# Impact of Short-circuit Ratio on Grid Integration of Wind Farms

## A New Zealand Perspective

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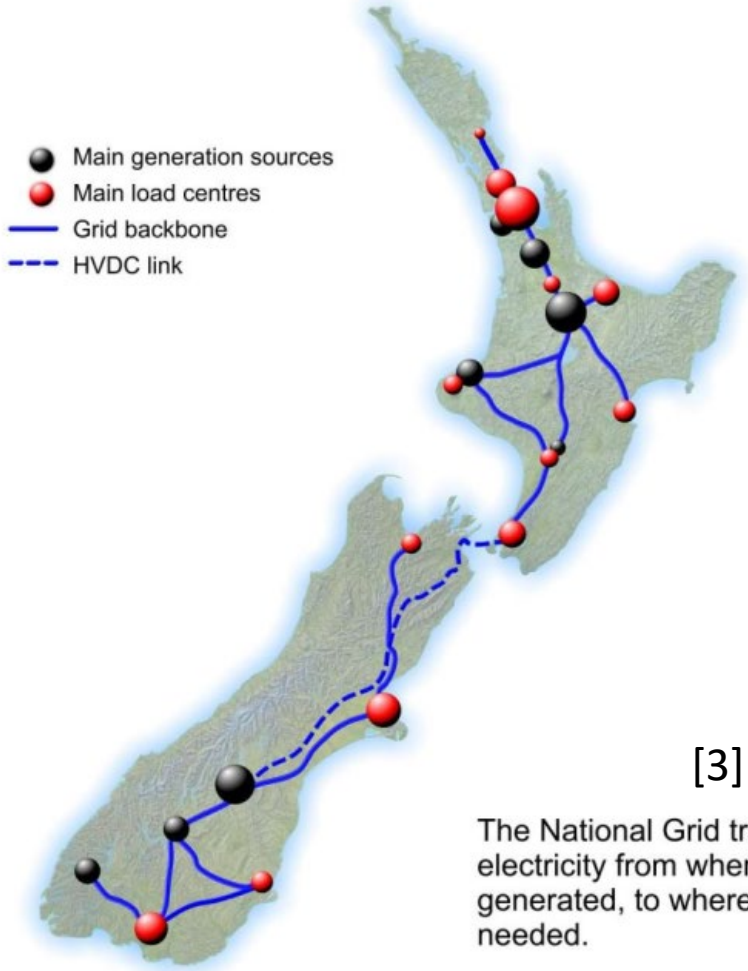
# NZ Power System

- 5 Million population (50 lakhs)
- Small islanded system (6.5GW peak/40TWh a year)
- Generation remote from load centres – long grid backbone with a HVDC link joining our two islands
- 7 predominant generation companies
- Single transmission company and 29 distribution companies
- 11 industrial connections from transmission
- 22 retailers



