

EXTREME WEATHER

Typhoon Mangkhut | Hong Kong | September 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
Typhoon



ORGANISATION
CLP Power Hong Kong Limited



INDUSTRY SUB-SECTOR
Transmission & Distribution
System Operator (TSO & DSO)



RESILIENCE RESPONSE
Physical hardening, technological innovation and improved communication and human resources



RESILIENCE COSTS
Flooding of substations



RESILIENCE BENEFITS
Improved prevention and mitigation strategies

Typhoon Mangkhut was the worst storm in Hong Kong's recorded history but resulted in zero deaths and minimal power disruption. Out of the 2.4 million customers that CLP Power Hong Kong serves, less than 2% (mainly rural) experienced disruption to their electricity supply, and more than half of these were brought back online within two days. The reason for the minimal disruption is the strong urban grid infrastructure, which is both modernised and frequently maintained. The application of future scenario planning in asset management, coupled with the frequent extreme weather risk assessments and equipment inspections, and implementation of mitigation programmes such as physical hardening of the critical 400 kV transmission and distribution (T&D) infrastructure, meant that the typhoon impacts were point shocks rather than system wide failures and were easy to repair quickly. Additionally, significant efforts were put into warning and informing customers of time frames when outages were possible, with regular updates through phone calls and app notifications. This meant households were prepared and resilient, and panic during the storm impact was minimised.

This case study explores the context of the power outages and the critical role of adequate preparedness in addressing dynamic system resilience.

CONTEXT

ORGANISATIONAL PROFILE: CLP POWER HONG KONG LIMITED

- Founded in 1901, wholly-owned subsidiary of CLP Holdings Limited and one of the largest investor-owned power businesses in Asia.
- It operates a vertically integrated power supply business in Hong Kong, covering electricity generation, transmission and distribution, and marketing and customer services.
- It supplies highly reliable electricity to over 80% of Hong Kong's population and has 8,888MW generation capacity.

TYPHOON MANGKHUT, SEPTEMBER 2018

Most intense typhoon to hit Hong Kong since 1946. Wind speeds reached 186 km/h on average with gusts up to 256 km/h. Storm surges up to 4m set record levels; the ocean climbed to its highest level since at least 1904.

ENERGY IMPACTS



400 kV and 132 kV overhead lines were affected



Power supply was interrupted for 40,000 customers mainly in New Territories North, Yuen Long and Sai Kung



47,000 trees felled

More than 30% of CLP's 14,500 km transmission and distribution network consists of overhead lines. There are more than 700 400kV transmission towers that form the backbone of its supply system. Overhead lines are exposed and susceptible to the influence of weather and the external environment.

TYPHOON MANGKHUT IMPACT

On September 16 2018, the right-hand eyewall — the worst part of the storm — made a direct hit over Hong Kong. Winds clocked in at 175 km/h in the city. The Hong Kong Observatory issued the highest typhoon warning signal – 10 – which remained in place for 10 hours. The storm damaged CLP’s wooden pole 400 kV and 132 kV overhead lines systems. Power supply to 40,000 customers covering the rural New Territories North, Yuen Long and Sai Kung was interrupted. Hong Kong metropolitan area was largely unaffected by the outages because the distribution network is mostly buried underground. As the sheer size of the storm was so powerful, it hit and damaged power supply facilities, prompting a lot of simultaneous customer calls to the CLP Customer Services Hotline. The resulting storm surge caused flooding, especially in low-lying and coastal areas, and over 47,000 trees were felled, blocking several major roads, impeding recovery. Service on the Mass Transit Railway (MTR) was also halted on all above-ground sections of track chaos for commuters who waited several hours in train stations.

RESILIENCE: PREVENTION AND IMMEDIATE RESPONSE

Since the year 2000, CLP has focused on planning for and managing the potential impacts from super typhoons especially for those assets located in coastal regions which experience increasingly adverse weather conditions. This includes comprehensive risk assessments based on climate change scenarios and sea level rise projections and flood vulnerability assessments to identify high-risk substations. In addition, several initiatives have been put in place to mitigate the potential impacts of extreme weather on the T&D systems in Hong Kong. These include:

