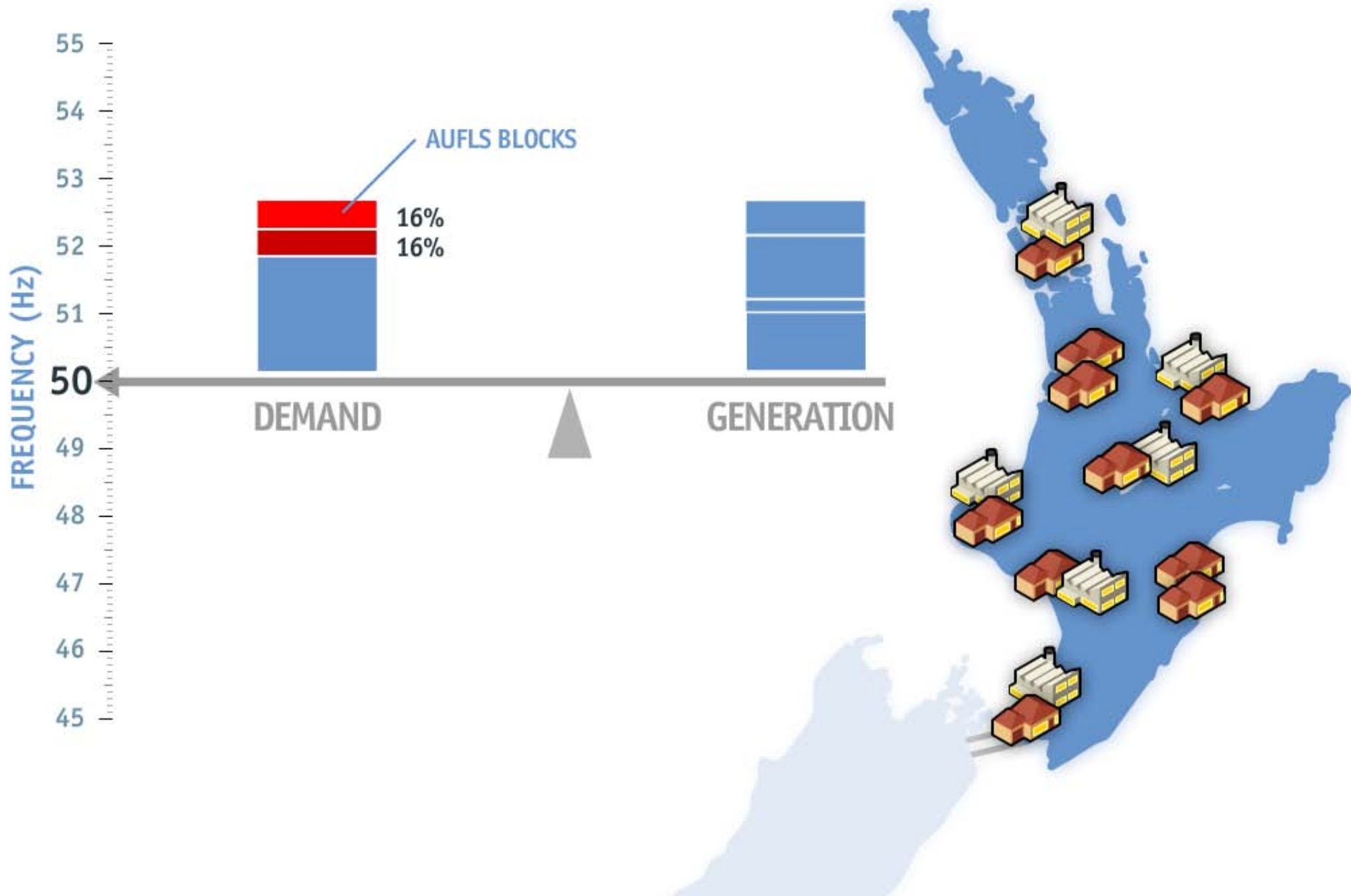


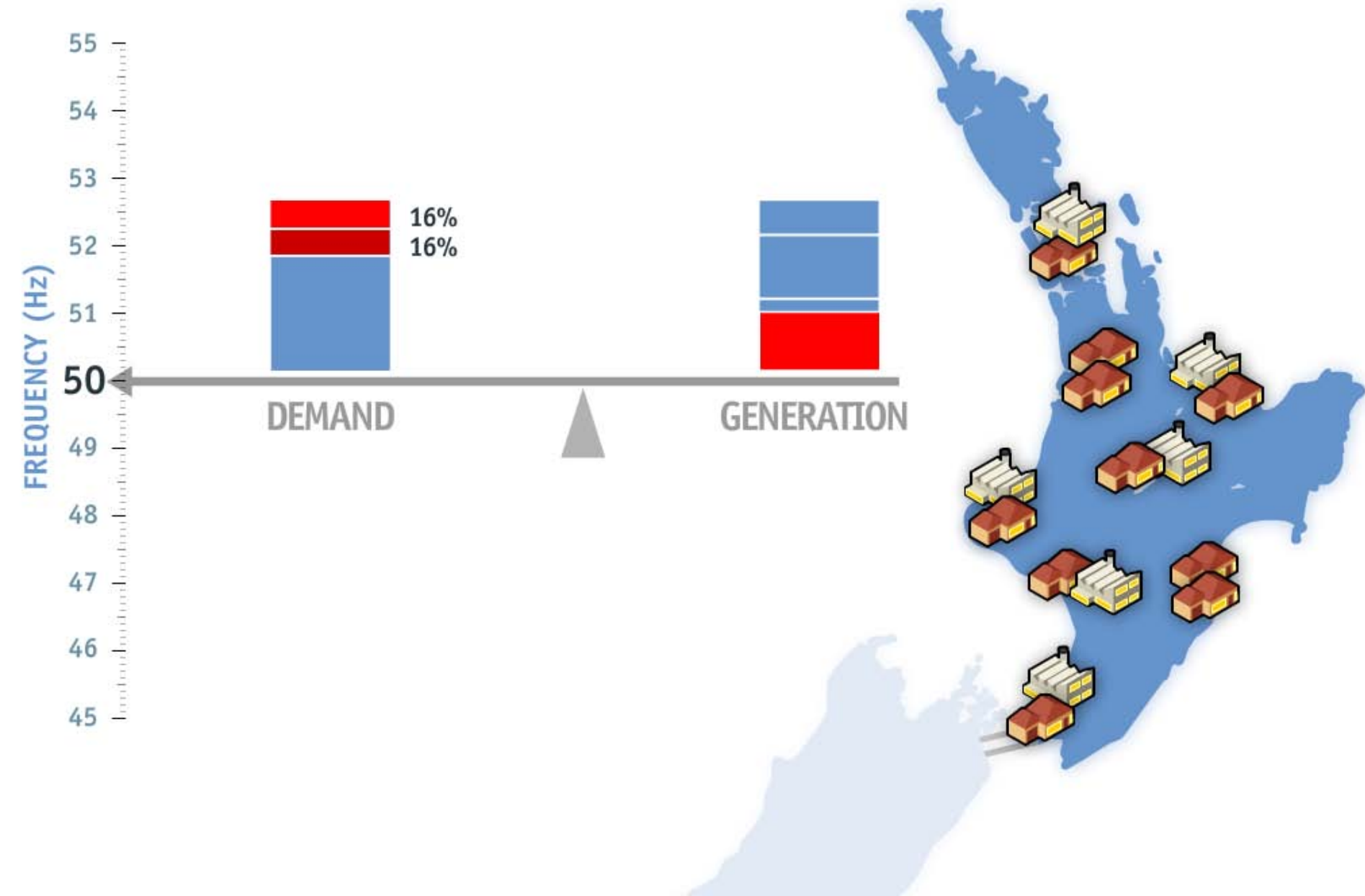


AN INTRODUCTION TO AUTOMATIC UNDER-FREQUENCY LOAD SHEDDING (AUFLS)

