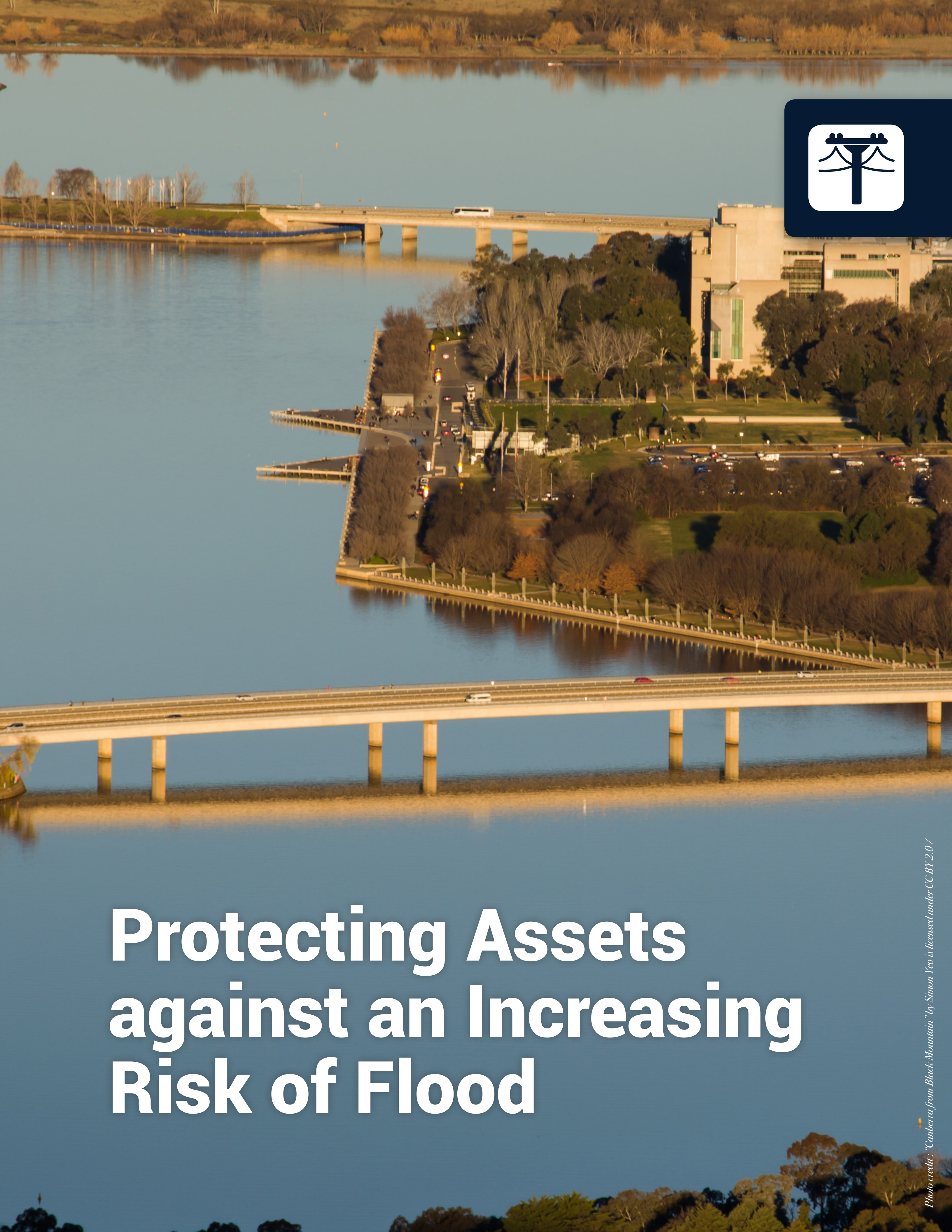

Protecting Assets against an Increasing Risk of Flood

SUMMARY

"When the client learned that keeping a one-metre safety buffer between the equipment and floodwater level was feasible and inexpensive, they gave us the go-ahead quickly".

Guillaume Prudent-Richard,
Associate Director of the Environment Department, AECOM[1]

In some parts of the world, climate change will likely increase the frequency and severity of floods. Components of an electrical network, such as substations, can be highly vulnerable to flooding. And when electrical equipment comes into contact with water, the damages are often irreversible; in some cases, entire substations must be replaced. Floods can cause entire sections of electrical networks to be de-energized resulting in a loss of power for customers. This case study describes the approaches and solutions adopted by several utilities to reduce vulnerability to extreme floods. A cost-effective approach is to create a safety buffer when building new substations by ensuring that vulnerable equipment sits above the higher floodwater levels expected due to climate change. As some utilities do not have the capacity to evaluate potential future floodwater levels, they turn to external consultants for assistance in determining the risk of flooding and the appropriate levels to use for planning.

