



# PROTECTION OF WINDFARMS

IN AUSTRALIA AND NEW ZEALAND

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# THE FOUR HORSEMEN OF RENEWABLES



- A Wind
- B Solar
- C Battery Energy Storage System (BESS)
- D Synchronous (Geothermal/Hydro)

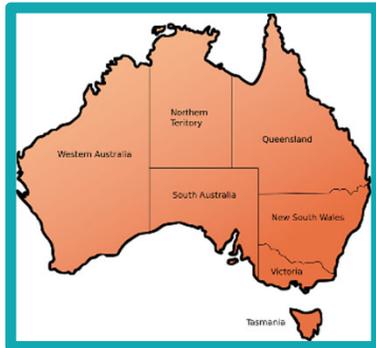
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WHAT IS PROTECTION?



PROTECTION AT A WIND FARM?



COMPARE AUSTRALIA AND NEW ZEALAND?

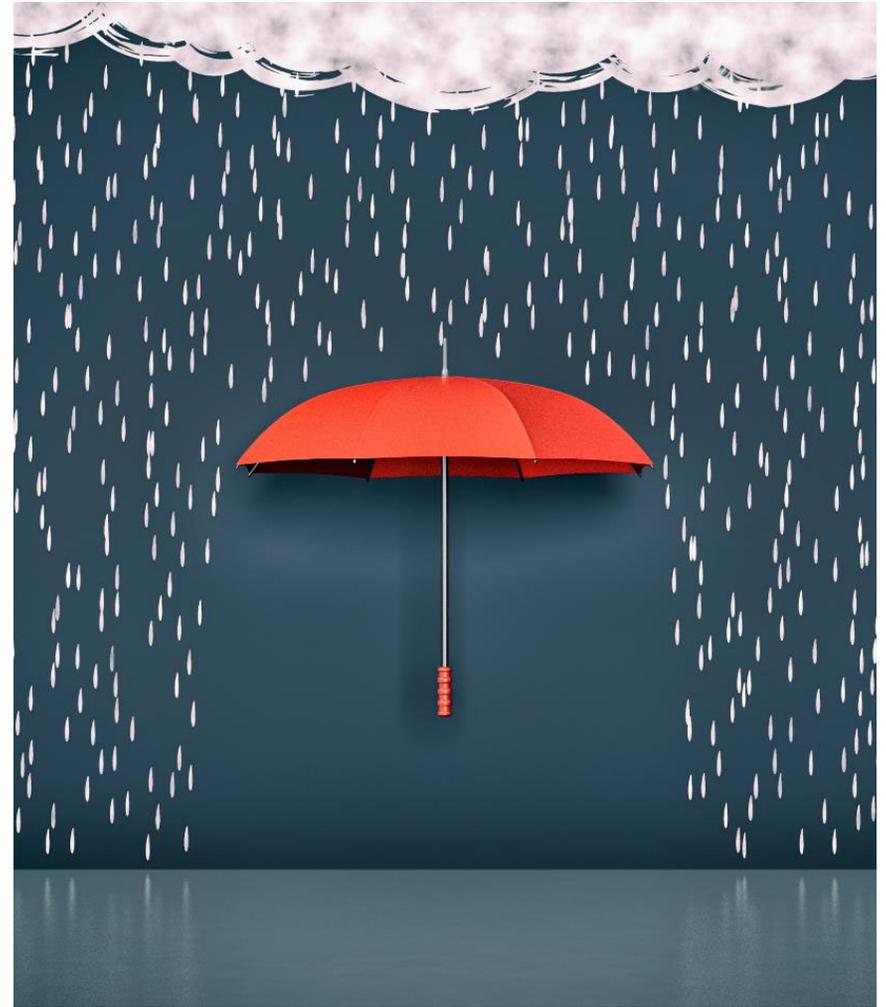


WHY AM I BALDING FASTER THAN I'D LIKE?