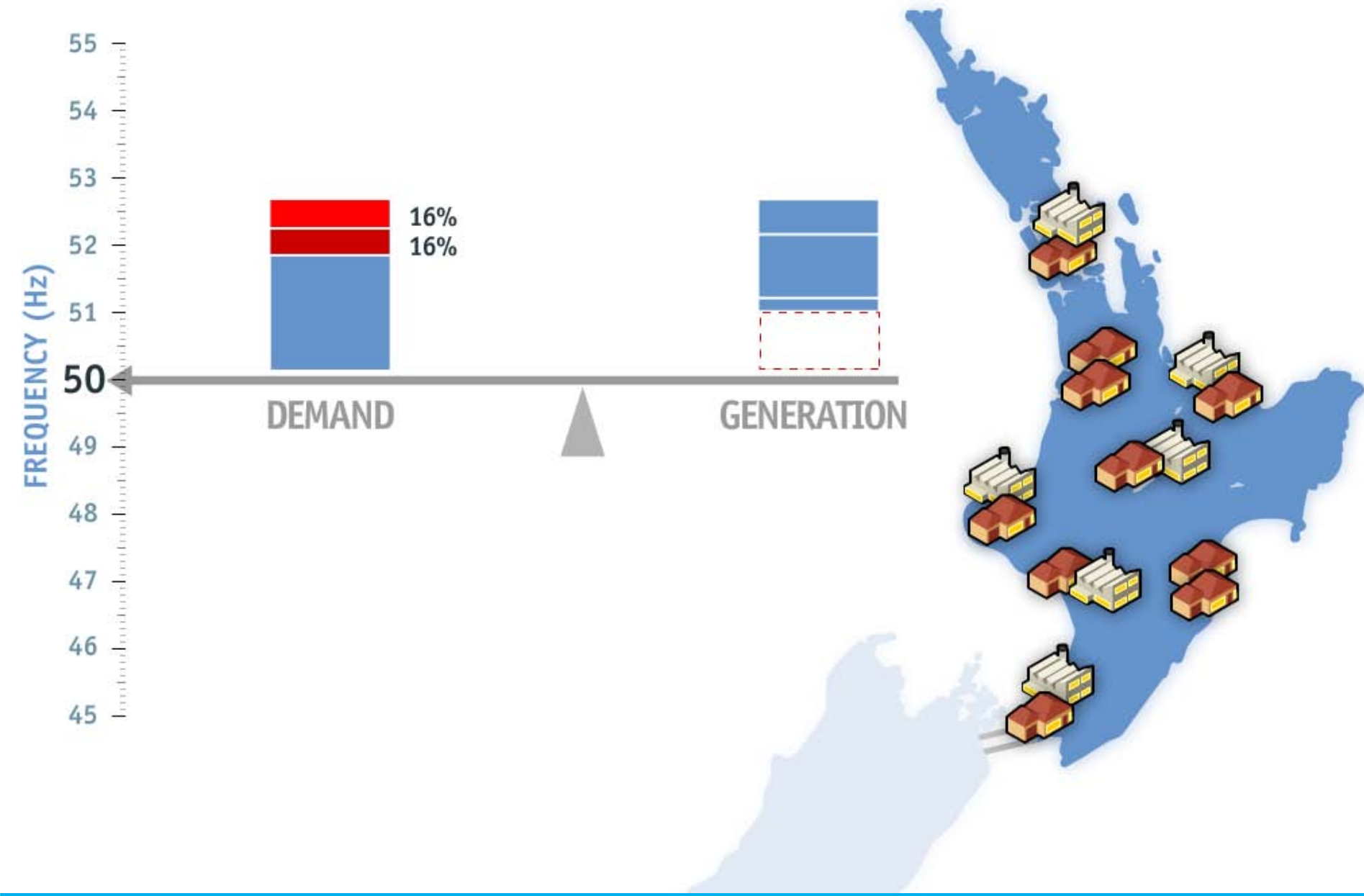
WHAT IS AUFLS?



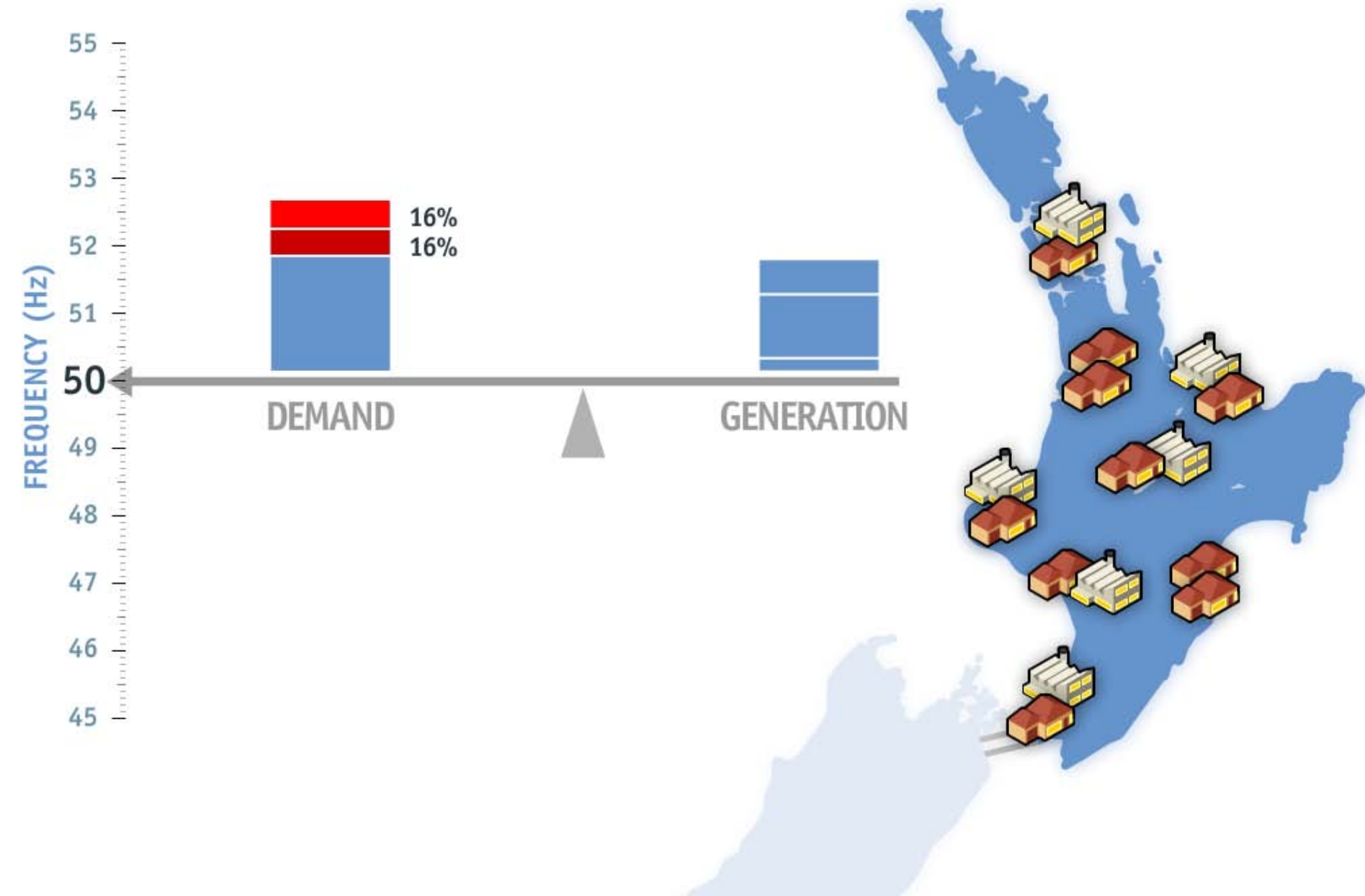
WHAT IS AUFLS?



