Pushing automation to the limit.
Hands off control of the NZ electrical grid.

Luke Reisima

16th September 2020

Thank you to sponsors for their support.

1

- Intro and background

2

Loves a hypothetical

Started chatting about it a bit more

Is this a serious risk?

What would happen if all operators just walked away?

Dispatch stopped

Demand keeps coming

1. Some key technical aspects.
2. How does the model work?
3. Load simulation
4. Generation simulation
5. Result on consumers
6. Model limitations
7. Conclusions

➢ Overview

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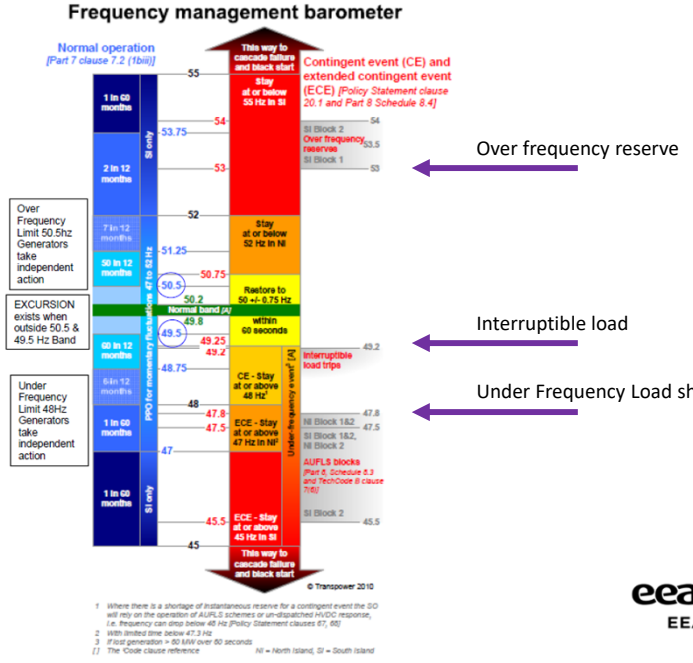
Frequency management barometer



➢ Technical aspects 1: Frequency limits

- EIPC ('The Code') limits
- Interruptible load
- AUFLS

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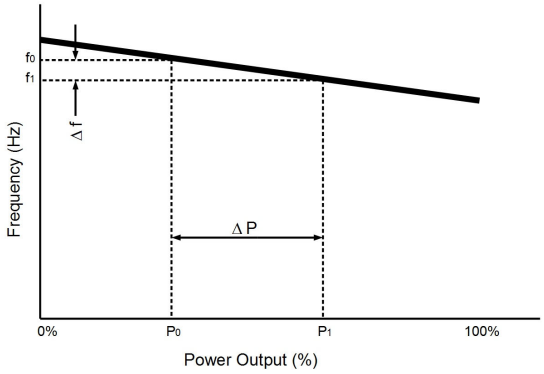

➢ Technical aspects 2: Governor Droop

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➢ Technical aspects 3: Some Hydro/Generator stuff

- Hydro's have inertia
- Can ramp all the way down to 1MW
- Will only trip on vibration
- Will run until water level trips machines (likely on cooling water)
- EIPC rules on frequency response

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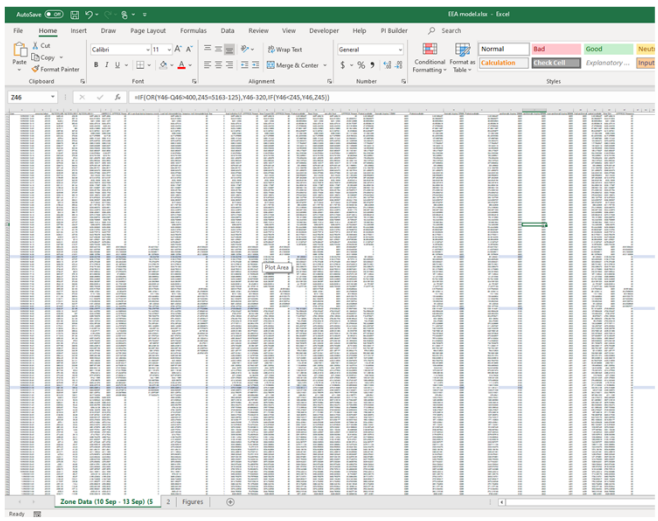
➢ Technical aspects 4: Tiwai things