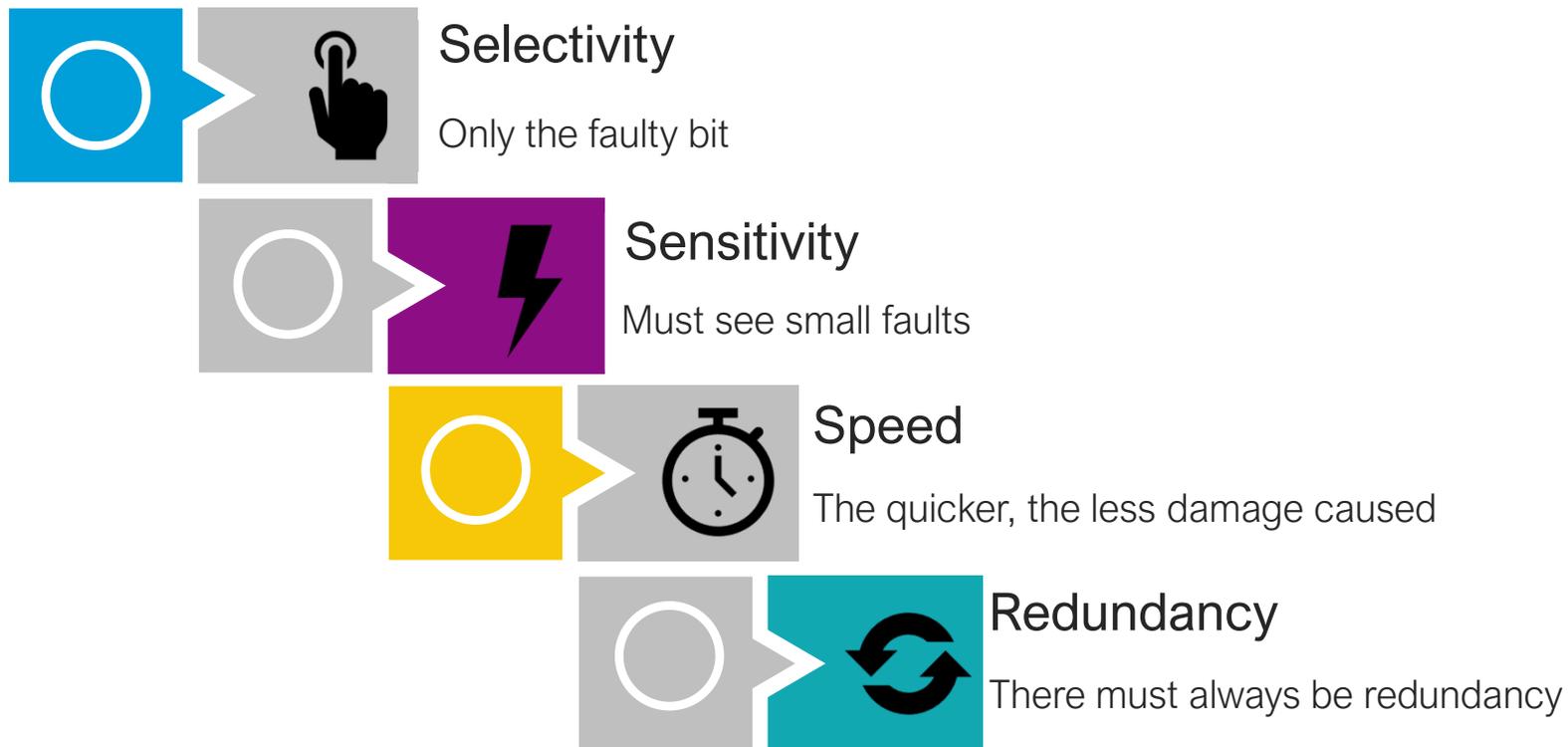
# WHAT IS PROTECTION?

Protection is the umbrella when it rains!

*“Protection engineers design systems that can detect when something goes wrong, isolate the problem, and allow the rest of the grid to keep running” - ChatGPT*



# PROTECTION FUNDAMENTALS



# REDUNDANCY

## Duplicate Main

- Two Independent Systems
- Prot1 and Prot2 Devices
- DC1 and DC2
- Expensive
- Reliable

