TRANSPOWER

Effects of ramping intermittent generation on the grid

Benjie Cummins

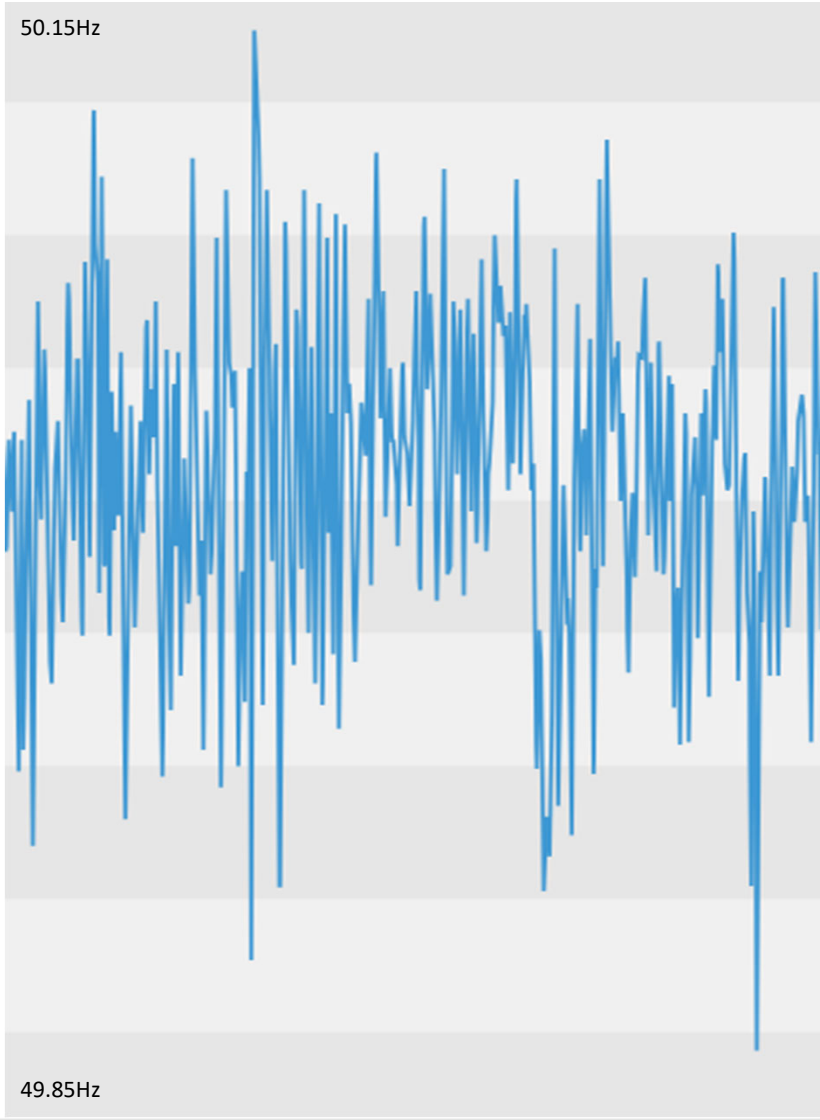
11/11/2025

Transpower:
guardian of the grid

- We own and operate the transmission grid.
- Determine optimal generation
- Power generated = power used
- Monitor the frequency