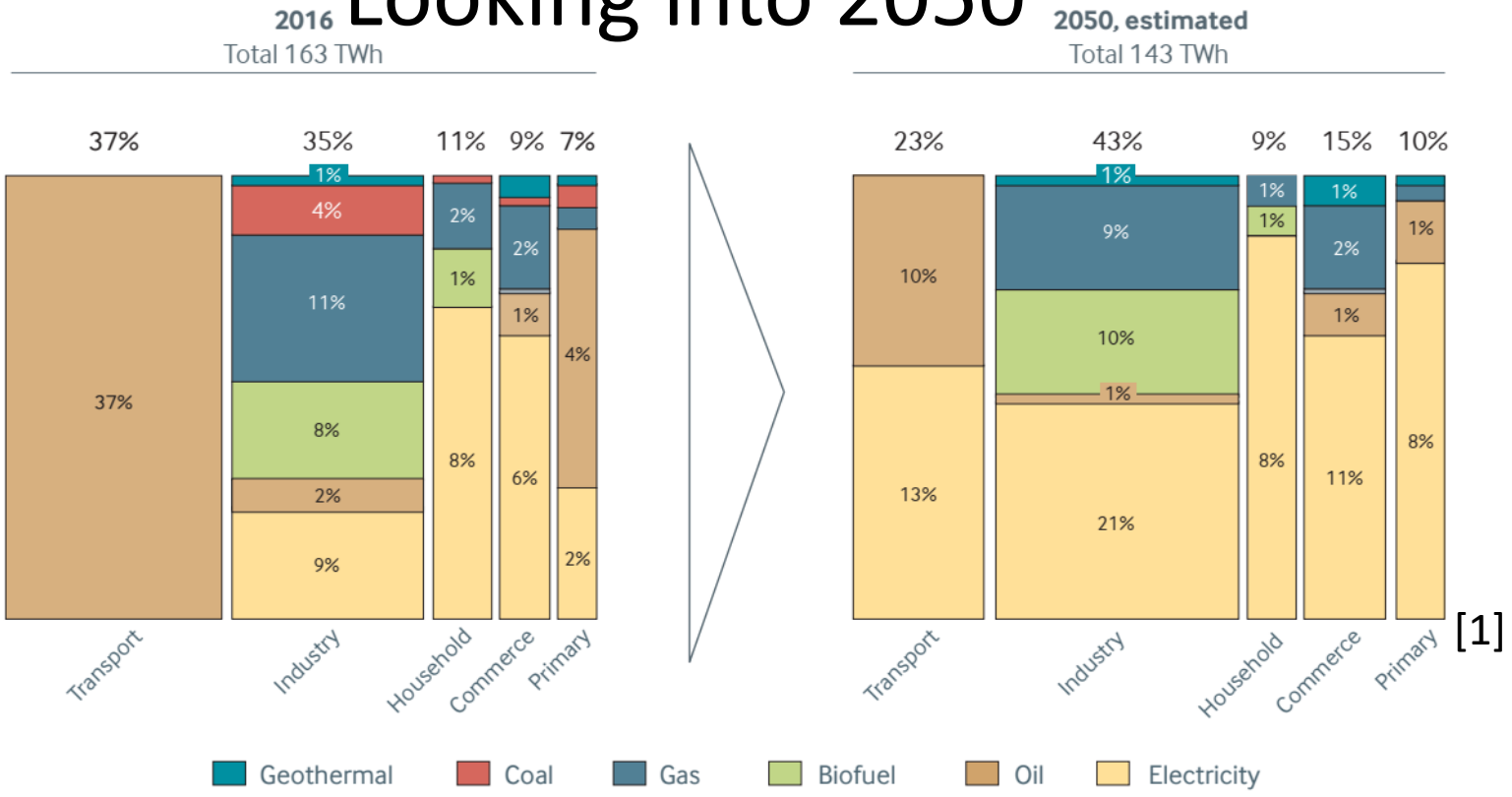

[3]

The National Grid transports electricity from where it is generated, to where it is needed.

# Wind Energy in NZ

- 17 farms with 490 turbines
- Installed capacity of 690 MW
- Supplies up to 6% of NZ generation
- Consented – 12 farms of 2371 MW capacity
  - Smallest 6.8 MW
  - Largest 860 MW (under development) [4]