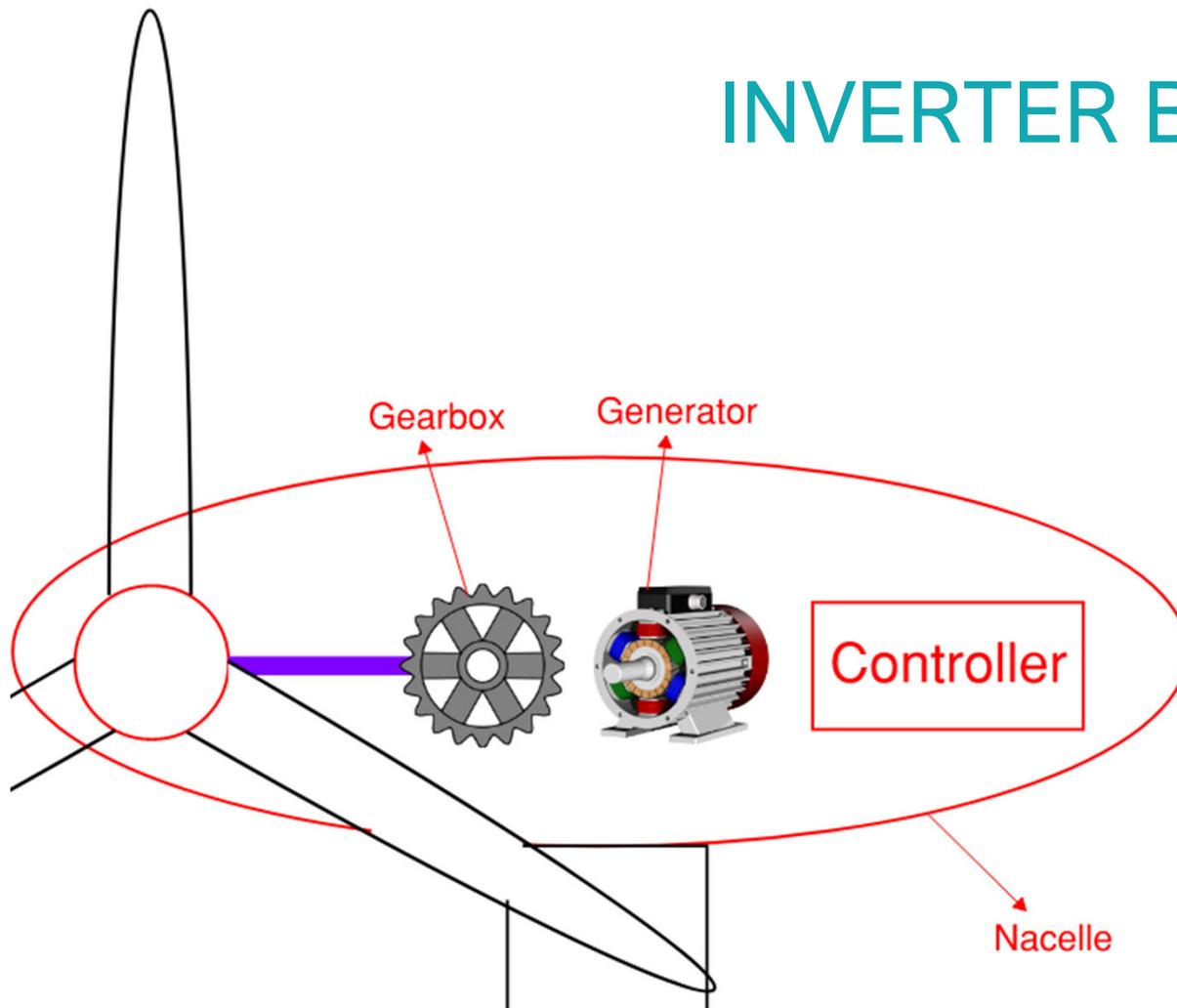
## Single Main and Backup

- Provided from outside faulted location
- Time delayed (slow)
- Operates if main prot fails
- Less cost
- Non-selective

WHAT DOES  
PROTECTION LOOK  
LIKE AT A WINDFARM?



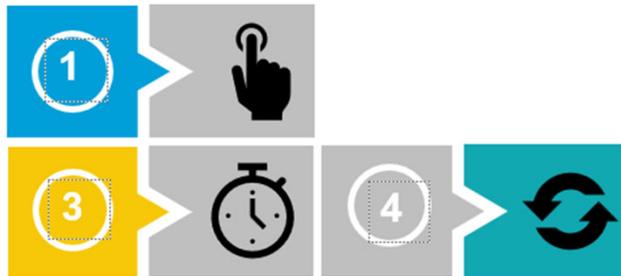
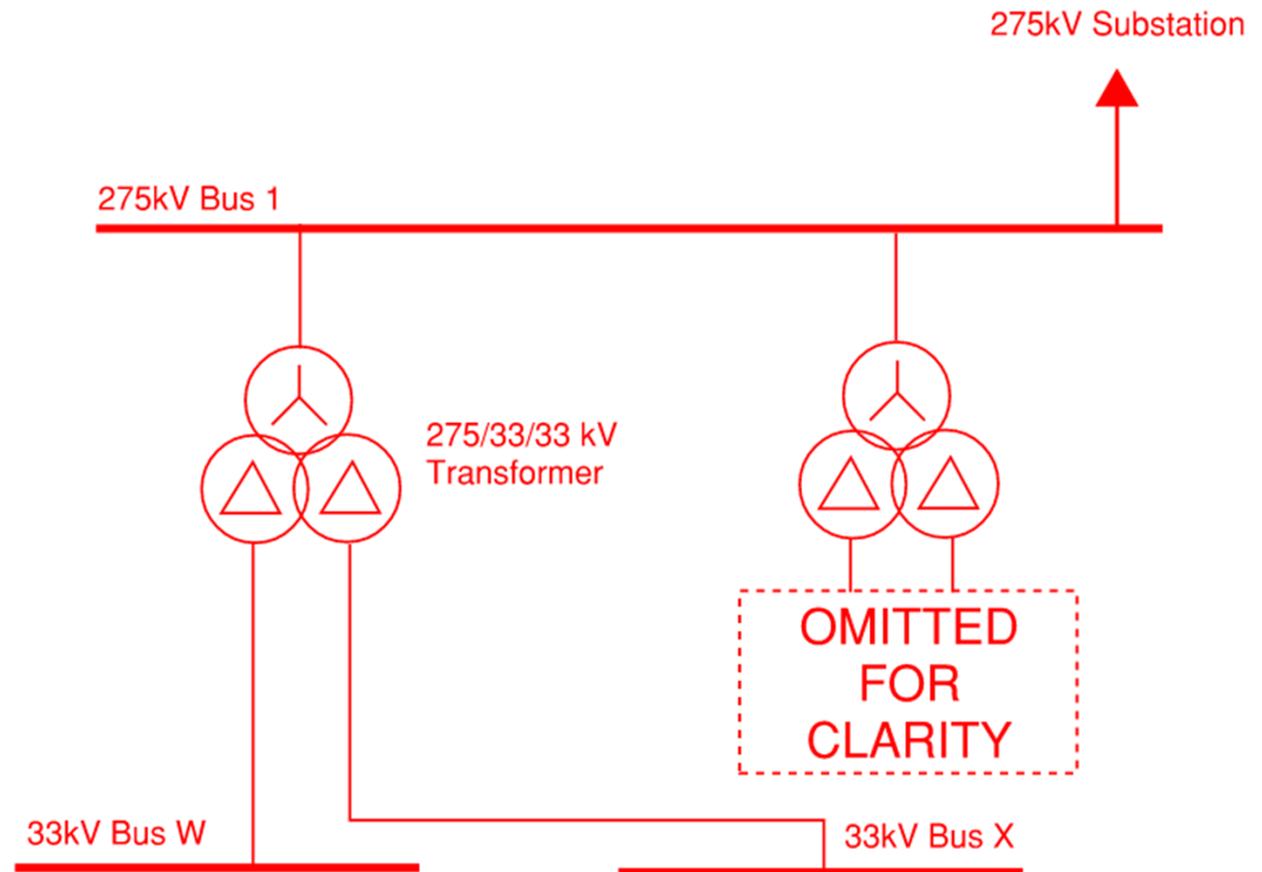
# INVERTER BASED RESOURCE



- Controller in Nacelle
- Variable-frequency AC
- Rectified to DC
- Inverter to grid synchronised AC