- Will run until open or short circuit occurs tripping a pot line
- Either metal boils, breaks open pot and open circuits or
- Over flows and short circuits
- Will take about 12 – 24 hours

9



Excel is not good for modelling the electrical grid.

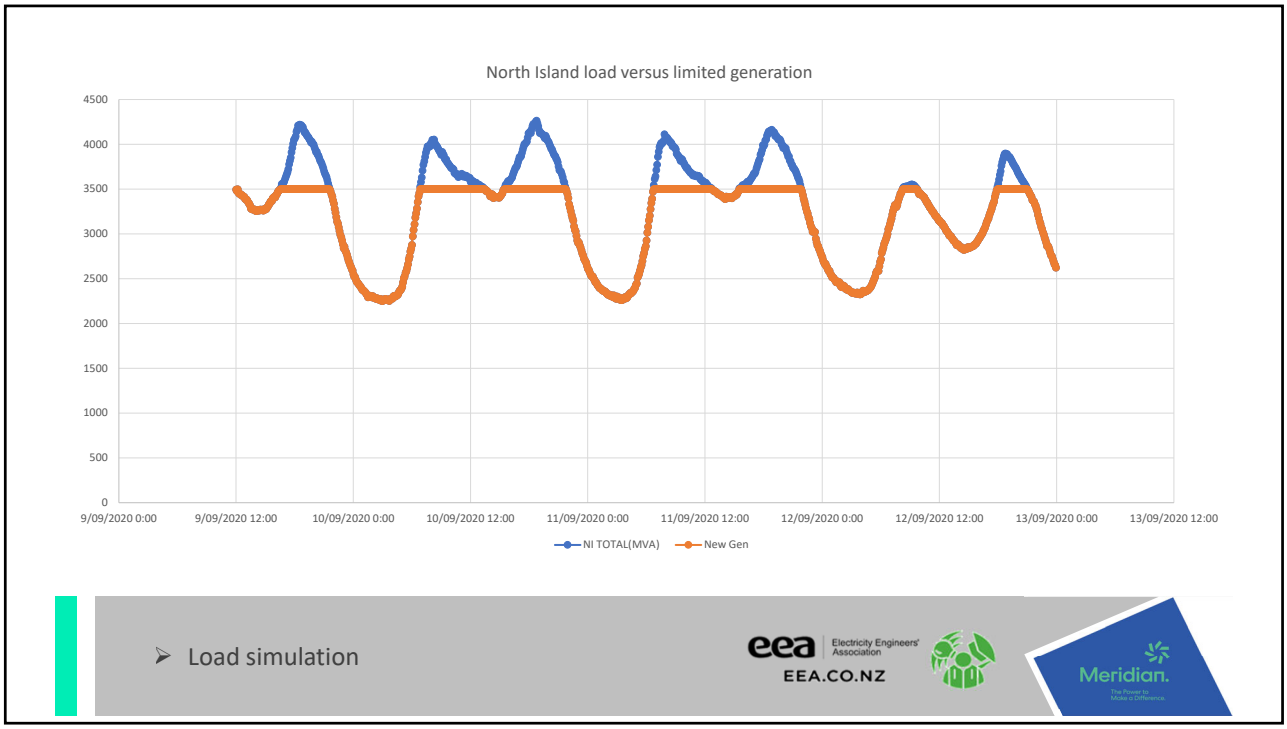
Usually requires monte carlo simulation…

Can get away with quasi-steady-state

But assumed no events occur

➢ How does the model work?