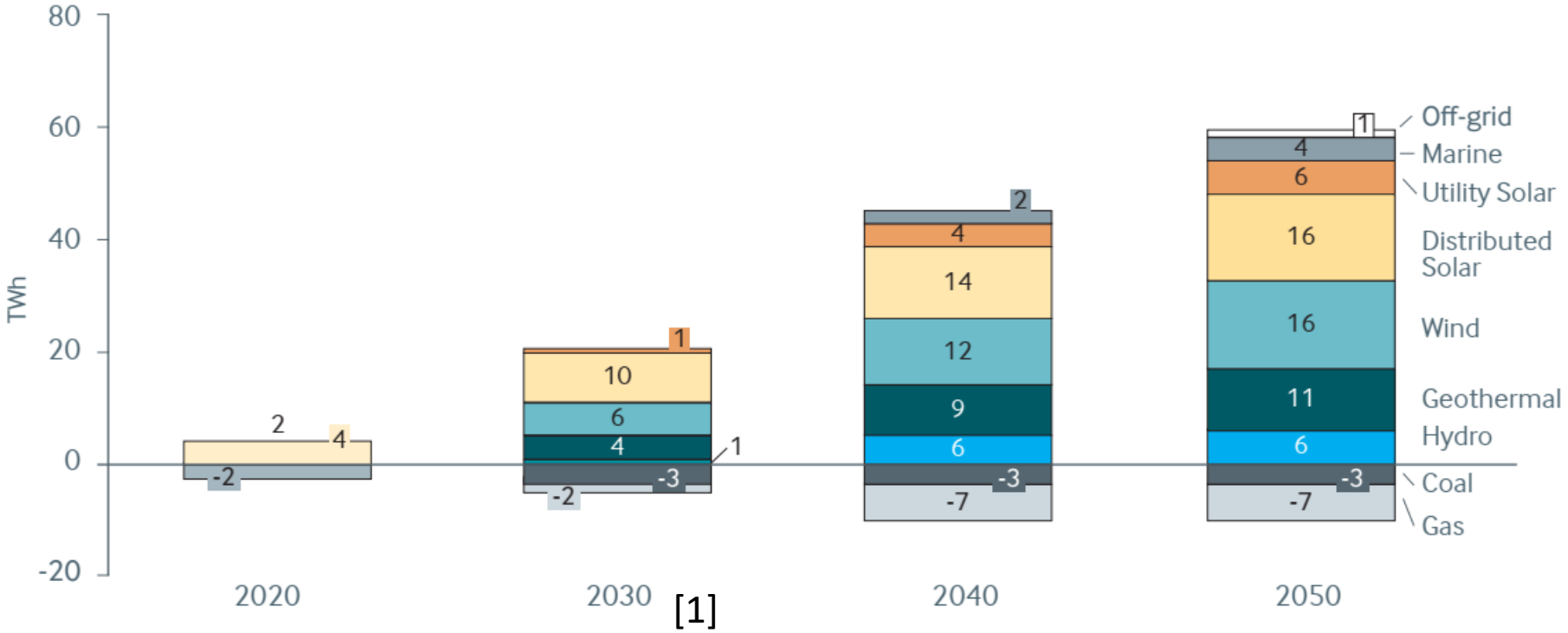
# Looking into 2050



[1]

- Electricity demand increase from 25% to 61%
- 60 TWh generation needed by 2050
- Estimates 16 TWh distributed solar
- Rest to come from utility scale RE

# Estimated new sources into 2050

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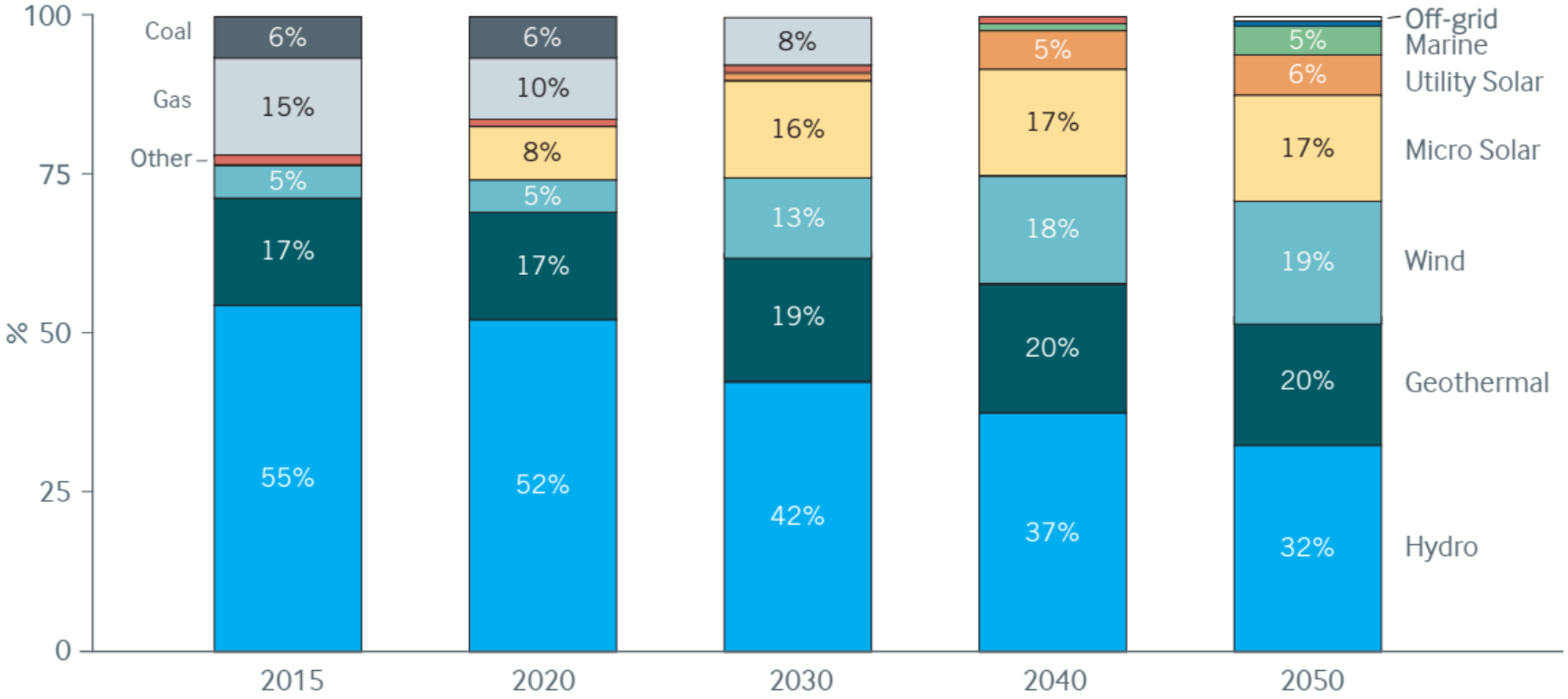
- Coal and Gas being retired
- Need for new Hydro beyond 2030

