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Amy Ferguson
By email: fyi-request-17068-a9bb0fc6@requests.fyi.org.nz

Dear Amy

Request for information about coronal mass injection

I am writing in response to your updated Official Information Act 1982 (OIA) request received by Transpower on 24 January 2022.

Thank you for your questions on Coronal Mass Ejections and how such events create ground induced currents which, depending on their magnitude, may impact on the power system.

As you may know, thanks to the earth's iron core, we have our own magnetic field which shields us from various forms of radiation and charged particles emanating from the sun. Sometimes extremely large explosions within the sun's magnetic field release vast quantities of charged particles called a Coronal Mass Ejection (CME). These particles interact with the earth's magnetic field causing currents to flow in the ground. These ground currents can cause transformers to overheat or go into saturation causing large power swings on the power system. Ground currents can also flow for many other reasons, including when the power system is operating in an unbalanced mode (during faults, for example).

For these reasons, Transpower monitors ground currents across the country as well as the total harmonic distortion of the power system, to identify areas that could be at risk. We have a mitigation plan we activate when space weather forecasts indicate a likelihood of significant events occurring or when ground currents are likely to exceed safe levels. Transpower participates in the international solar tsunami research effort and provides the team with our GIC monitoring data to assist the research team calibrate its predictive model. We have experienced the impact of past solar storm events; including a 2001 transformer failure and power swing event. This is part of the reason why we are involved in international research on this matter to estimate the magnitude of extreme storms and mitigate their impacts.

To your questions:

1. **Do we in New Zealand have backup transformers should such an event occur? How long would these backup transformers provide power to the country?**

   Yes, Transpower has spare transformers. We have 14 strategic spares covering 220kV & 110kV transmission voltages. In addition, we have a full trailer mounted 110/33-11kV mobile substation for small sites. The strategic spare transformer is swapped for a damaged one and is fully capable of providing the same power as the one it replaces.

2. **Are there any specific areas of the country that would not be provided with power from a backup source?**

   We cannot say with certainty there are specific areas of the country that would not be provided with electricity during a CME event. The areas of Transpower's network most exposed to CME are duplicated and smaller load centres (<20MW) which may have a single transformer, are less exposed and have the option of a spare transformer or the mobile substation or backup diesel generators.

3. **Please provide me with the plans and procedures in place should New Zealand experience a major outage caused from a solar flare**

   We have plans and procedures for managing CME events. However, for security risks we prefer not to release these publicly; we trust you will understand and agree with that approach.

4. **Further to the point of information I seek in this enquiry I would like further information in relation to what I believe may be referred to as a backup power supply or emergency power system? Otherwise known as uninterruptible power supply system? But on a citywide scale I hope this makes sense.**

   On the matter of an Uninterruptible Power Supply (UPS) for a city, you raise a good question and a desirable goal. However, it is not a practical proposition due to the share quantity of energy that is required to be stored, and the technology options available to us:

   - A typical house uses about 15-21kWhr of electricity a day; that's a typical jug boiling continuously for about 10 hrs.
   - A single TESLA Powerwall holds about 14kWh and costs about NZ$15,000 each.
   - Wellington uses about 6,800,000kWh of electricity a day so would need about 486,000 TESLA Powerwalls which at a price of only NZ$5,000 each would be around NZ$2.4B.

For this reason, we generally rely on having multiple large central generation stations and duplicated transmission lines and transformers.

I have included for your reference however a presentation from a recent Lifelines forum where this issue was discussed. This will give you a high-level overview that we:

- are connected into international space weather forecasting and alerting services;
- have a power system and transformer monitoring system in place which we maintain and actively manage and expand as required;
- have a response plan, which we review and test against the latest international knowledge and measured data, and simulate different responses and combinations to identify solutions that minimise the risk posed by CME GIC;
- are working with local and international research bodies to refine our knowledge further and identify specific individual transformers at possible risk from specific magnitude events; and
- follow international standards and practice where available, e.g. NERC and CIGRE.

I trust this helps answer your question. We are pleased to find others who are interested in this area of research and applied engineering.

Kind regards

Andrew Renton
Senior Principal Engineer

Attachment: 1 off Lifelines GIC presentation