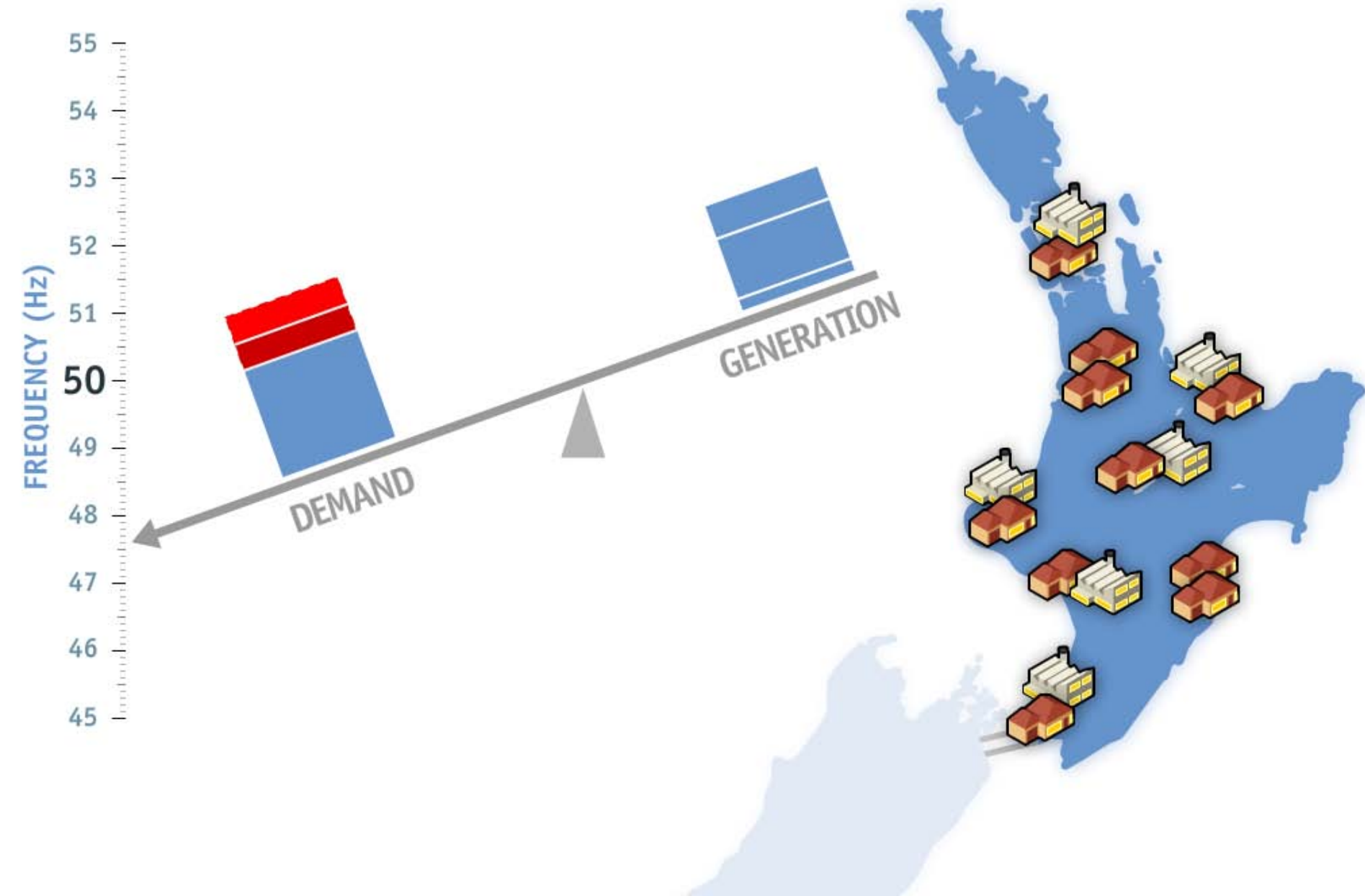
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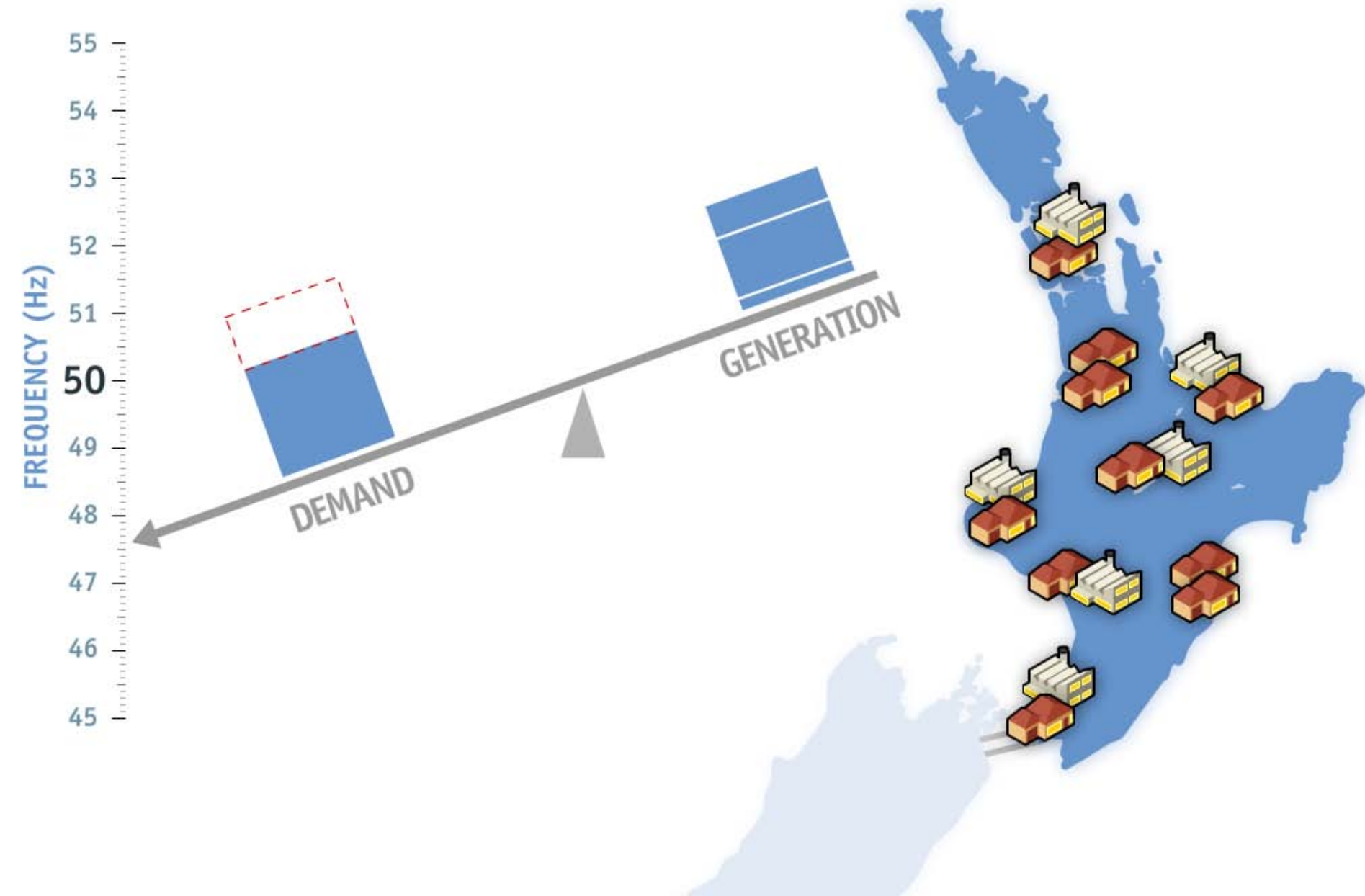
WHAT IS AUFLS?



