is increased salt deposition on conductors, which in turn forms a conducive layer that can damage the line insulator. It is uncertain whether this issue will become more widespread and common in the future. In addition, southern Italy has also been experiencing more wild fire events, which could become more frequent and widespread in the future.

BARRIERS

- Poor maintenance of local road and motorway infrastructure during extreme events
- Poor communication infrastructure between customers and distributions operators
- Lack of coordination with the large customers (e.g. industry)

ENABLERS

- Forecasts from the WOLF system.
- Use of helicopters to swiftly dispatch repair teams and transport spare parts and equipment
- Good communication and coordination between TSOs and distribution companies

> **IF WE WANT TO KEEP THE LIGHTS ON, WE NEED TO HAVE AN ELECTRICAL SYSTEM WITH COMPLETELY DISPERSED GENERATION**
>
> **- Terna -**