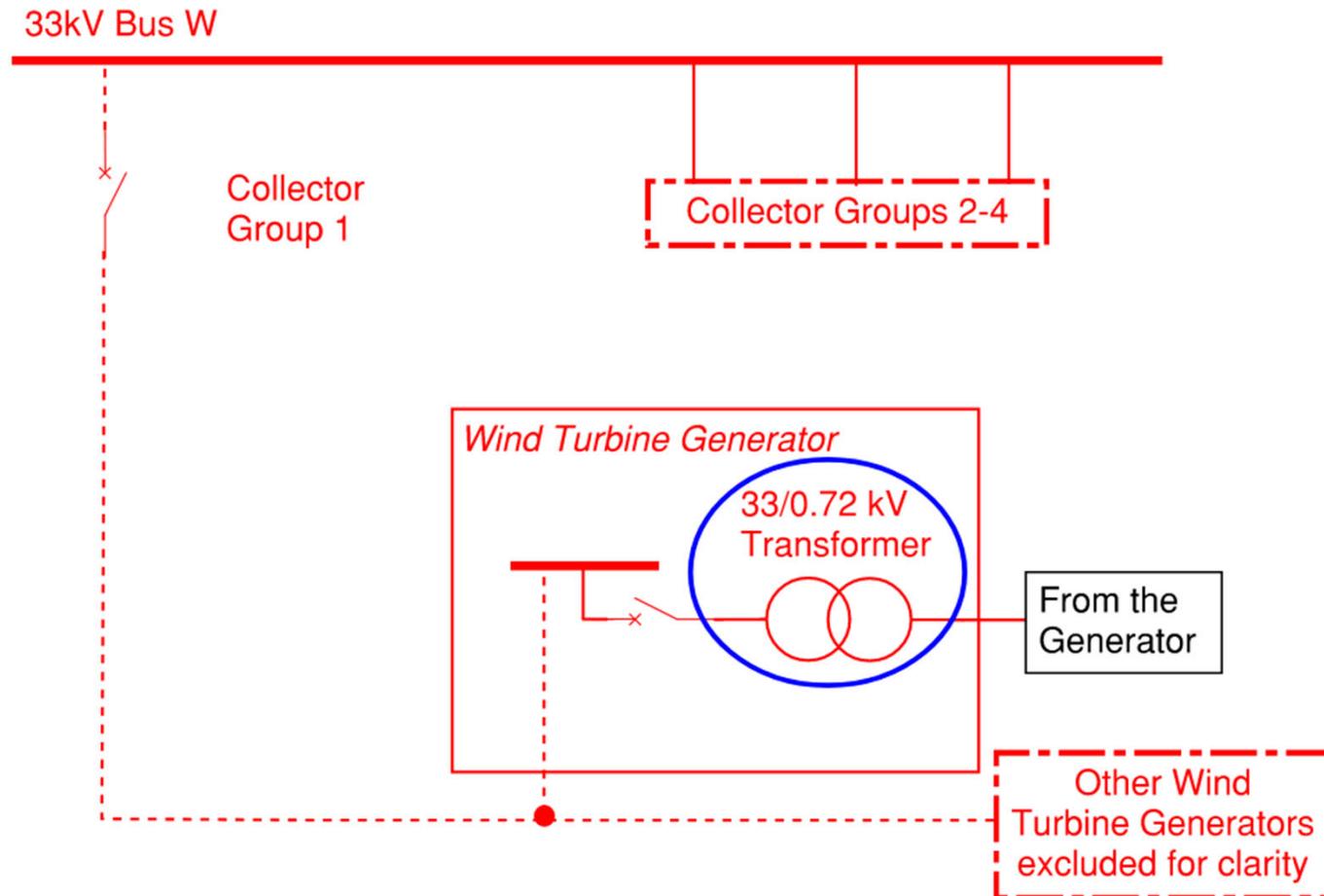
# ANONYMOUS WINDFARM PT.1

- 275 kV Transmission
- 33 kV busses
- All zones come with duplicated main protection