WHAT IS AUFLS?



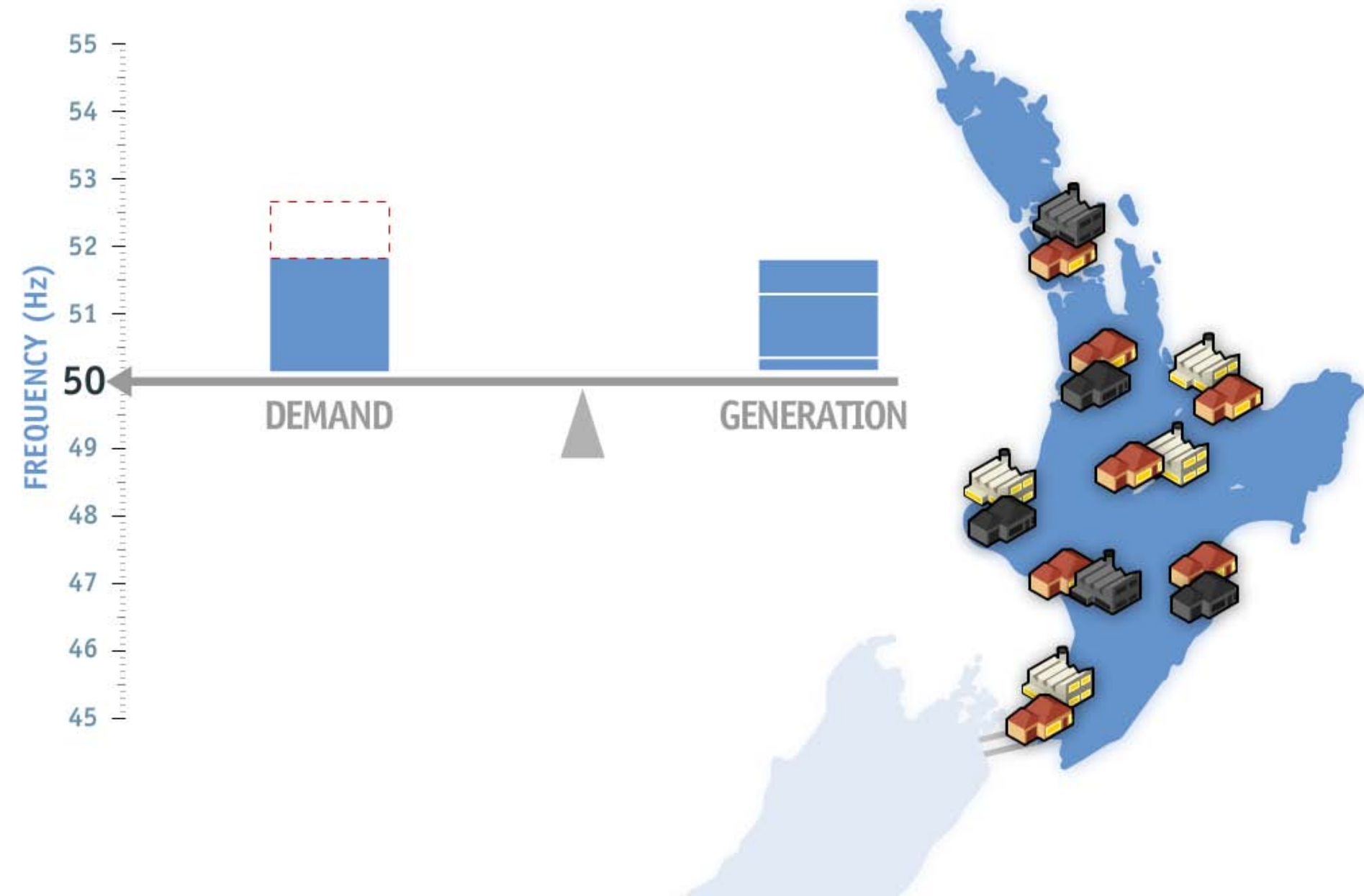
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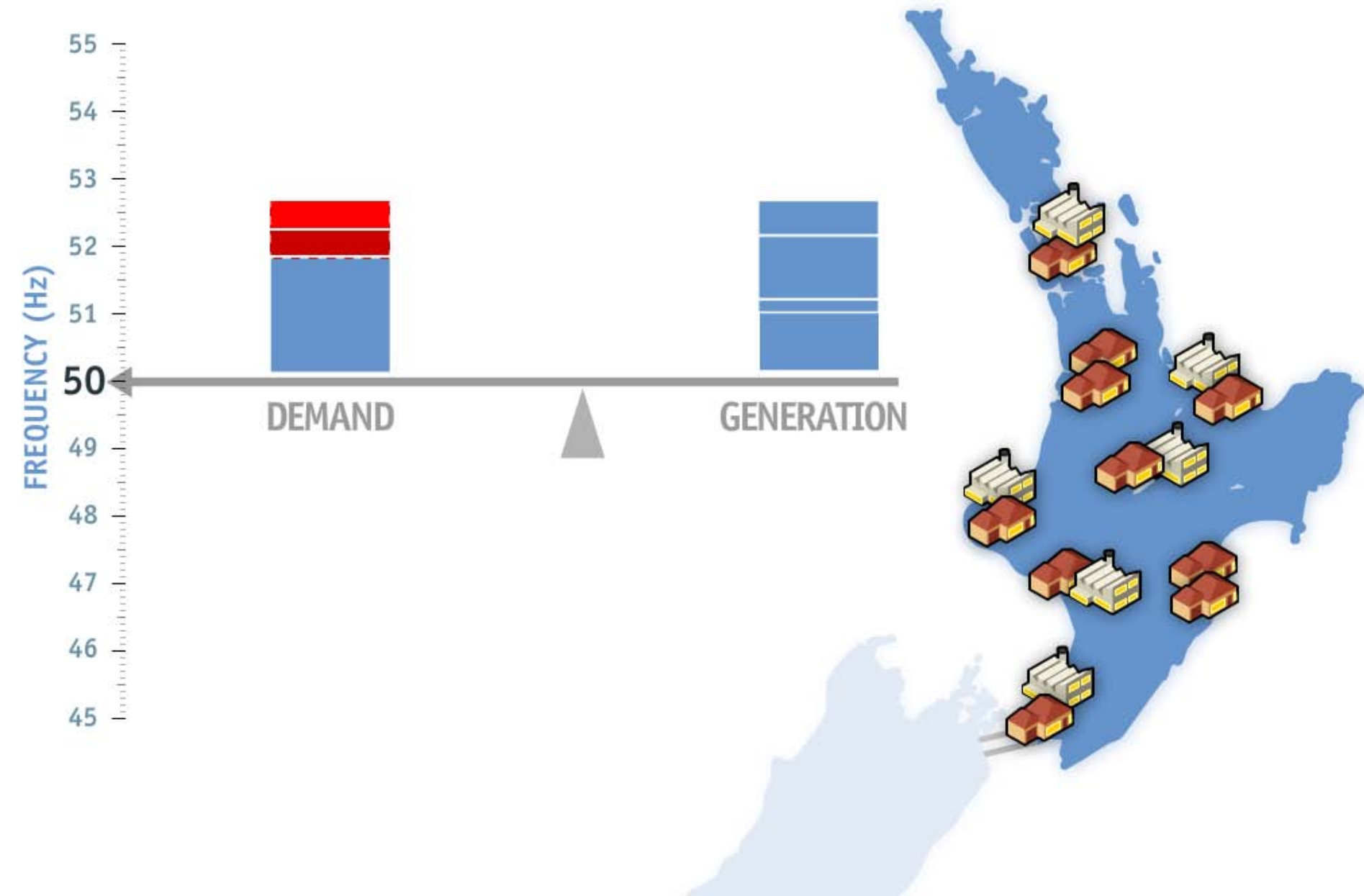
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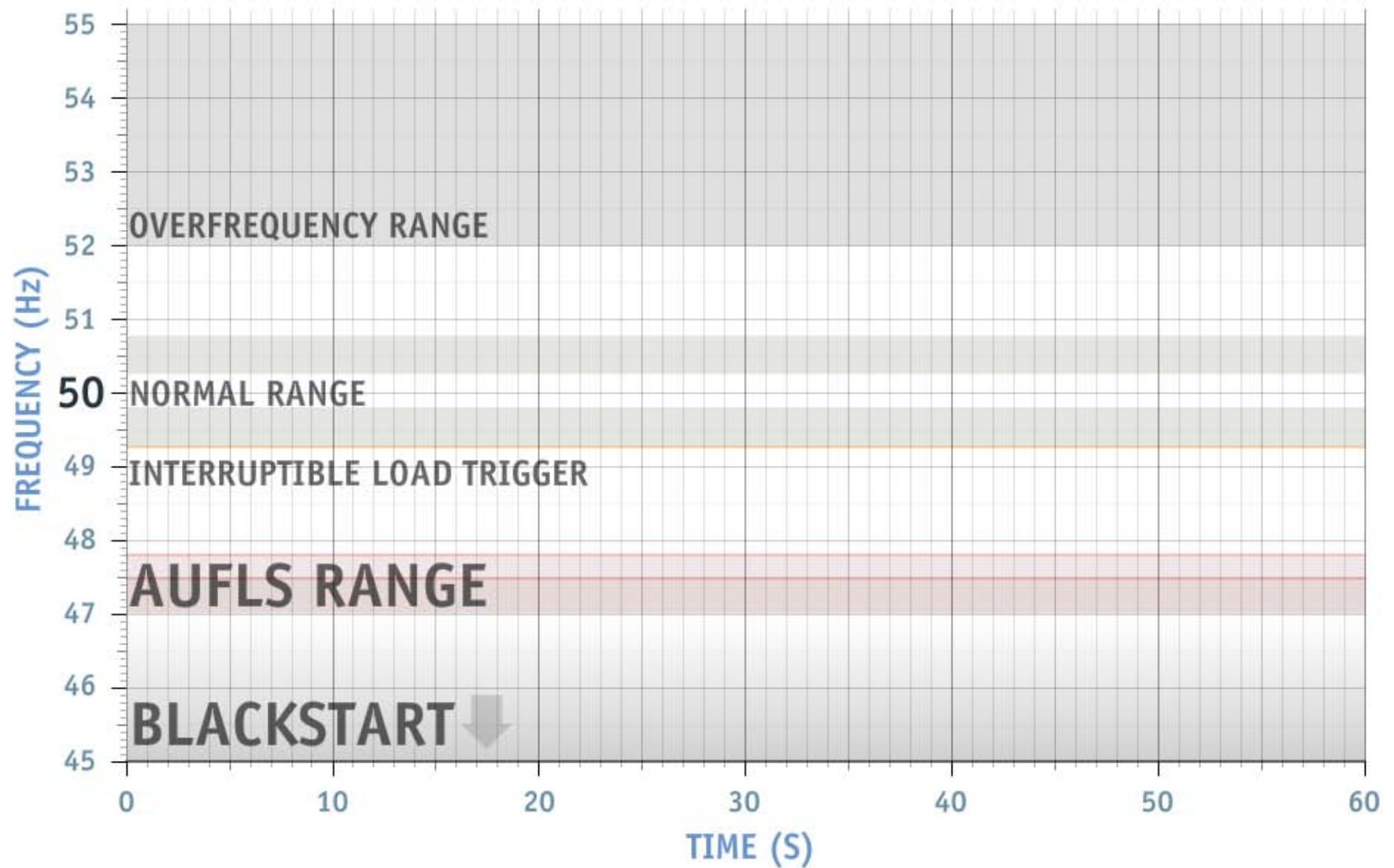