The frequency is always in motion

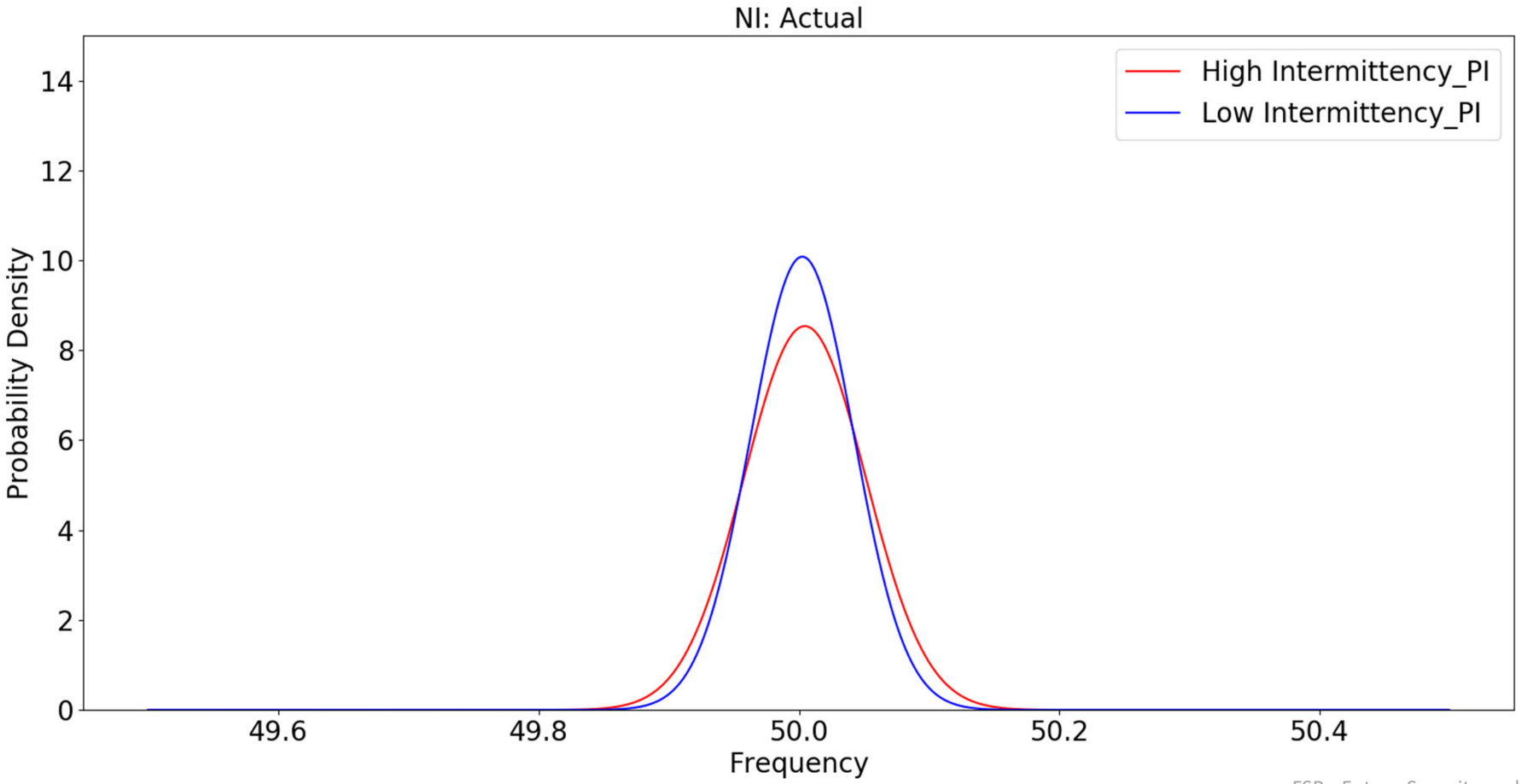
- Normal frequency: 50Hz
- Sharp changes disturb the balance
- Examples of this are:
  - A generator emergency shutdown
  - Rapidly changing winds near a wind farm
  - Everyone boiling the kettle at the same time



Intermittent generation (IG) needs added care

- Worldwide attention
- Wind speed is not constant.
- Power $\propto$ wind speed
- Wind and solar makes balancing the grid harder.

FSR: IG increases frequency deviation occurrence



Slide 5

MM1 You may need to put FSR in full down the bottom in a note?
Maggie Makrogianni, 2025-10-30T19:02:27.400

MM1

Globally practiced frequency control methods

INERTIA

HVDC

DROOP RESPONSE

FREQUENCY KEEPING

Slide 6

MM1 Four methods of frequency control

Maggie Makrogianni, 2025-10-30T19:04:56.136

MM1

Generation constraints prevent transmission events

- Grid stability is essential.
- Generators must sometimes reduce power output.
- Without constraints the grid would overload.