# The shape of NZ Electricity in 2050

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# The Focus of This Paper

- To investigate NZ Grid's Short Circuit Ratios (SCRs) at nodes that connect future generation
- Wind energy is the prime focus
- Estimate maximum capacity for the nodes
- Performance through fault ride through (FRT) studies
- Does weak grid definition hold for NZ grid?

# Short Circuit Ratio (SCR)

$$SCR = \frac{S_{cc}}{S_{wf}} \quad [9]$$

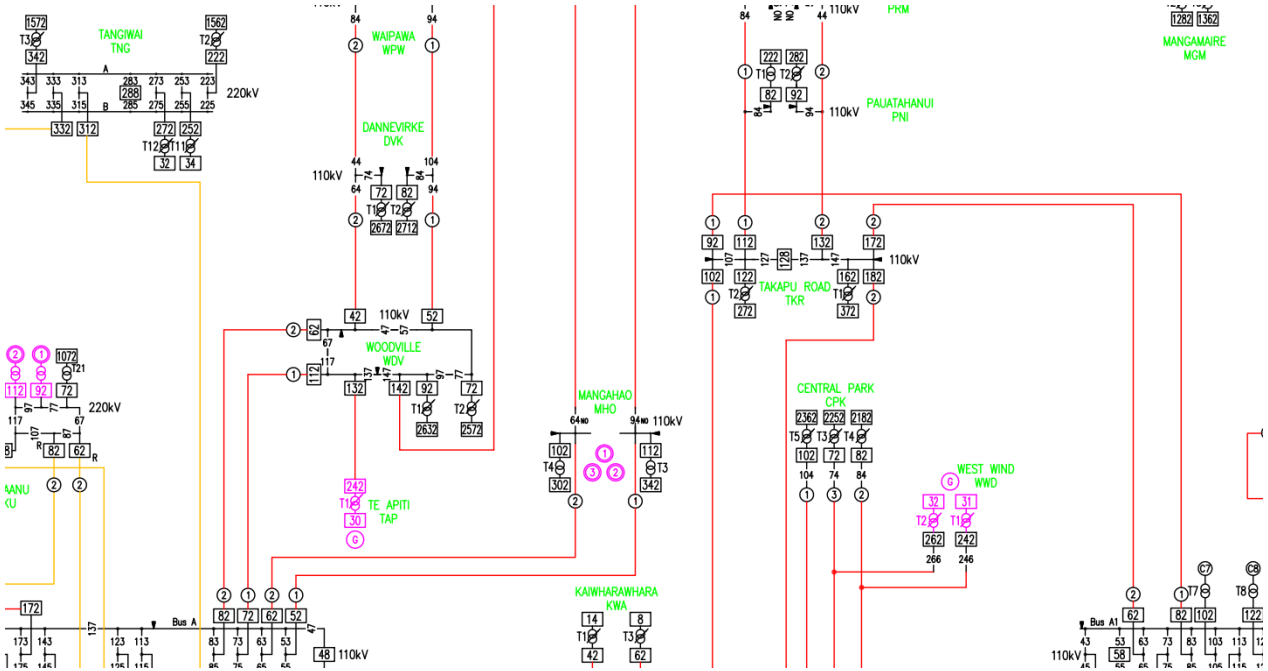
$S_{cc}$ is the short circuit level at the bus without connecting a wind farm

$S_{wf}$ is the wind farm name plate rating in MW

- The SCR of a node represents the ability of a bus to withstand the voltage fluctuations in response to a fault.