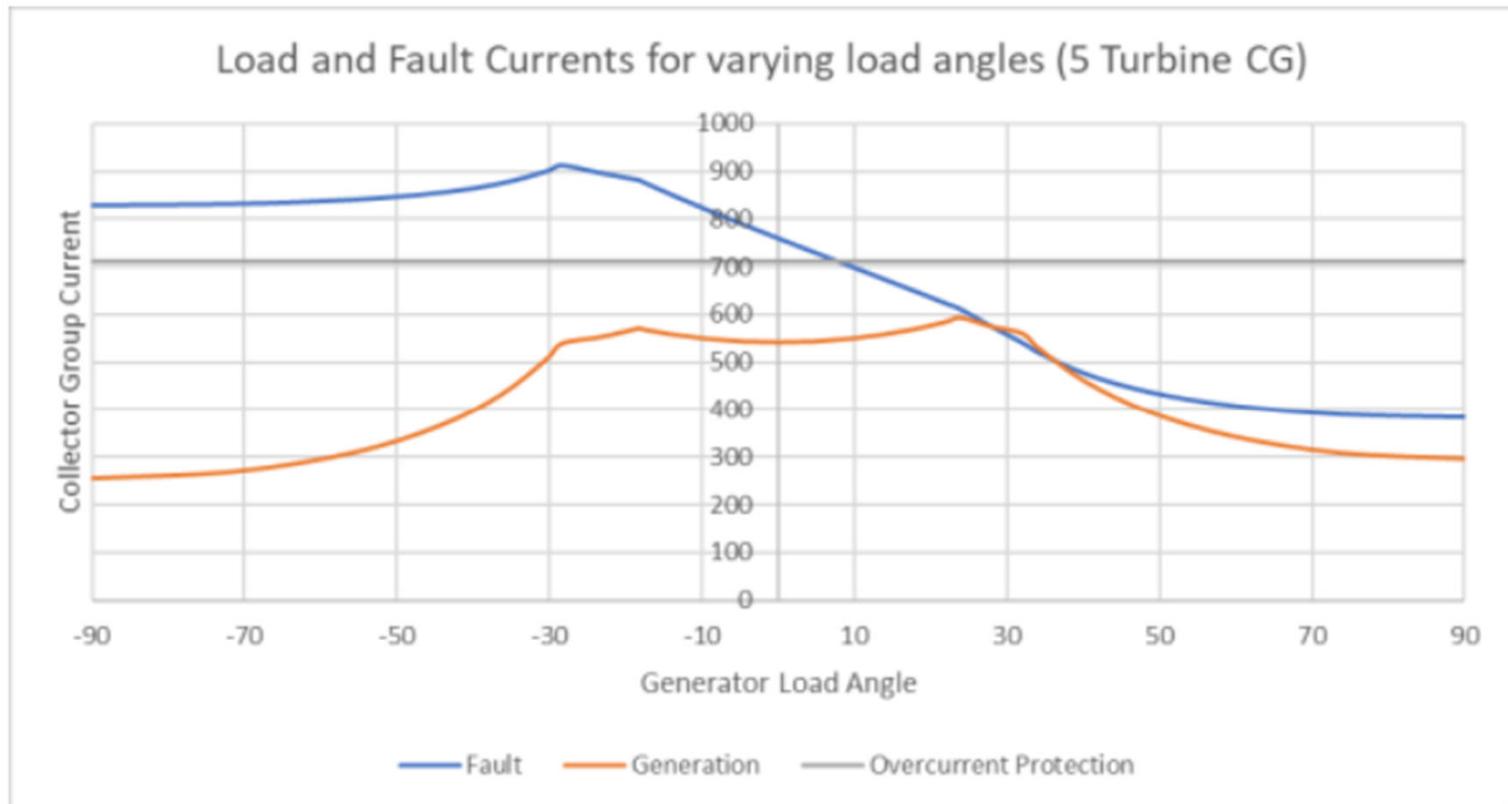


# ANONYMOUS WINDFARM PT.2

- Collector Groups
- 5 WTGs
- Step Up Transformer (SUT) needs backup to be provided
- Duplication not economical



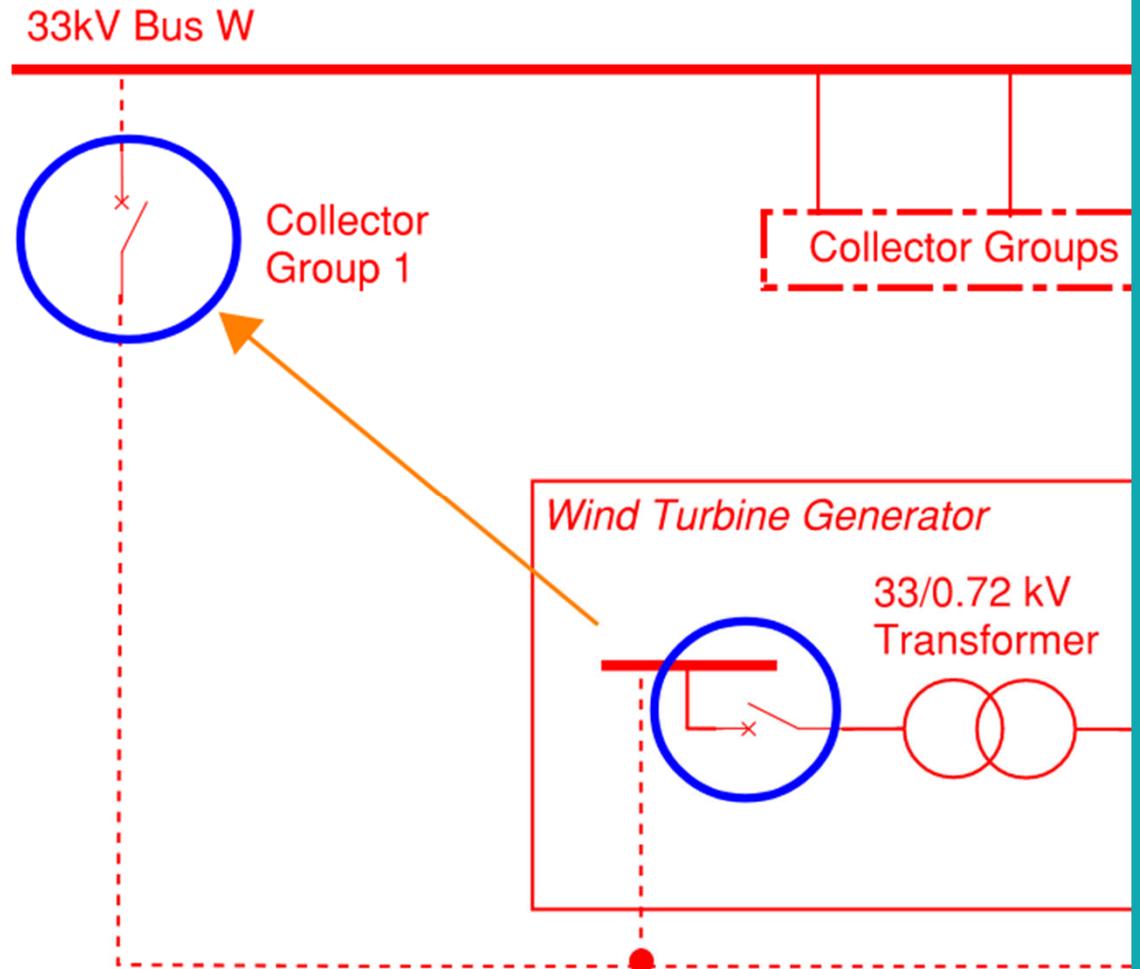
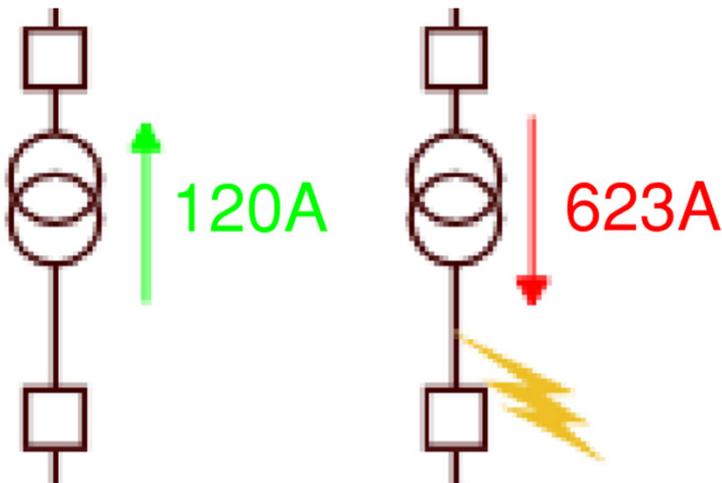
# OVERCURRENT PROTECTION