Slide 7

MM1 Generation constraints prevents transmission (or grid which ever word you want to use) events

Maggie Makrogianni, 2025-10-30T19:06:50.957

MM1

When released, constrained IG can disturb the balance of the grid

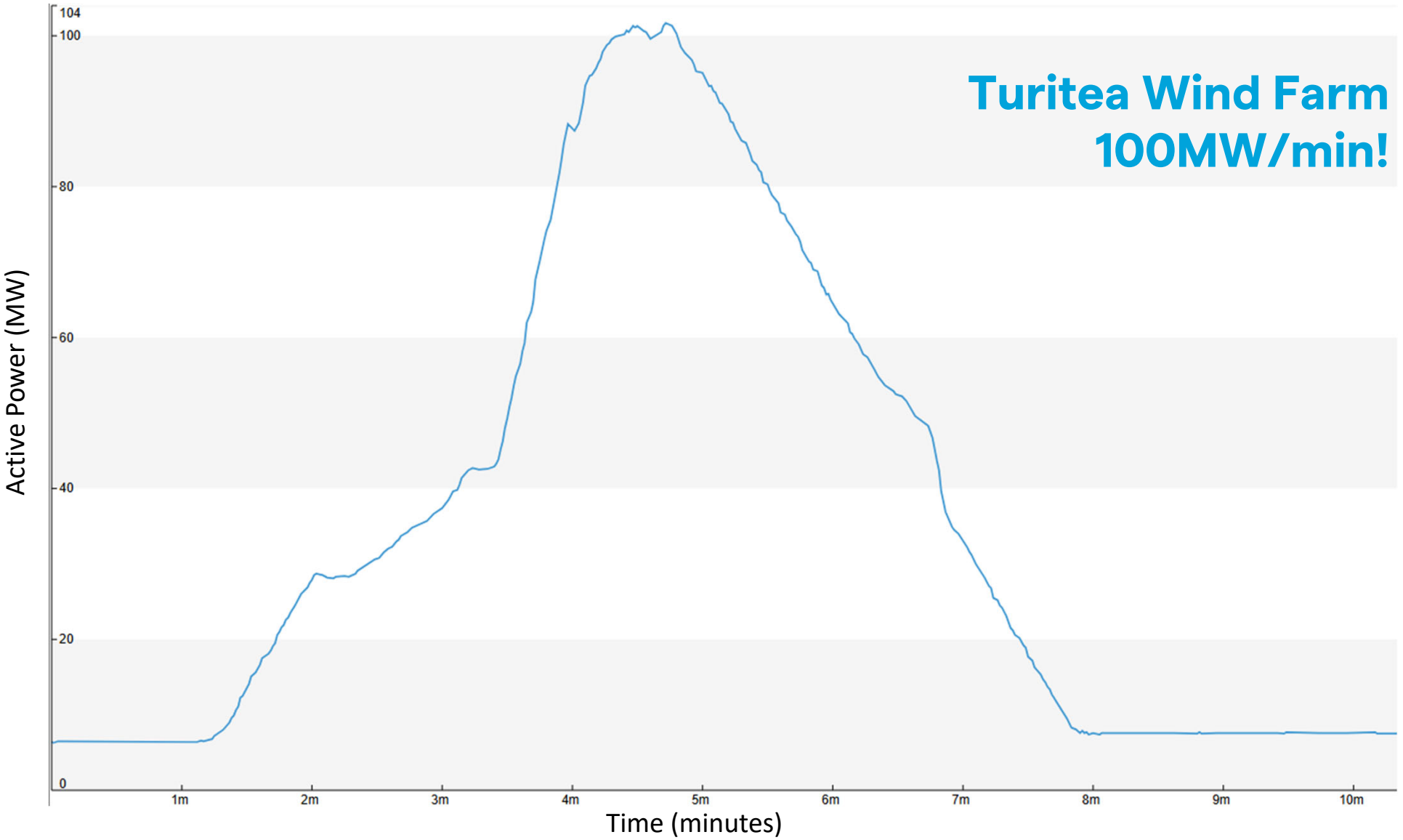
When IG is constrained, it is not producing its maximum power.

When IG is released, it quickly bounces back to maximum like a spring.