# The model

- Operational model of NZ Grid in PowerFactory
- Has existing operational wind farms in the model (along with other generation)



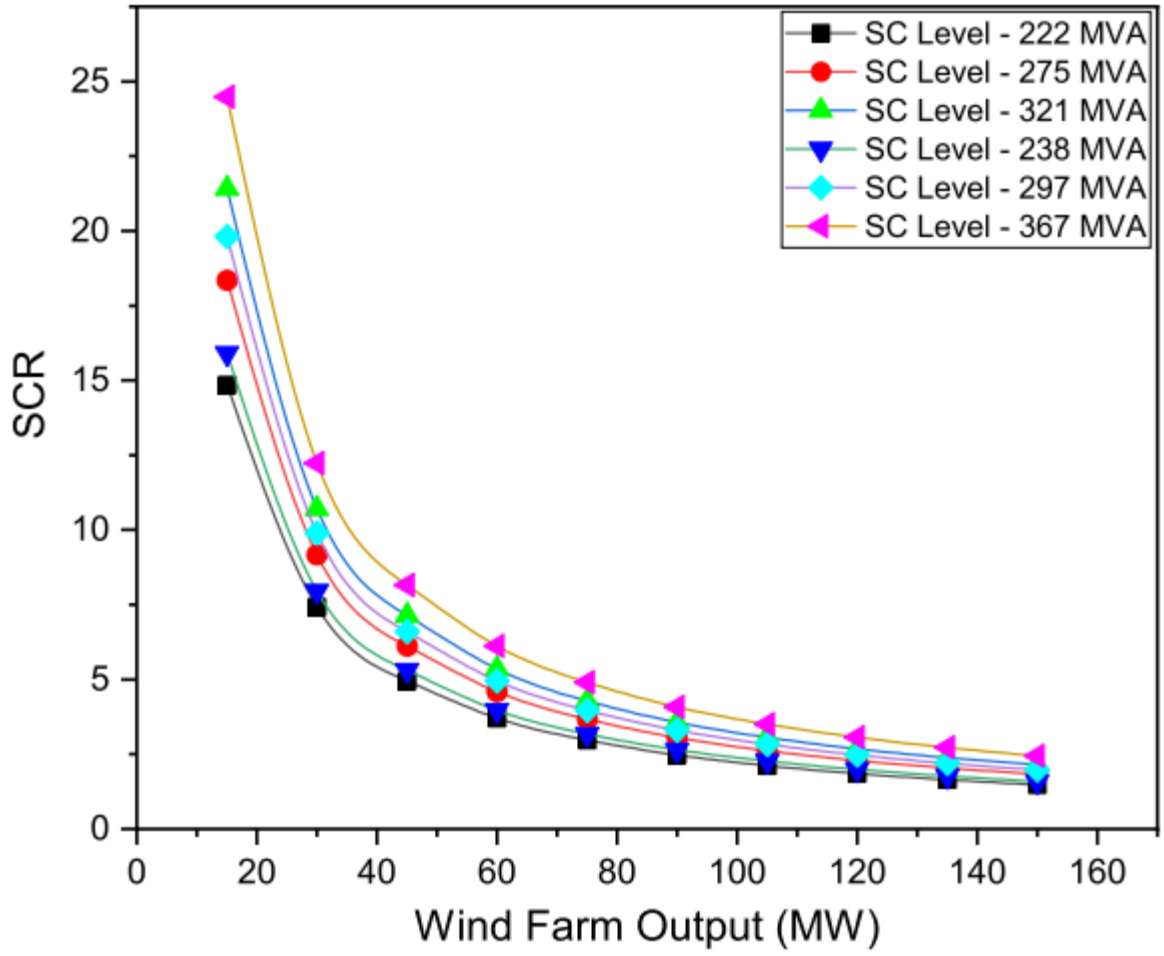
# The procedure

- Perform short circuit capacities on all the nodes (between 222 MVA to 3376 MVA)
- Select five nodes from both islands:
  - Kaitaia
  - Gisborne
  - National Park