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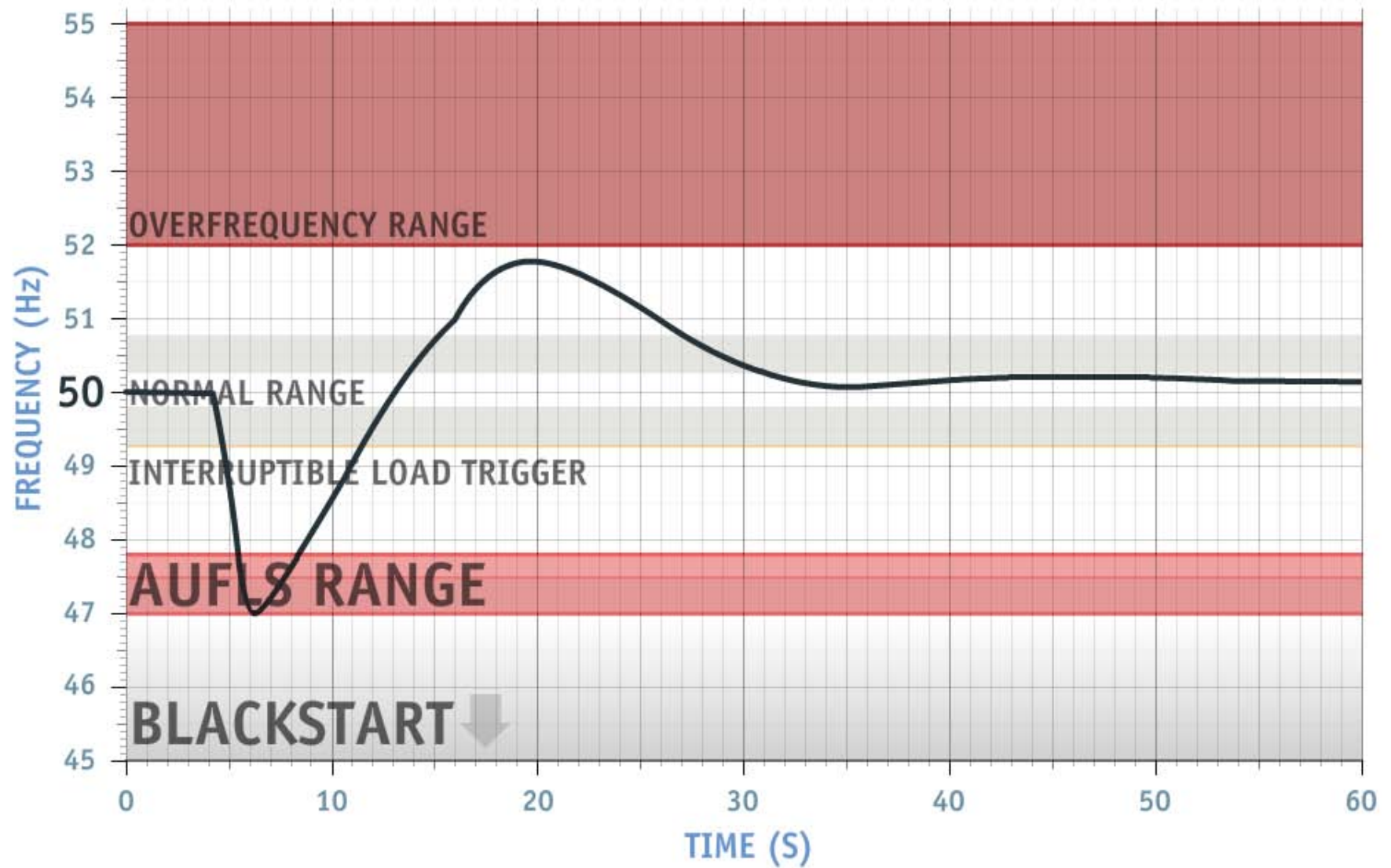
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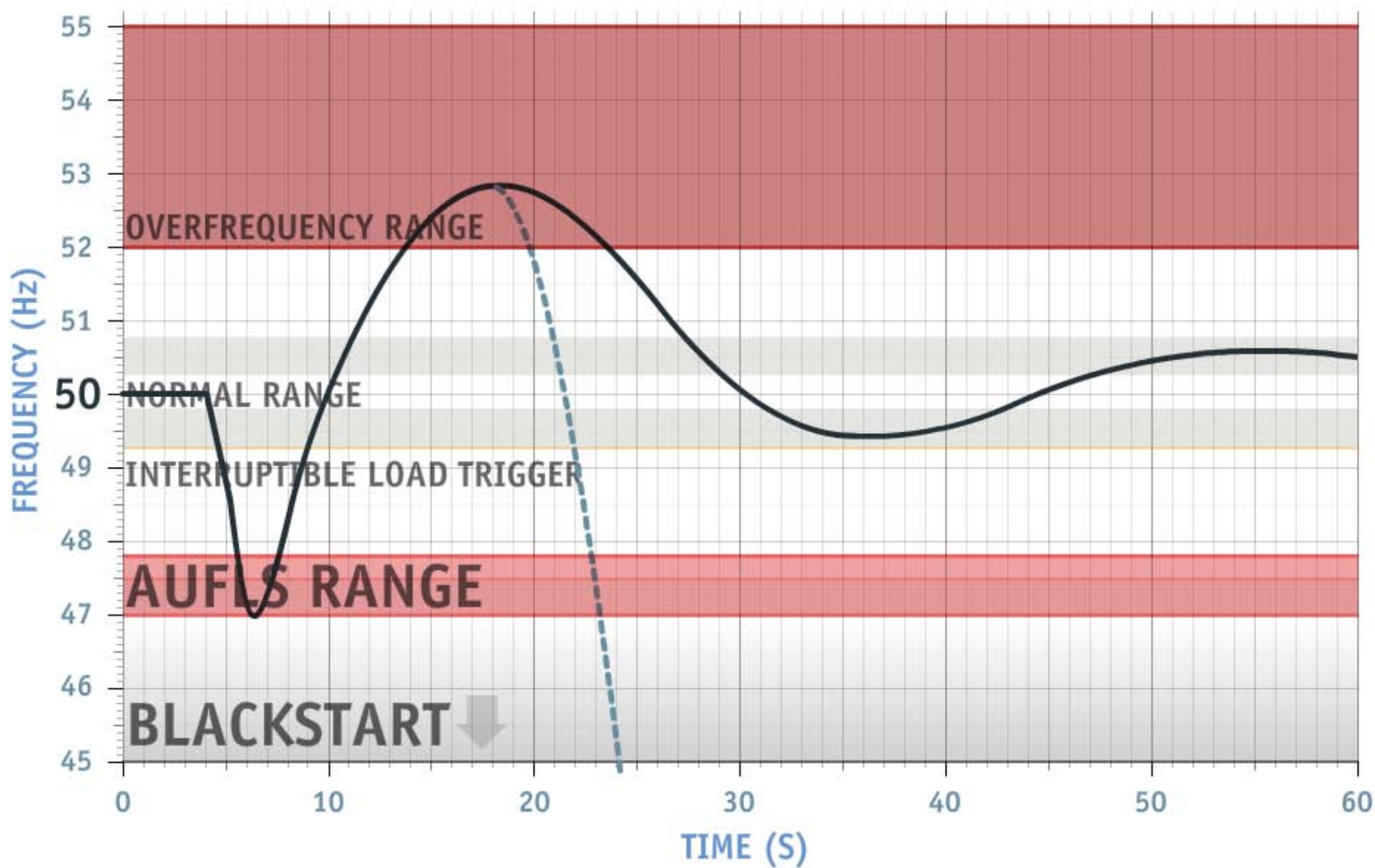
HOW AUFLS WORKS