10


North Island load versus limited generation
4500
4000
3500
3000
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
NI TOTAL(MVA)
New Gen
Load simulation
eea Electricity Engineers' Association
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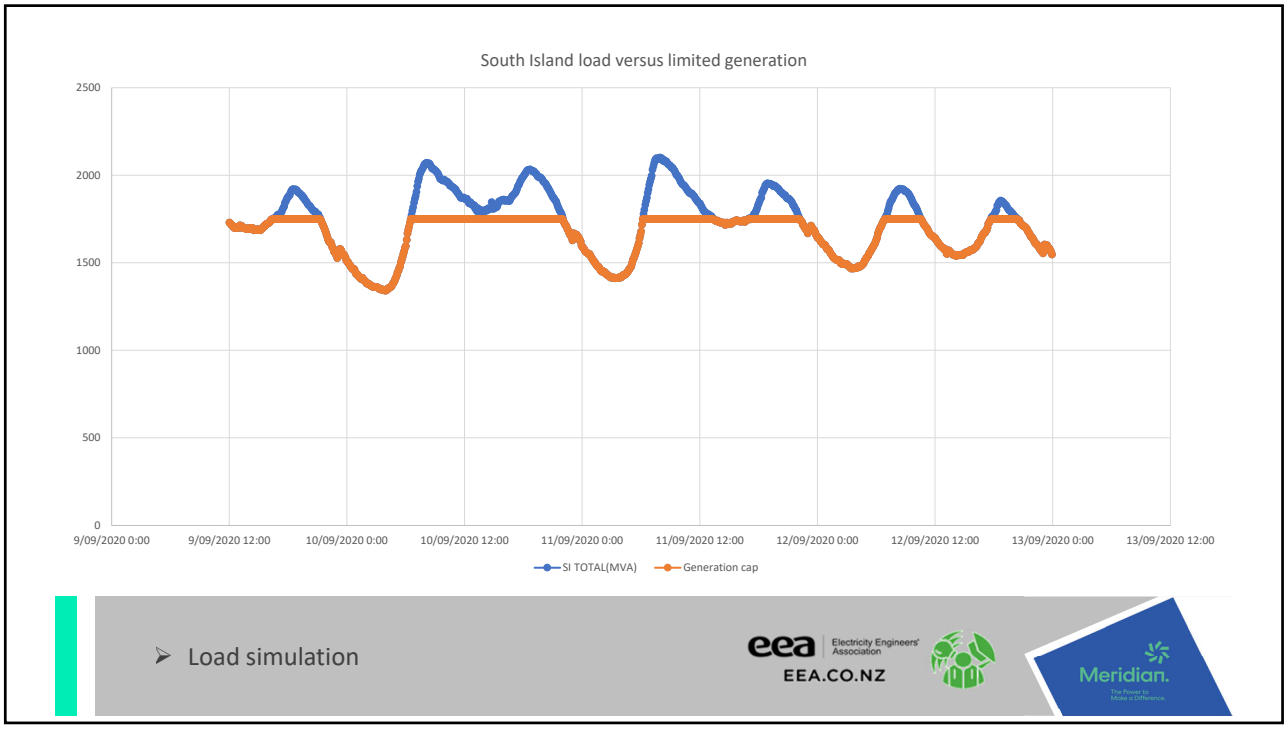
Meridian.