# The Procedure

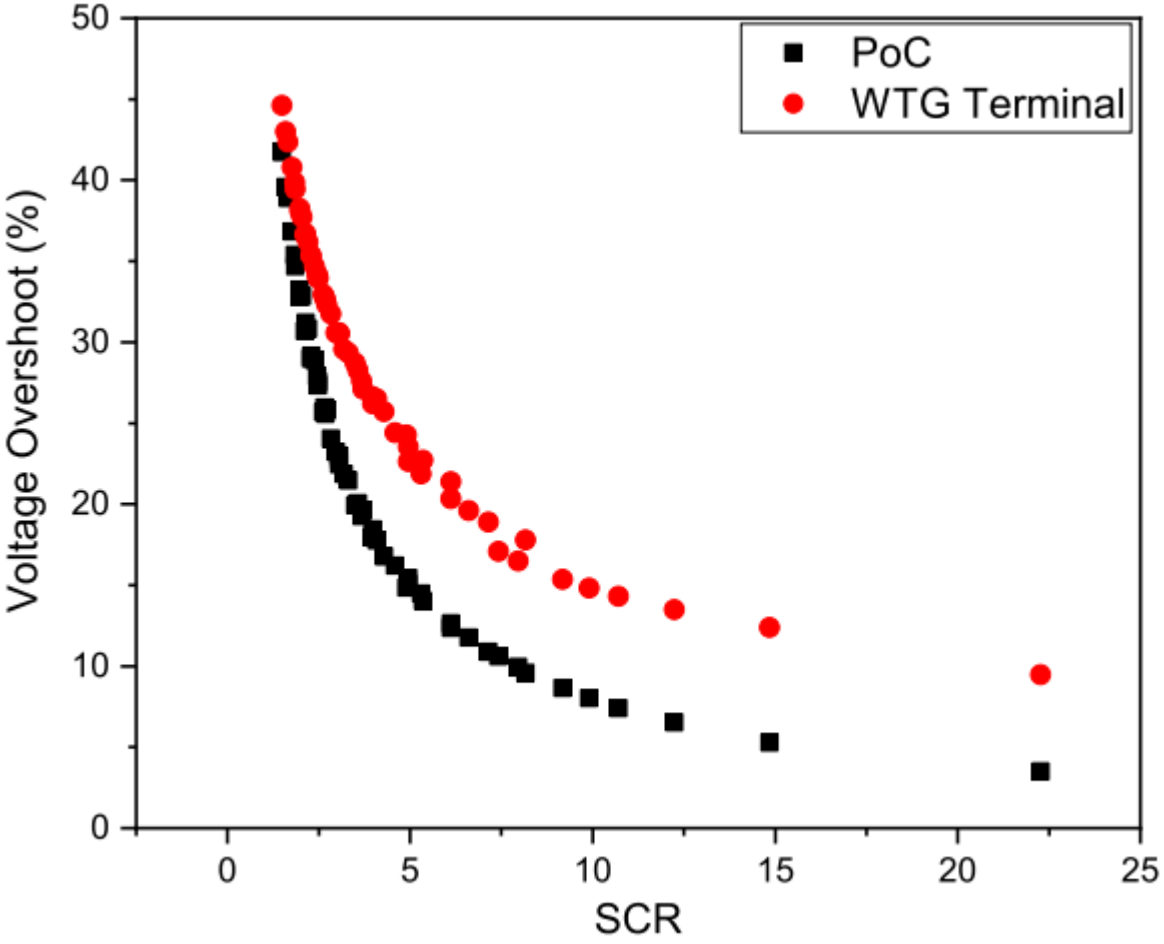
- South Island:
  - Reefton
  - Oamaru
- SC Capacities of 238.57 to 367.15
- Connected wind farm of rating from 15 MW to 150 MW (currently the largest farm capacity in NZ)
- SCR values between 1.59 to 24.48