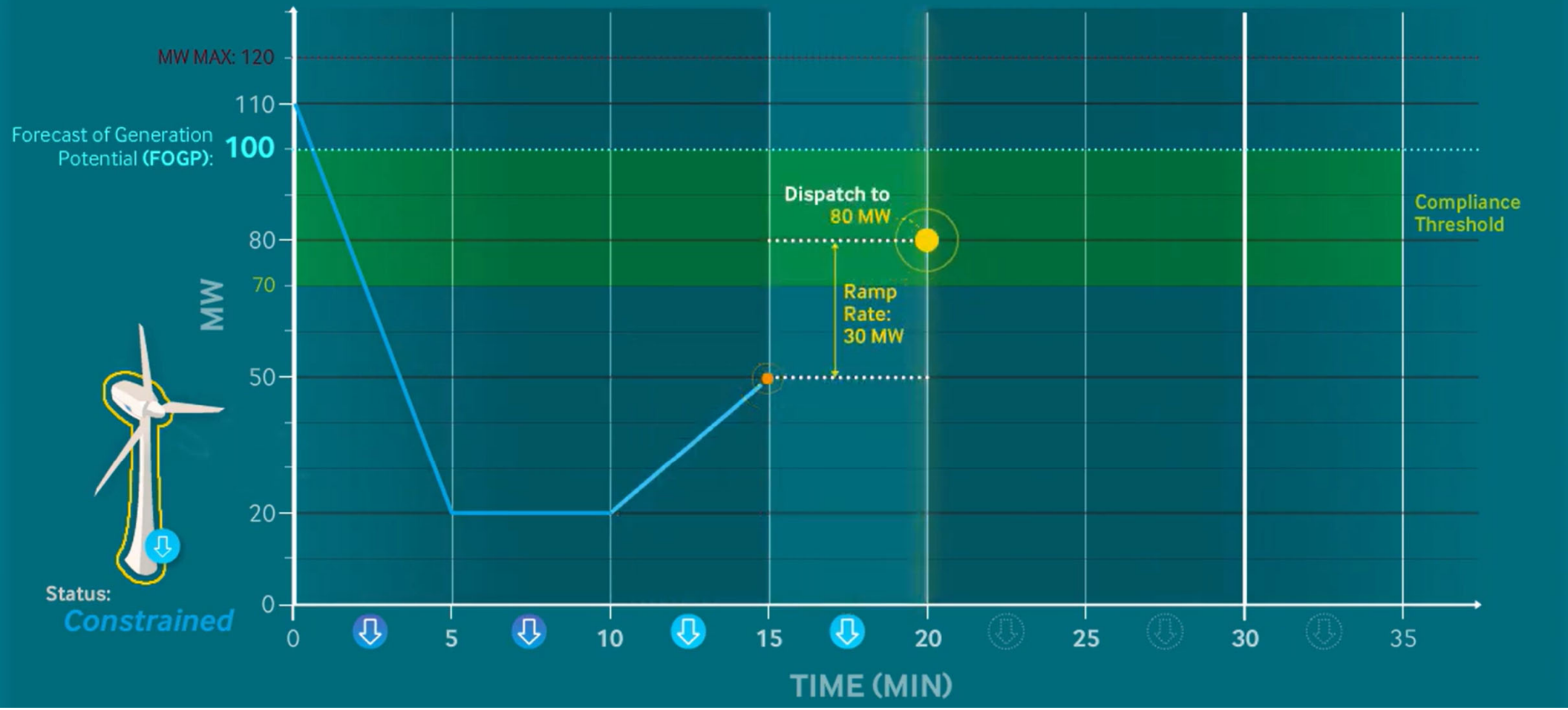
This effect is multiplied if groups of IG are released simultaneously.

Slide 8

MM1 When released constrained IG can disturb the balance of the grid.
Maggie Makrogianni, 2025-10-30T19:09:46.177


Turitea Wind Farm
100MW/min!
Active Power (MW)
104
100
80
60
40
20
0
1m
2m
3m
4m
5m
6m
7m
8m
9m
10m
Time (minutes)

Constraints are now increased in 30MW steps before the plant is finally released to maximum.



Transpower's role in supporting the sector with IG development

- Frequency changes happen when groups of IG that are simultaneously released from a constraint rapidly increase the amount of generation on the system.
- What, if anything needs to be done to mitigate IG fluctuations?