- Overcurrent Protection cannot be set reliably
- Same as load current

# SOME SOLUTIONS

- Communications
  - Send trip
- HV Fuse
  - Could operate for load current
  - Change of standard design

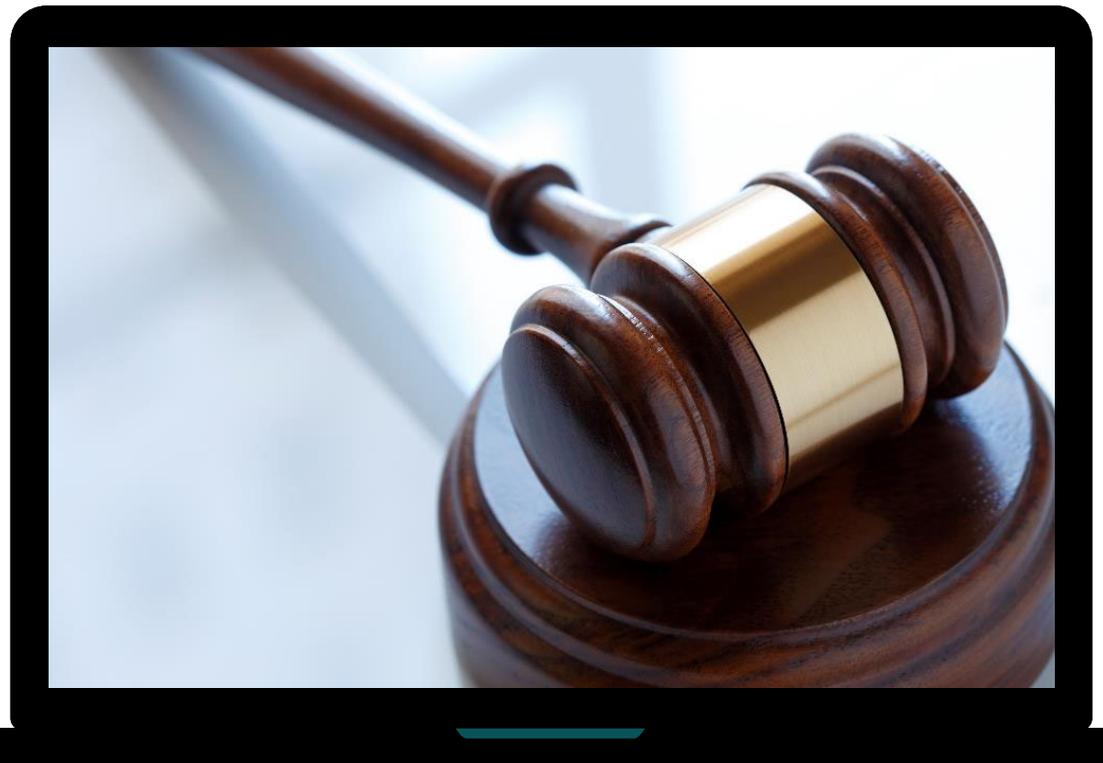


# SO WHAT ARE THE DIFFERENCES BETWEEN NEW ZEALAND AND AUSTRALIA?



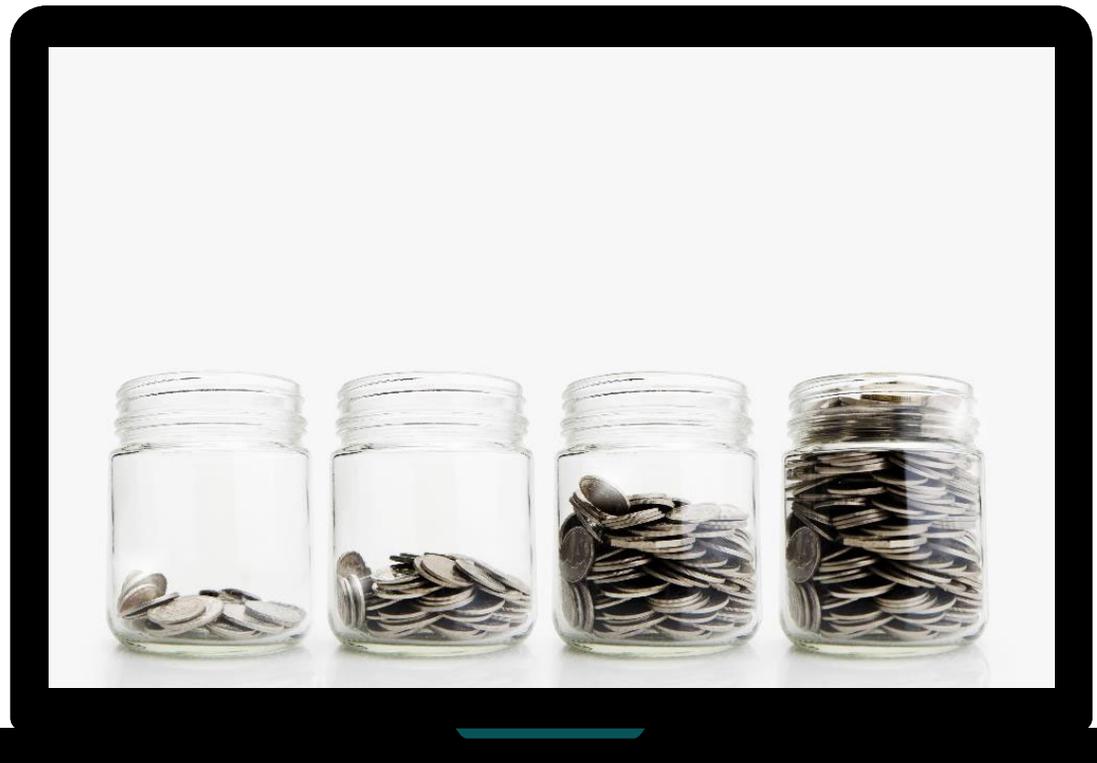