CONTEXT

An essential part of electricity networks, substations convert high-voltage electricity from generating stations into lower-voltage levels for distribution to homes, institutions and businesses. Substations also isolate faults, regulate voltage and monitor the quality and security of electricity.

Floodwater can cause severe structural and material damages to substations and lead to power outages and fire.[2] Other problems caused by water include the loss of temperature control (heating and air conditioning) and communications failure. In the last 15 years, storm surges and river floods have caused major damages to substations. During Hurricanes Katrina and Rita, for instance, controllers, switches and other components of substations in Mississippi and Louisiana suffered damage due to storm surges and waves.[3] In Rhode Island, floods in 2010 inundated 67 substations.[4] In 2013, a major flood in southern Alberta completely destroyed AltaLink Barrier 32S substation (see figure CS1.1).[5]

Figure CS1.1 The flood-damaged Barrier 32S substation, June 2013 [5]

To prevent exposure of infrastructure such as substations to flood hazards, the electricity industry typically considers a "one in 100 years flood"—a flood with a one-percent chance of occurring each year, and that poses a severe hazard. When deciding where and how to build substations, engineers typically either avoid locations in one in 100 years flood zones or install vulnerable equipment higher than the expected floodwater level. Many substations were built before flood hazards had been properly documented, however.[6] Furthermore, climate change and factors such as increased urbanization can increase the one in 100 years flood level and the related risks for substations. The electricity industry has adopted several methods to mitigate the increased risks. Experience has shown that relocating substations outside flood zones and increasing the height of control buildings and vulnerable equipment tends to generate more cost-benefit advantages than building flood-protection infrastructure.[7]

EXAMPLE OF ADAPTATION

Many companies around the world adapt their substations to the increased risks posed by river floods and storm surges. National Grid, an electricity distributor in the United Kingdom, Massachusetts, New York and Rhode Island, continues to decrease its vulnerability to floods on both sides of the ocean. The company assessed the risks associated with the one in 100 years flood at 130 of its substations using river- and tidal-flood risk data from the UK Environmental Agency. Some 47 substations were found to be in the one in 100 years flood zone; 13 of these were prioritized based on detailed site surveys and cost-benefit analyses. The company will rebuild and elevate parts of these substations by 2022. Each substation will then be ready for a flood of between one in 200 years and one in 1,000 years, depending on the cost-benefit analysis and societal risk.[4]

American companies with coastal facilities can access a useful tool to determine appropriate elevations for substations vulnerable to floods: the Seas and Lakes Overland Surges (SLOSH) model. Developed by National Hurricane Center of the National Oceanic and Atmospheric Administration (NOAA/NHC), SLOSH is a numerical model that estimates storm-surge heights and wind speeds caused by hurricanes. Following the results of SLOSH, some substations were elevated by 7.60m to withstand a hurricane of category 3. Hurricanes of category 4 and 5 occur so infrequently that the risks associated with them are usually managed by investing in spare equipment; the cost-benefit ratio does not usually justify investments in raising substations to withstand hurricanes above category 3. In some areas, elevating substations was not feasible and utilities opted to install flood infrastructure such as concrete walls and levees.[3]

AECOM CONSULTING APPROACH FOR ADAPTATION TO CLIMATE CHANGE

Given the growing demand for expertise in managing climate change risk, companies around the world are building their capacity in the discipline. AECOM, for example, is an international engineering consulting firm with a team devoted to climate change and resilience. The company often collaborates with transmission and distribution companies in the Asia-Pacific region. AECOM recently assisted ActewAGL, a provider of electricity to 195,000 customers in the Australian Capital Territory, to conduct an environmental-impact assessment (EIA) of a project to relocate a substation near a wetland. The project, known as East Lake Electrical Infrastructure, was needed to accommodate a new residential development, and local laws required an EIA that takes into account the impacts of climate change.

Guillaume Prudent-Richard, Associate Director of the Environment Department at AECOM who contributed to the East Lake Project EIA, explains: "As with every EIA, we started by considering local climate and climate projections. We worked with engineers to understand the impacts of floods [on the substation] and to find solutions to respond to these impacts".[1] To identify the potential risks associated with Australia's current climate, Prudent-Richard and his team used a risk-rating matrix—a tool that takes into account both risk probability and risk consequence (see figure CS1.2). The team then studied climate projections to understand how climate hazards will change over time. Based on this information, the team updated the risk-rating matrix.

To evaluate future climate hazards and risks for the East Lake project, the team used public data from the Australian Government Bureau of

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
	1	2	3	4	5
Almost certain (5)	M (5)	M (10)	H (15)	E (20)	E (25)
Likely (4)	L (4)	M (8)	H (12)	H (16)	E (20)
Possible (3)	L (3)	M (6)	M (9)	H (12)	H (15)
Unlikely (2)	L (2)	L (4)	M (6)	M (8)	M (10)
Rare (1)	L (1)	L (2)	L (3)	L (4)	M (5)

Notes:
E = > 20: Extreme risks demand urgent attention at the most senior level and cannot be simply accepted as a part of routine operations without executive sanction.
H = > 12: High risks are the most severe that can be accepted as a part of routine operations without executive sanction but they will be the responsability of the most senior operational menagement and reported upon at the executive level.
M = > 5: Medium risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level.
L = < 5: Low risks will be maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.