Method – investigating resistance of frequency to change

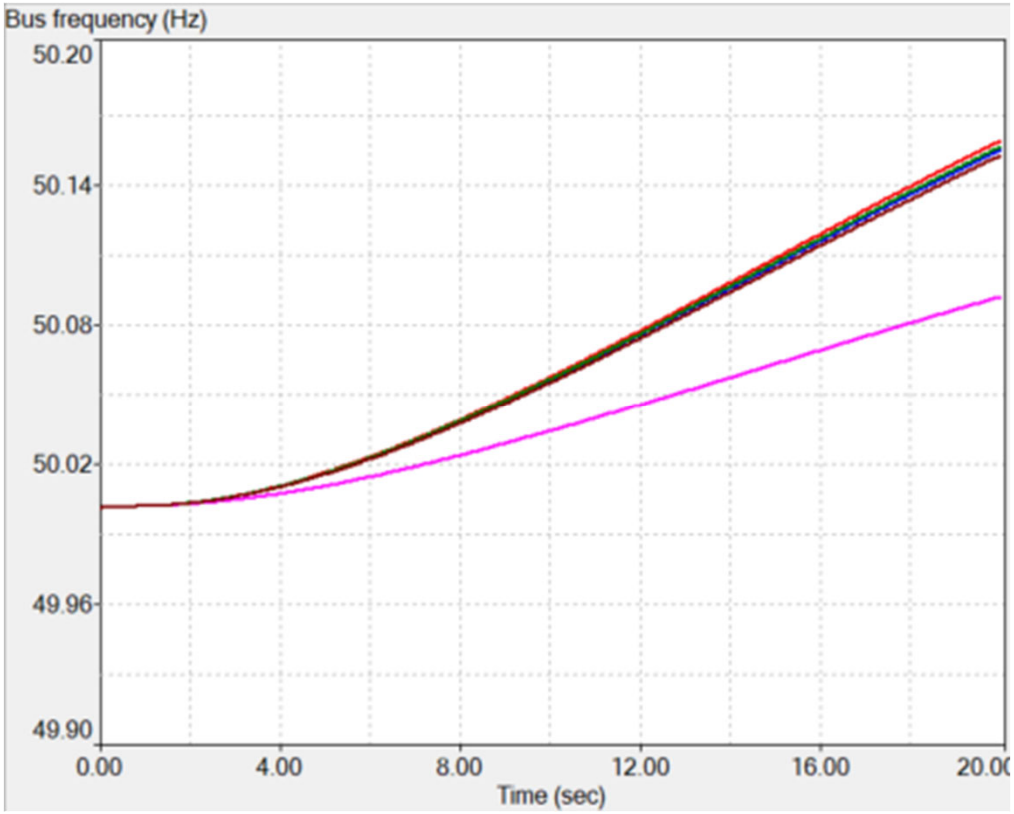
LOOK FOR CASES OF BIG GROUPS OF IG RELEASED FROM A CONSTRAINT

SIMULATE THE LARGEST GROUP RAMP EVENTS THAT WERE FOUND

FIND THE LIMITING RAMP RATE BEFORE THE FREQUENCY EXCEEDS THE NORMAL BAND

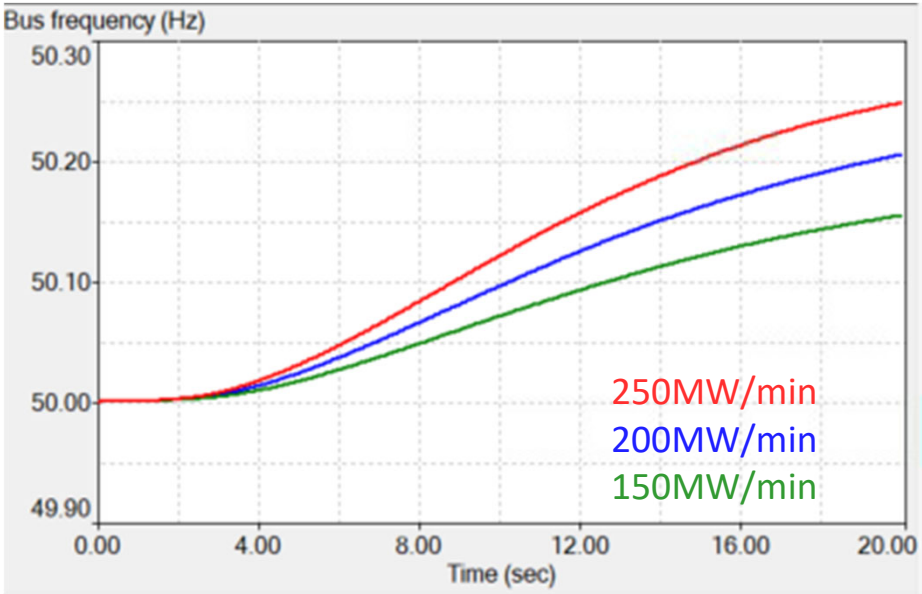
Frequency is Close to Limits When HVDC is Out of Service