# DUPLICATION IN AUS

- Increased duplication
- 500kV to 22kV
- Generator Performance Standards
- Fast Clearance Times



# COST CONSCIOUS IN NZ

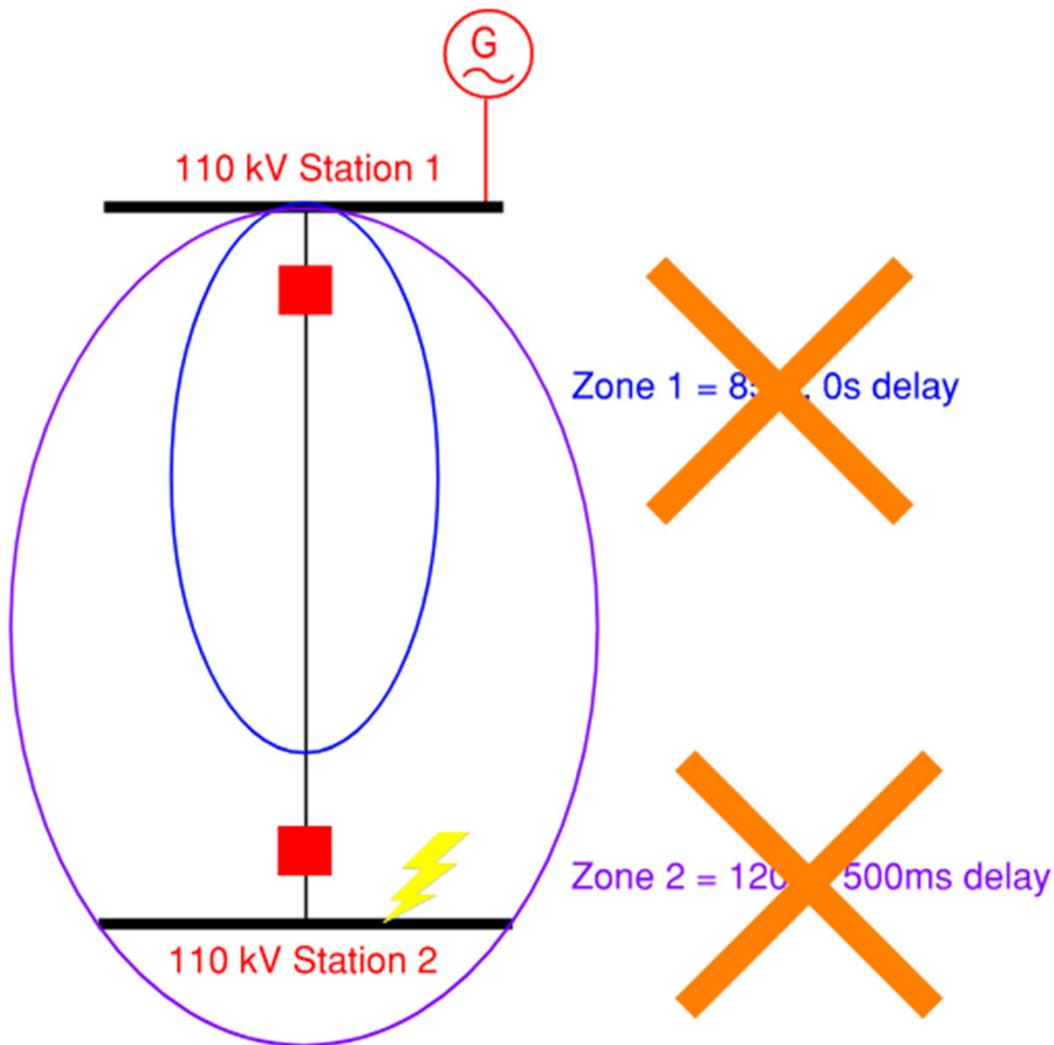
- 220kV+ duplicated only
- Electricity Industry Participation Code (EIPC)
- Save money historically
- Proper grading + engineering judgement