11


South Island load versus limited generation
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
SI TOTAL(MVA)
Generation cap
Load simulation
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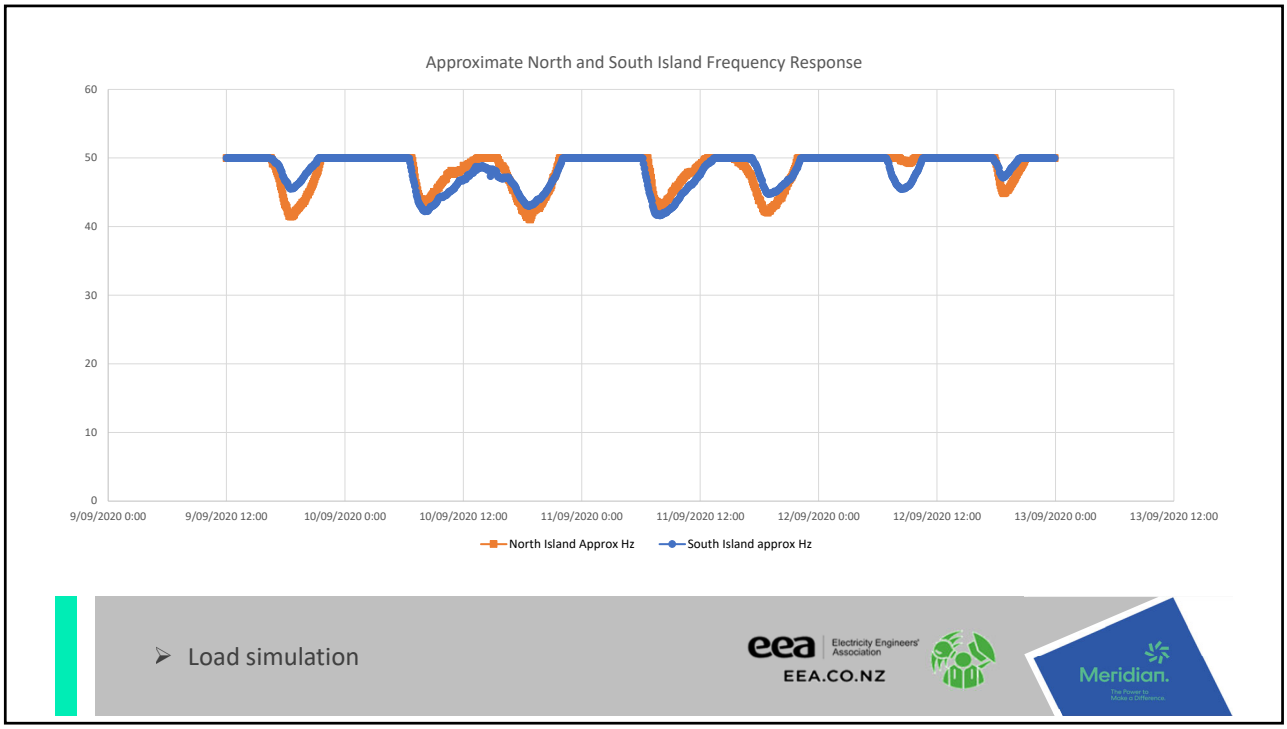
12