Simulation of the largest recorded event during past HVDC outages

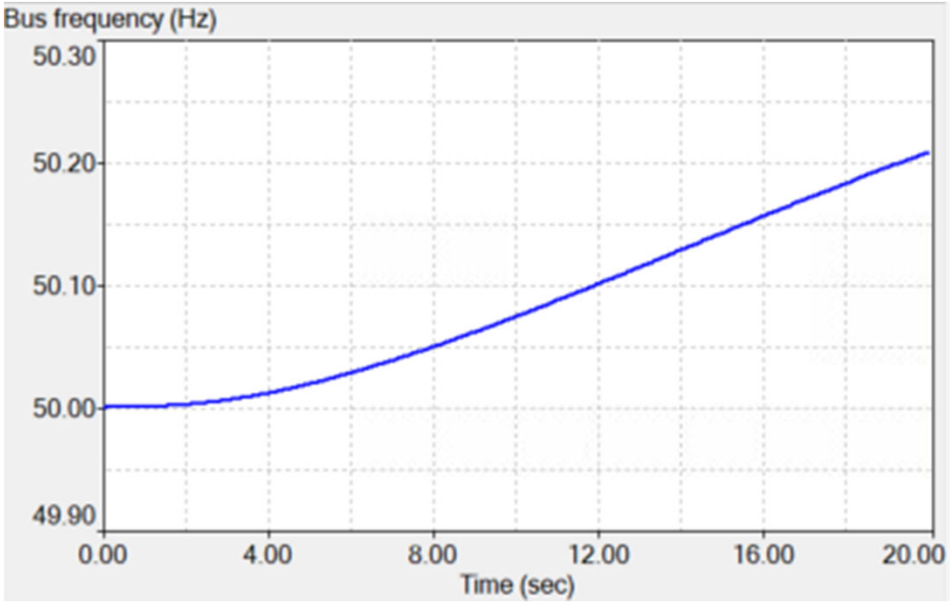


A combined ramp rate of more than 200MW/min would push the frequency outside the normal band