## SO WHAT'S THE OUTCOME?

- It's a balance of cost, safety and reliability.
- Becomes a challenge when introducing complicated schemes.
- Is this a problem?



## WIND FARM ADDED

- Inverter Based Resources
- Distance may be unreliable
- No/poor negative/zero sequence elements
- Power electronics are different to conventional
- No backup

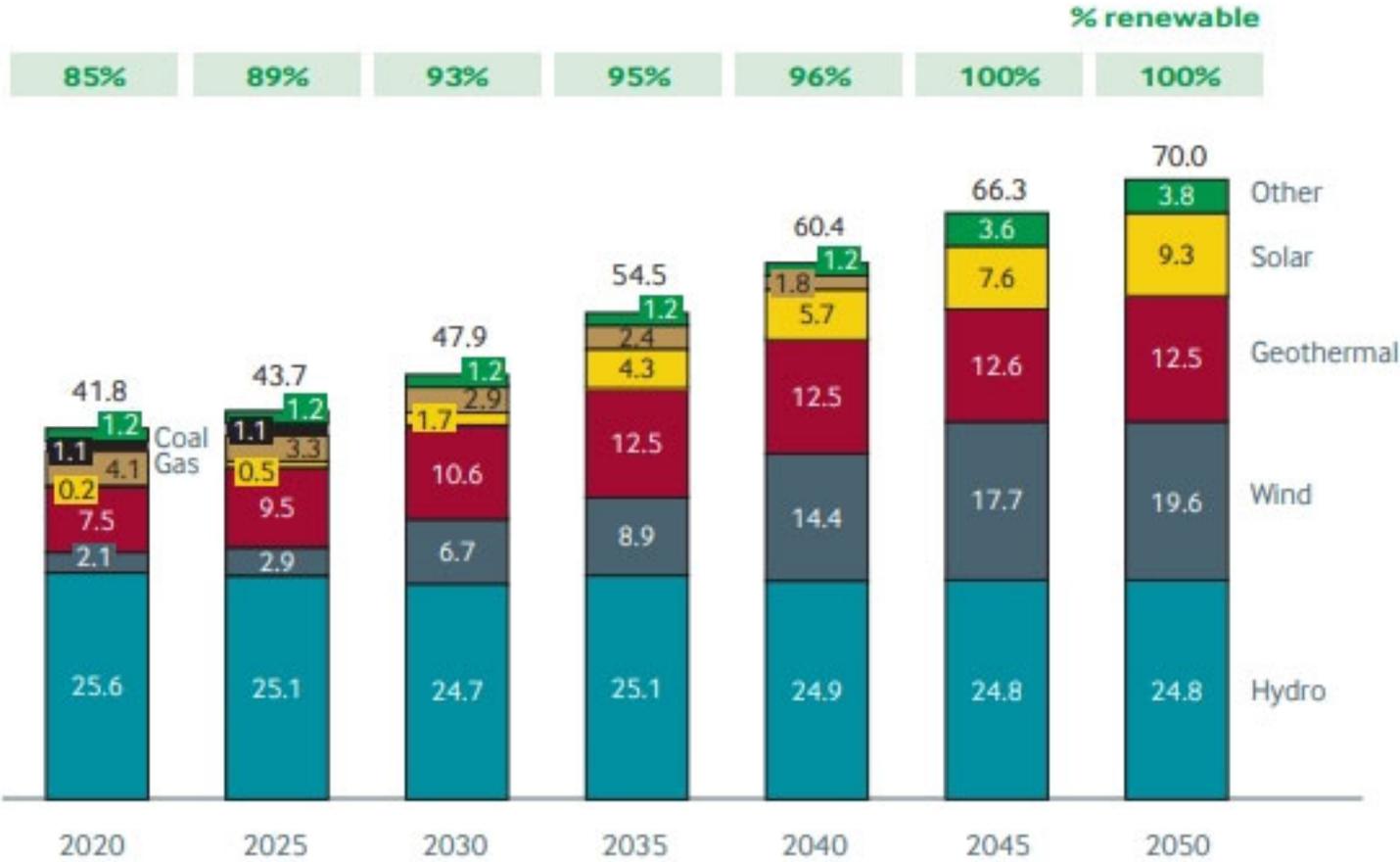
# CONCERN?

- Protection has worked for 100+ years
- Inverter Based Resources require new technology
- Have we reached the tipping point?



Figure 9: Delivered electricity by generation type

(TWh, Accelerated Electrification)



## NEXT STEPS...

- We try to save costs in NZ
- More complex designs and studies
- End up duplicating
- More cost, more work, less benefit
- Time to learn from the Aussies?





# PITCHFORKS!

Not an issue until a small town is kicked off the grid for several hours!

All is fine until the pitchforks are out to get ya!

QUESTIONS?