Approximate North and South Island Frequency Response
60
50
40
30
20
10
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
North Island Approx Hz
South Island approx Hz
Load simulation
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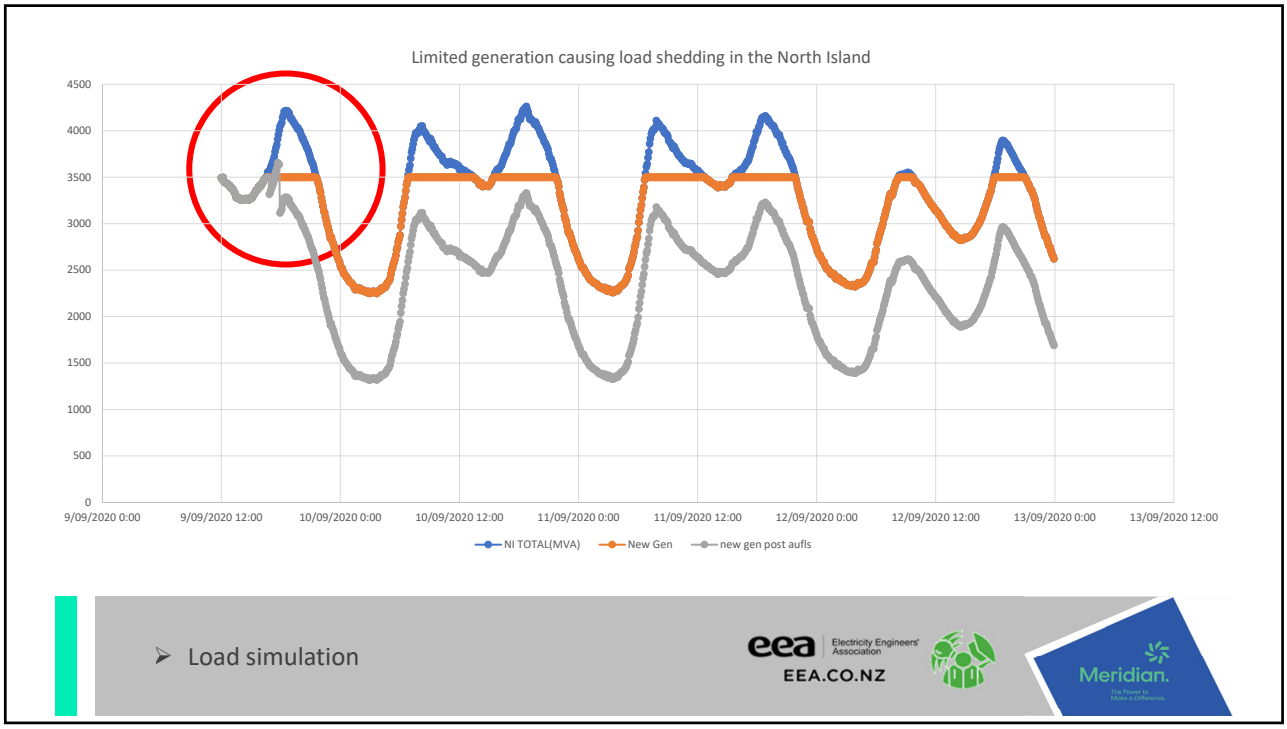
13