Normal combined ramp limit: 200MW/min



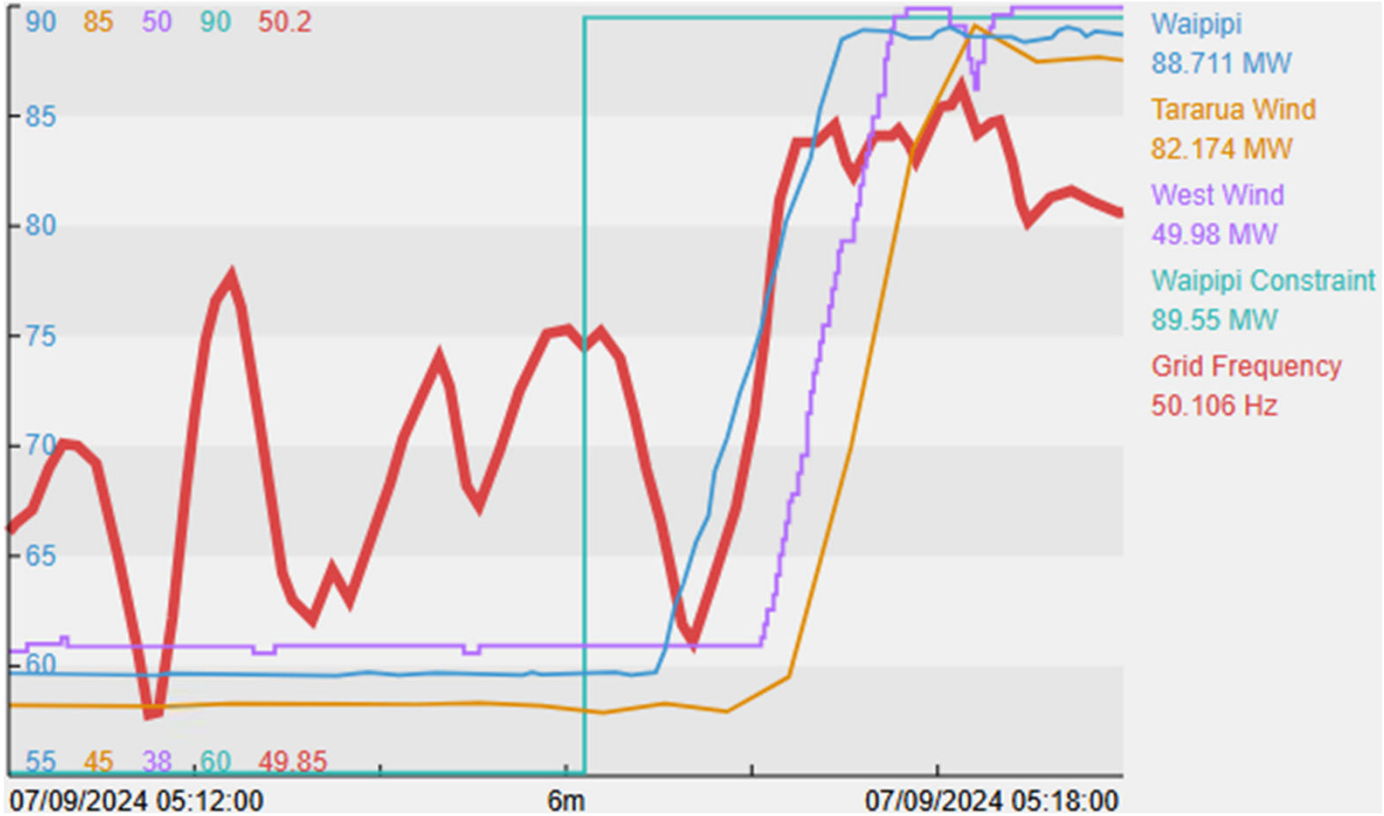
HVDC outage combined ramp limit: 100MW/min



MM1

Past events show frequency stays within a safe range

Large historical constraint releases do not cause frequency to leave the normal band



Slide 15

MM1 Past events show frequency stays within limits/safe range

Maggie Makrogianni, 2025-10-30T19:12:41.381

MM1

Current IG fluctuations could reach the limits

- But only during a bipole outage
- Largest group of five IG
- Max ramp rate of 30MW/min
- 30 x 5 = 150MW/min
- 150 < 200
- Normal operation is fine
- Studies are pessimistic

Slide 16

MM1 Current IG could reach the 150mw/min limit

Maggie Makrogianni, 2025-10-30T19:14:53.163

MM1

Good news - no need to impose permanent ramp limits

Temporary ones may need to be applied during an HVDC bipole outage (20MW/min). Otherwise, IG would operate as normal.

This would change if new IG had abnormal control systems.

Large solar farms should be monitored closely to see how they respond to constraints.

Slide 17

MM1 Great news - No need to impose new ramp rates

Maggie Makrogianni, 2025-10-30T19:15:25.992

MM1

Different transmission systems take different approaches to IG

EirGrid (Ireland)

- Large fleet of batteries and multiple HVDC links
- Imposes a power ramp limit on all generation

AEMO (Australia)

- Very fast droop response (sub one second reserve market)
- Gradual relaxing of constraints rather than a binary on/off

MM1 Different IG management methods work for different transmission systems

Maggie Makrogianni, 2025-10-30T19:16:24.507

New Zealand is world leading in renewable integration

- The world is electrifying
- Intermittent generation requires careful attention
- We are constantly monitoring the grid
- There are solutions for the effects of intermittent generation
- Weekly average of 99.5% renewable power!

MM1 in management of IG on the transmission network/grid?
Maggie Makrogianni, 2025-10-30T19:18:45.399