Figure CS1.2 AECOM's Risk Rating Matrix

Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). "We also have the internal capacity to generate custom-made climate change information," says Prudent-Richard. "We have software that enables us to generate projections at the project scale. The choice to go for the custom-made data that have a high production cost often depends on the budget allocated to the project. On this project, an increasing hazard of higher flood levels due to increases in extreme daily rainfall and in the frequency and intensity of storm was identified."

"The next step after identifying the risk is the decision of whether to consider adaptation options. It is not a decision that should be made by the consulting firm, but rather by the organization that will be investing and owning the risks." The current one in a 100 years flood level of Jerrabomberra Creek is 556.8m; the substation site lies between 558.1m and 559.1m, leaving a buffer of 1.3m (see figure CS1.3). It was decided that a minimum buffer of 1m should be kept to protect the substation against the increasing risk of flood.[8] "For East Lake, there was no cost-benefit analysis carried out. The decision to keep a one-metre buffer between the vulnerable equipment and the current one in a 100 years flood level was made quickly, during a meeting involving engineers and the client. The decision was obvious".

Figure CS1.3 The one in a 100 years flood zone of Jerrabomberra Creek[8]

LESSONS LEARNED

Guillaume Prudent-Richard has been working on projects similar to East Lake for several years. He acquired good insight into the challenges of implementing climate change adaptation.

The first challenge involves communication: many of the studies he completed are not publicly available. "Obviously, private companies are not interested in publishing a risk profile, because there are few benefits or incentives for them to do so," Prudent-Richard explains. "It can take up to 15 years to publish this kind of information if it is published at all." It is therefore quite difficult to rely on published literature to understand climate change adaptation from the private sector. On the East Lake Project, information about climate change was made available only because it was part of the EIA process, which requires public consultation.
Shifting politics represent another significant challenge for Prudent-Richard's team. When the government changes after an election, priorities also change, which can lead to a significant decrease in the number of climate change adaptation projects. Also tricky for the company is coping with legislative changes and the various methodologies for climate change impact studies. "Sometimes two areas with identical geographic characteristics are subject to different legislation and methodologies," says Prudent-Richard. "That leads to duplication of effort or confusion."

Prudent-Richard appreciates that the motivation for climate change adaptation comes not only from legislation: "Most of the studies we carried out were financed by companies on a voluntarily basis, and the main motivation was to save on long-term costs. Many companies are also motivated by the fiduciary duty to understand their risk profile and to take appropriate action."

Prudent-Richard emphasizes that more and better data on climate, physical and socio-economic conditions are needed for some parts of the world, such as Asia. He also stresses the advantages of working with custom-made data. "It enables us to work with the same format of data that engineers use, such as the actual return period and duration of events used for the design and construction of infrastructure," he says.

Prudent-Richard notes that it is easier for clients knowledgeable about climate change to adapt effectively. "They better understand the issues, the methodology and the results," he says, "so we have richer discussions and the process goes faster." He also notes that problems within a working group can arise when not everyone accepts climate change science to the same degree. Finally, he explains that some companies will turn to his team to start the discussion about climate change and begin capacity building. "We help some companies with the scoping part of the assessment, provide training and then they take over the rest of the assessment," he says. "Sometimes we revise their final work." In this case, the engineering consultant acts like a facilitator in the adaptation process.

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AT A GLANCE

KEY TAKEAWAYS

1. **The assistance of a consultant at the beginning of the climate change adaptation process is a good way to start building capacity.**

2. **Learning from peers is difficult in some parts of the world, because companies are reluctant to disclose their adaptation initiatives and risk profiles.**

ORGANIZATION(S)

ActewAGL and AECOM (Australia),
National Grid (United Kingdom and United-States)

POWER SUB-SECTOR(S)

- Transmission and distribution

ADAPTATION TYPE(S)

- Informational – Climate Services
- Physical – Equipment protection, upgrades and alternative materials

CLIMATE CHANGE IMPACT(S)

- Higher river floods and storm surges

ADAPTATION COSTS

- The cost of elevating equipment and control rooms above floodwater level for new substations is low to medium.
- The cost of elevating equipment and control rooms above floodwater level for existing substations is high.

ADAPTATION BENEFIT(S)

- Minimization of damages during floods
- Increased network resilience

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FULL REPORT

https://ouranos.ca/en/programs/energy-adaptation-case-studies/

Ressources naturelles Canada / Natural Resources Canada
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