Limited generation causing load shedding in the North Island
4500
4000
3500
3000
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
NI TOTAL(MVA)
New Gen
new gen post aufls
Load simulation
eea Electricity Engineers' Association
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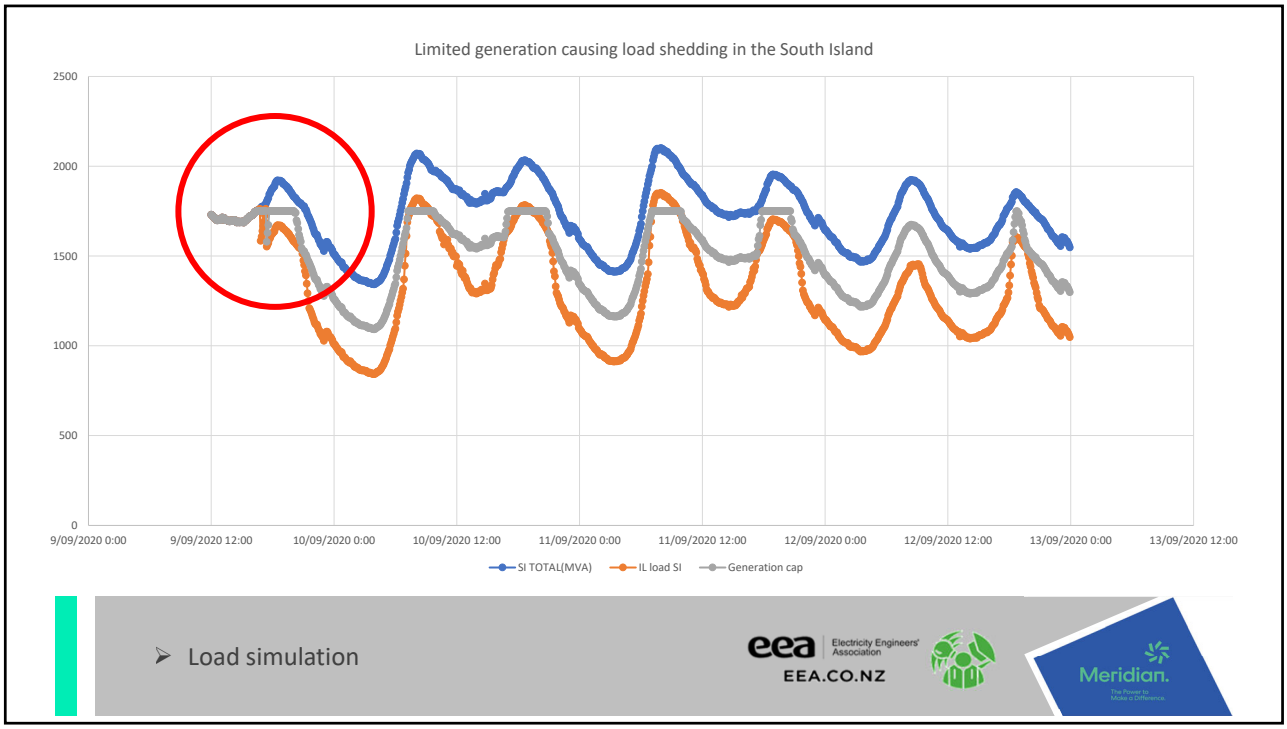
14


Limited generation causing load shedding in the South Island
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
SI TOTAL(MVA)
IL load SI
Generation cap
Load simulation
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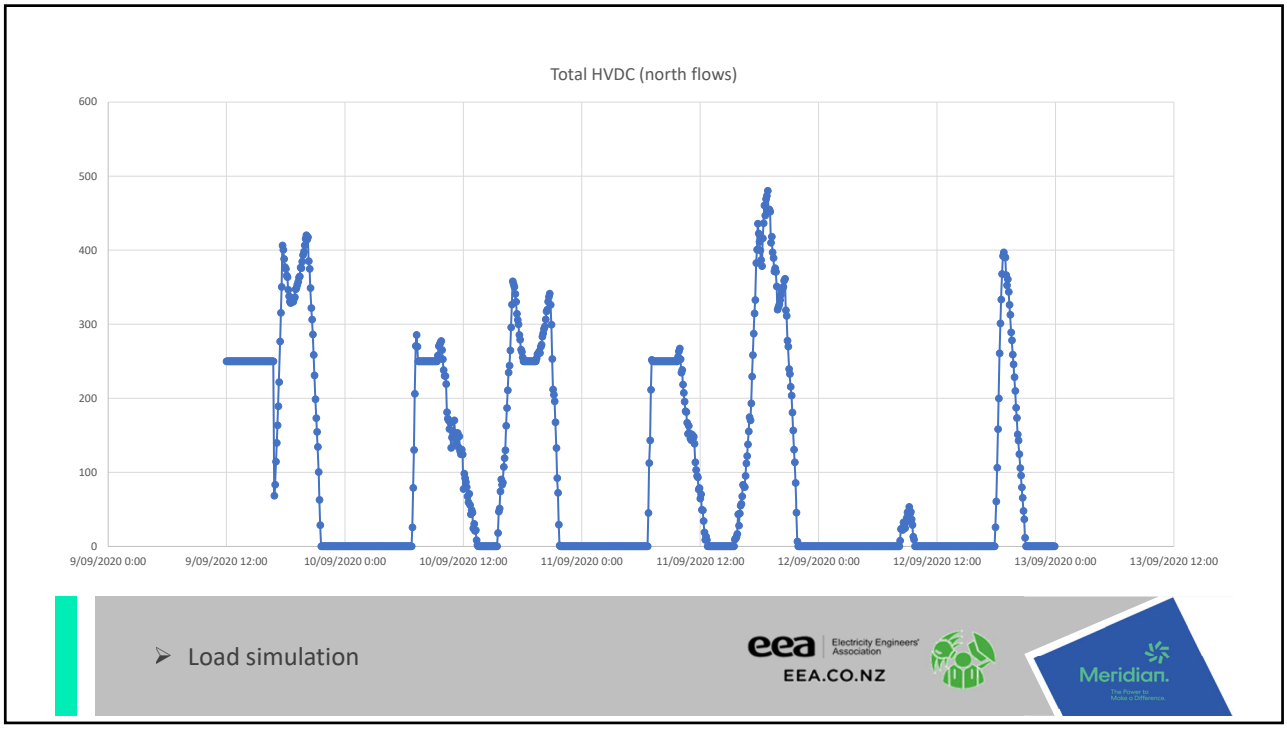
15