EFFECTIVE AUFLS RESPONSE



INEFFECTIVE AUFLS RESPONSE LEADING TO OVER-FREQUENCY



North Island AUFLS event

December 13 2011

Industry presentation

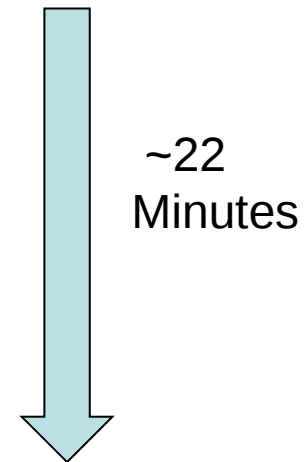
March 2012

TRANSPower



What happened

- At 12:33pm, Genesis' Unit 5 and the Transpower circuit breaker tripped, leading to the two remaining generators operating at Huntly (Units 1, 2) to be disconnected.
- Prior to that, a dc power supply fault at Huntly had caused relay damage resulting in unexpected tripping of circuit breakers. The sequence of events immediately before and after this is shown below.
- The loss of HLY generation caused a fall in frequency and the activation of Interruptible Load and AUFLS across the North Island.
 - 12:11:39.8 pm- Unexpected opening of CB422
 - 12:11:39.9 pm - Unexpected opening of CB242
 - 12:30:44.8 pm – Unexpected opening of CB362
 - 12:30:47.4 pm - Attempted close CB242 fails
 - 12:31:25.5 pm - Attempted close on CB422 fails.
 - 12:33:44.8 pm - Unit 5 Trips
 - 12:33:47.5 pm - Unit 2 trips
 - 12:34:07.5 pm - Unit 1 trips