- A plan to strengthen the key transmission tower structures and foundations of 400kV overhead lines to withstand super typhoons with wind gusts up to 300km/h. Retrofitting of 11 flood-prone transmission substations. This was a crucial prevention initiative, which in turn enabled to maintain the infrastructure intact during typhoon Mangkhut.
- A storm surge warning system, installing flood gates, sealing the cable inlets and equipping the substations with sump pumps at flood-prone substations. The former enables to remotely switch-off high-risk substations, thus avoiding dangerous explosions due to the contact between the superconductor and floodwater.
- An Emergency Restoration System has been in action since 2013 to improve the emergency response capability of the CLP transmission network.
- Regular drills to ensure CLP management and frontline staff are ready to handle different emergency scenario.
- CLP Power has also maintained close contact with its overseas counterparts and exchanged experiences in the

areas of technology, management and operations. The adoption of a flood calculator originated from Con Edison, a power company in New York which has considerable experience in combating storm surges.

A week prior to the arrival of super typhoon Mangkhut and following the recommendations from the government and the media, CLP implemented several additional preventive measures including:

- Inspections to check that the flood mitigation equipment (e.g. floodgates and water pumps) are properly installed and operational. CLP carries out inspections regularly every year. If, after the risk assessment and field inspection, vulnerable substations are identified, then the field teams will install floodgates at those locations. In the case of highly vulnerable substations, where the floodgates are likely to fail, water pumps are installed to take the water out.
- Encouraged alertness among its customer base using social media posts.
- Set up emergency accommodation for call centre staff to mitigate the risk of their journey home during the typhoon and increase the capacity of customer calls processed during the event.
- Stockpiled repair equipment and emergency response teams. Regionally distributed response teams were ready to start repair work as soon as typhoon signal dropped below 8 – the highest level at which CLP’s health and safety protocol allows repair crews to operate in the field.

EMERGENCY PROTOCOL

During the typhoon, CLP relies on the Hong Kong Observatory to provide storm signals. When typhoon signal no. 3 is activated, real-time information on storm surges at selected locations is received. Based on these data, CLP can predict which substations will be flooded. This helps to send inspection teams accordingly to check operational status. Furthermore, these teams can contact a control centre to switch-off damaged substations. Storm signals from the Observatory are publicly available to anyone via the internet and phone apps, however, CLP can ask for additional data through its subscription-based service.

The government has a Security Bureau that manages crisis situations. This bureau has emergency teams that will interface with other government departments such as the Electrical and Mechanism Services Department (EMSD). During the typhoon, CLP keeps a close dialogue with EMSD and reports to them: the duration of outages, number of affected customers, expected restoration time. In turn, EMSD escalates this information with the Emergency Bureau.

TIMELY RECOVERY

After the typhoon passed, CLP carried out a comprehensive review to assess the effectiveness of its response and prevention actions and identified areas for improvement.

- 1 Establish an interface with the government in order to escalate tree clearing requests with the senior management and grant priority quicker;
- 2 Stockpile tree clearing equipment (e.g. chainsaws) and provide training to internal staff on how to operate it.
- 3 Develop IT systems aimed at enhancing customer experience, reporting and notifying of power outage through mobile or web-based platforms.
- 4 Implement smart grid programmes that integrate advanced metering infrastructure with outage management systems, and digital customer interaction mechanisms to improve supply reliability (e.g. ping” smart meters, which use data communications networks to verify outage status and better coordinate dispatch of repair crews to outage locations).
- 5 Online monitoring for switchgears and transformer to produce timely maintenance schedule and enhance supply reliability.
- 6 Mobilise and increase resources, particularly creating more response and repair teams in order to better manage crisis situations.
- 7 Vegetation management techniques (pruning of trees) to enhance the stability and reliability of the power supply while ensuring the safety of the public and contributing to the conservation of the environment.
- 8 Establishing more UAV crew teams to conduct post-typhoon surveillance for power network.

BARRIERS



Poor access to customers (fallen trees, which caused roadblocks, and in turn prevented repair teams to reach customers to restore supply).



Communication (lack of resources for CLP Power’s emergency call centre, and poor communication with the government during the crisis).

ENABLERS



Availability of risk assessments and future scenario planning.



Regular equipment inspections and drills.



Innovation technology.



Engagement activities with external stakeholders (e.g. experience sharing with peer utilities).

“

RELY ON OTHER PEOPLE TO HELP YOU. IF YOU RELY ON THE GOVERNMENT TO HELP YOU, IT WILL PROBABLY ENGAGE WITH OTHER EMERGENCIES AND BECOME UNAVAILABLE. WE HAVE TO RELY ON OURSELVES.

- CLP -

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