Total HVDC (north flows)
600
500
400
300
200
100
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
Load simulation
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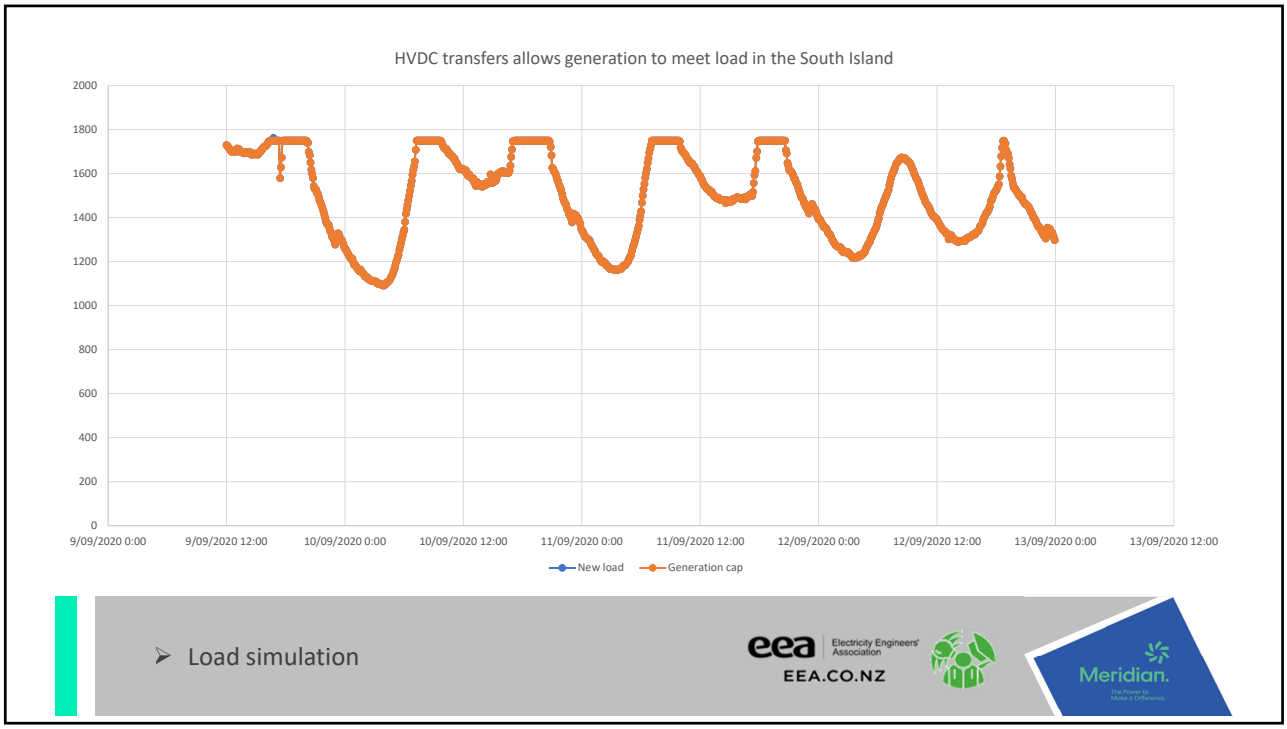
Meridian.