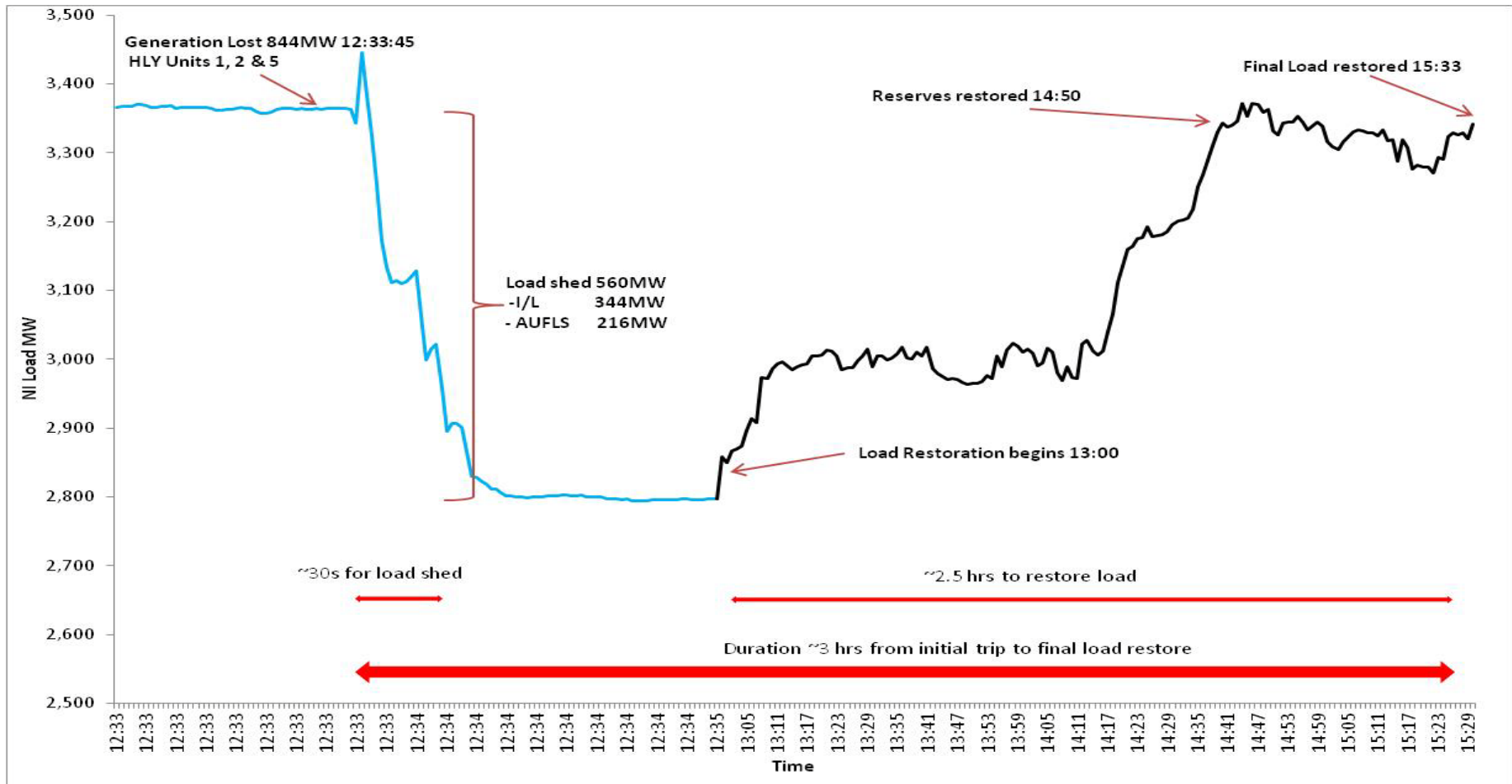
Risk identification

Through a regulatory process the System Operator categorises events that it will manage against

- Some events are common and economic to cover against using reserves (contingent events) and for rarer events reserves and AUFLS. (extended contingent events)
- There are also the very rare, large events that are difficult to identify and expensive to manage against. The loss of HLY station was one of these 'black swan' events .
- While reserves and AUFLS will still activate for 'black swan' events there is no certainty that they will be successful.

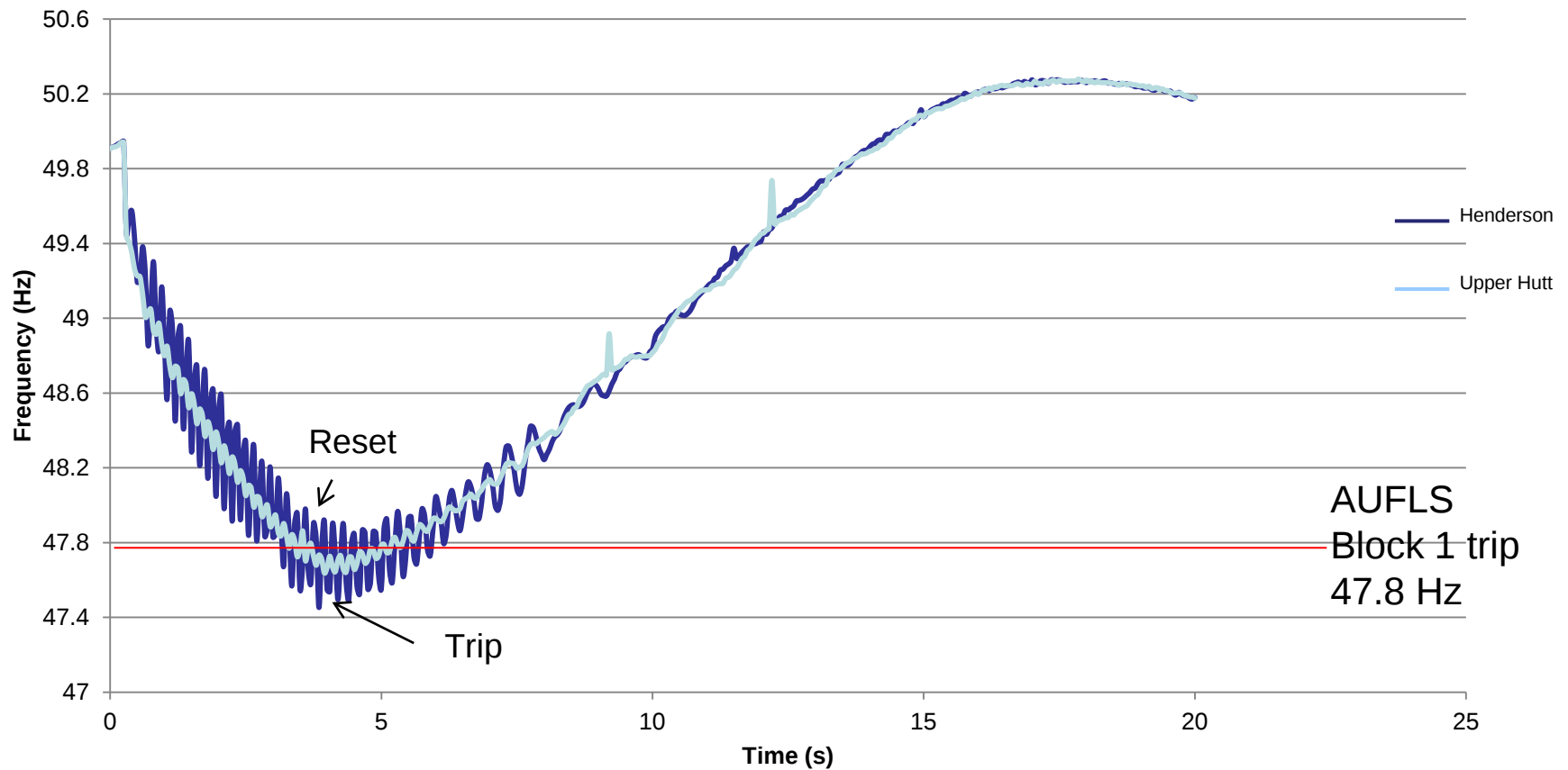


Load loss and restoration



AUFLS Operation

Different Locations Frequencies



System performance

- The current work on AUFLS being undertaken has raised a number of concerns:
 - Potential for over frequency.
 - With only 40 % of AUFLS tripping the frequency rose to 50 Hz.. Had the full quantity of AUFLS tripped then the frequency would have gone very high.
 - At 52 Hz the large gas fired plant will trip potentially returning the frequency back below 48hz, but this time without the protection of an AUFLS scheme to stop it.
 - The AUFLS programme is currently testing a number of options around this see-saw effect including having more but smaller AUFLS blocks and triggering them on rate of change of frequency.
 - Fast rate of change of frequency creating relay discrimination issues.
 - Where the frequency falls too fast there can be insufficient time for the first AUFLS block to operate before the second is tripped, leading to unnecessary consumer disruption and potentially the over frequency issue discussed above. The staggered nature of the generator tripping in this event prevented this occurring.
- The system response to this event confirmed concerns with the current design.



Restoration process

- Restoration was co-ordinated by the System Operator and we received full co-operation from network companies and direct connects and generators.
- The Codes are silent on the restoration of AUFLS and parties could have restored when ever they liked. This is a gap in the codes which could lead to insecure operation of the system.
 - This has been flagged and we are looking at ways to mange this and add clarity and operational certainty.
- Some confusion was experienced between the restoration of IL and AUFLS.
 - Ancillary Service Contracts and operational procedures will be reviewed and strengthened
- While most relays could be reset remotely by lines company operators, some delay was experienced as small number required onsite reset at substation.
- Public communication during the restoration was lead by Transpower. Feedback indicates messages were appropriate and timely.



