TRANSPOWER

OPTIMAL RESERVES ALLOCATION

Background

In electric power systems, if the frequency falls too low then generators will automatically disconnect to protect themselves, exacerbating the problem, and the whole system can collapse in a 'cascade failure'. This causes a widespread, possibly national, blackout that can take many hours or even days to re-energise.

As a safeguard against this New Zealand, likes most countries, automatically sheds significant quantities of load to prevent such dramatic falls in frequency after, for example, generators failing. This is done by placing voltage-sensitive relays on load feeders around the system, usually within the distribution, medium-voltage network. The system has historically been called automatic under-frequency load shedding or AUFLS but is now referred to as extended reserves. Detail on this regime is available here[1].

Motivation

An issue is how to optimise the placement of these relays so that they can meet given physical requirements (e.g. percentage of load covered) at least cost, as different types of load have different characteristics including costs of non-supply (sometimes referred to as value of lost load or VOLL). It is thus an economic problem given physical constraints.

The mathematical formulation for this is large but relatively simple, and is available here[2].

The problem

The problem is that it is an integer formulation, as relays are either on or off, and the number of potential relay locations and constraints is huge. Standard solvers such as CPLEX cannot find a global optimal solution, and the solution can be very sensitive. We need a solution that is either optimal, or both as close as possible to optimal and repeatable.

The plus is that there is no real urgency in the solution's run-time, as the main solve is five-yearly, and sub-solves perhaps a few times yearly. It is therefore logical to explore whether iterative and/or segmentation approaches to finding a solution could be appropriate. Maybe too there are other ways of tackling it that we have not yet considered.

Transpower as New Zealand's system operator will provide the MISG with a full set of representative data and staff to support the group. We look forward to some clever and innovative approaches to addressing this problem, which is of considerable economic and physical importance to New Zealand.

---

[1] https://www.ea.govt.nz/development/work-programme/wholesale/efficient-procurement-extended-reserves/

[2] http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/ERTWG%20Selection%20Methodology.pdf