# The Results

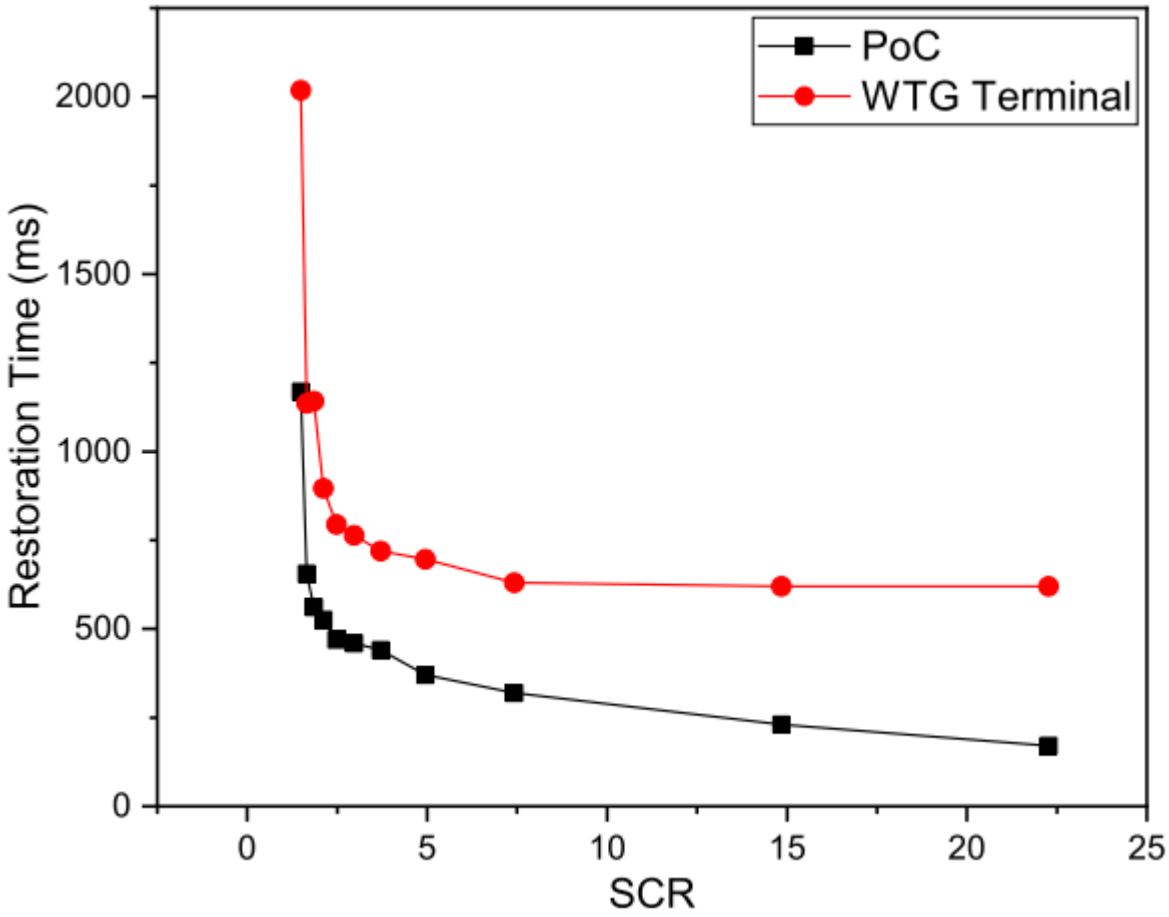



SCR Vs Wind farm output

# Voltage Overshoot



# Restoration times



# Some Observations

- If SCRs are same, the behaviour is similar although SC capacities are different.
- Even with SCR of 22 (rigid system), restoration times are four times longer than anticipated.
- Voltage spikes are as much as 45% for low SCRs
- Spikes are worse at WTG terminal than PoC even at SCR > 10.
- Restoration times are higher at WTG terminal level than PoC

# Conclusions

- NZ grid can be classified as weak grid if wind capacity > 60 MW, is connected at many of the nodes.
- Fault Ride Through (FRT) is an issue and needs further investigation.
- New Zealand's weak grid definition might lean on SCR < 5 rather than a traditional value of 3.
- SCRs are a good way to analyse grid stability.

# Thank you


THE DAILY TOON
BY MARK LYNCH
IT'S EITHER SWAYING PALMS OR COLD BEER... YOU CAN'T HAVE THEM BOTH!
LYNCH