Reserve management

- Cause of the fault was not immediately apparent.
- The System Operator therefore had to consider the probability of a repeat event
- 13/12 17:46 – Market advised that HLY station will be treated as a single risk
- As Genesis and Transpower provided information the SO was able to cover HLY U5 as a separate risk but remained of the view that a joint risk did still exist on units 1-4.
- 14/12 17:23 – Market advised HLY U5 now an independent risk from HLY U1-4 as of 18:00
- Full industry co-operation enabled operational procedures to be put in place that would protect consumers against the risk while enabling Genesis to generate from HLY U1-4.
- 22/12 19:00 – HLY risk status returned to normal

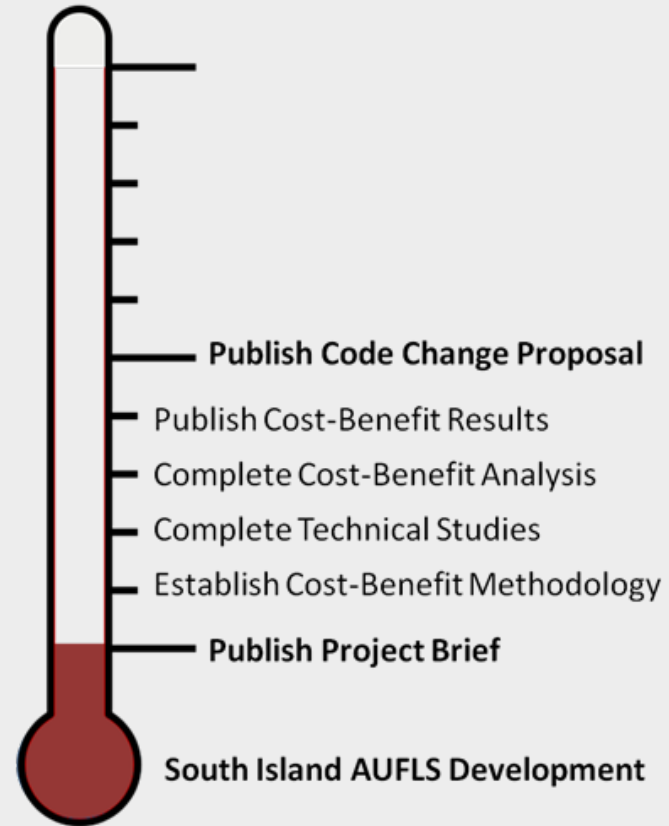
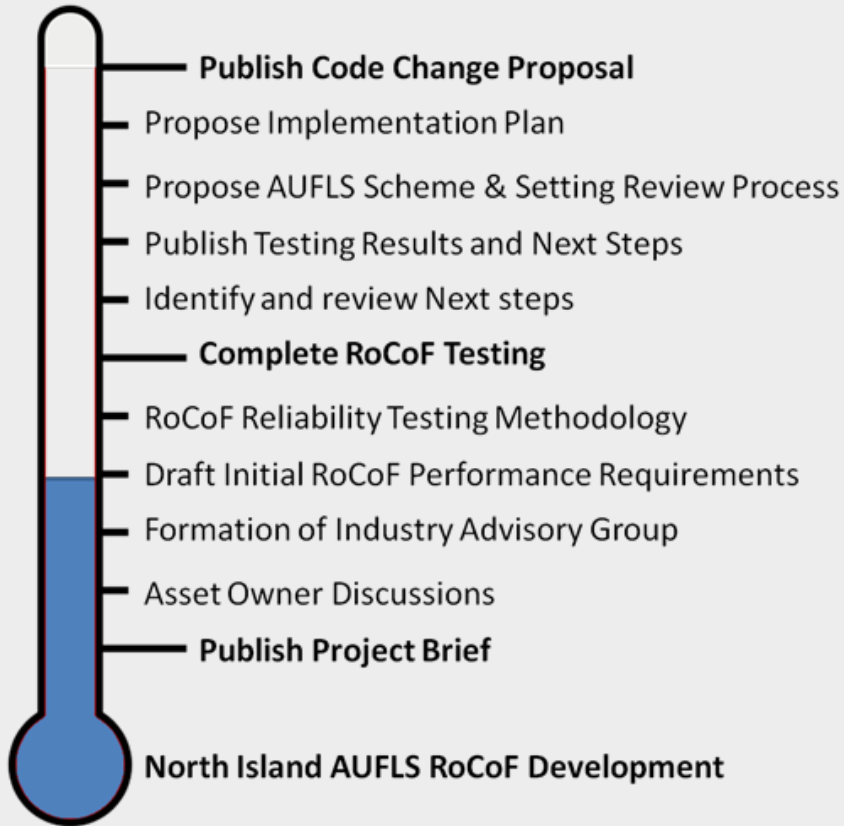


Conclusions

- Event was rare and complex .
- Systems worked largely as expected.
- Good co-operation from the industry enabled timely restoration and fault identification.
- The event reaffirmed the importance of the work currently underway to redevelop the AUFLS scheme.
- Transpower will continue to work on protection co-ordination with its customers applying the lessons learnt in this event.



Current AUFLS programme



Right outcome at the right time

- Over the next 12- 18 months we will commission:
 - 4 new generating stations
 - NAaN
 - NIGUP
 - Pole 3
 - Pole 2
- To provide certainty for consumers over this period there are a number of issues that we must address.
 - Current over provision of AUFLS
 - Poor discrimination
 - Non compliances/exemptions
- Current programme schedule will need modifying to achieve this.

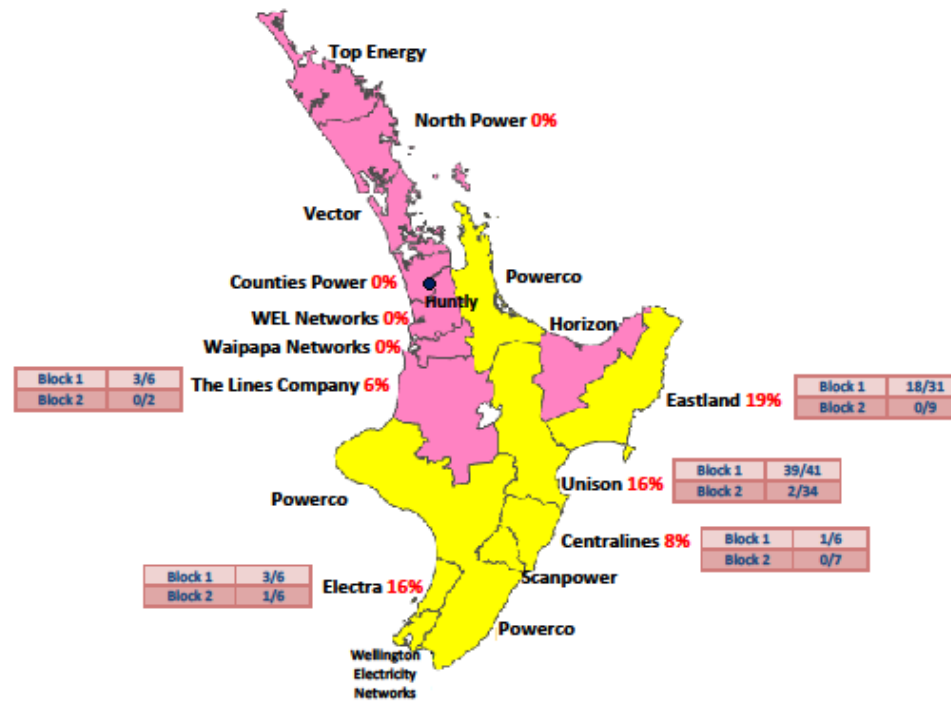


Option for progress prior to commissioning

- ~40% of NI AUFLS relays are in Transpower sites.
- A project is being established to bring forward the solution implementation on current Transpower sites ahead of the rule change process.
- This would involve the replacement of relays across 25 substations in the North island.
- Relays would be configured to the new blocks and settings and be able to be remotely monitored and switched.
- This would require:
 - Customer agreement
 - Input from customers
 - Dispensation



13th December 2011 - AUFLS Operated for Distributors



Frequency response If all Huntly machine trip together