16


HVDC transfers allows generation to meet load in the South Island
2000
1800
1600
1400
1200
1000
800
600
400
200
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
New load
Generation cap
Load simulation
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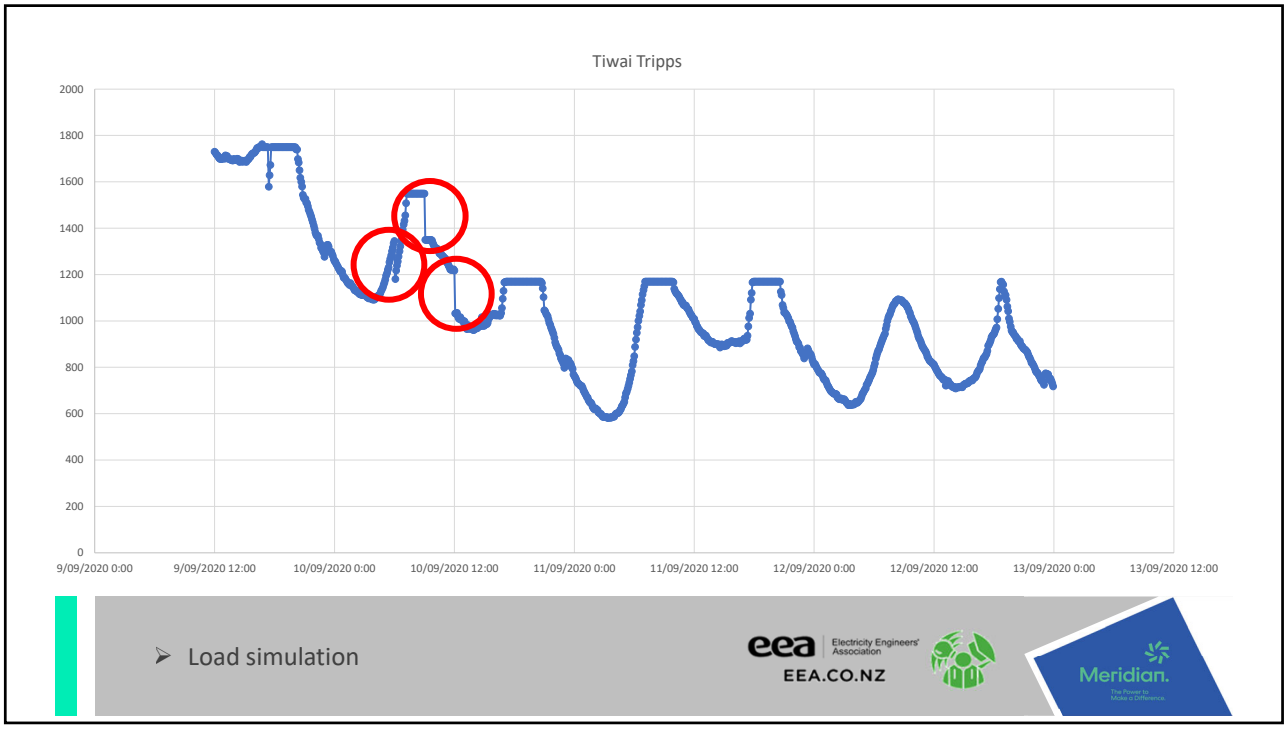
17


Tiwai Tripps
2000
1800
1600
1400
1200
1000
800
600
400
200
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
Load simulation
eea Electricity Engineers' Association
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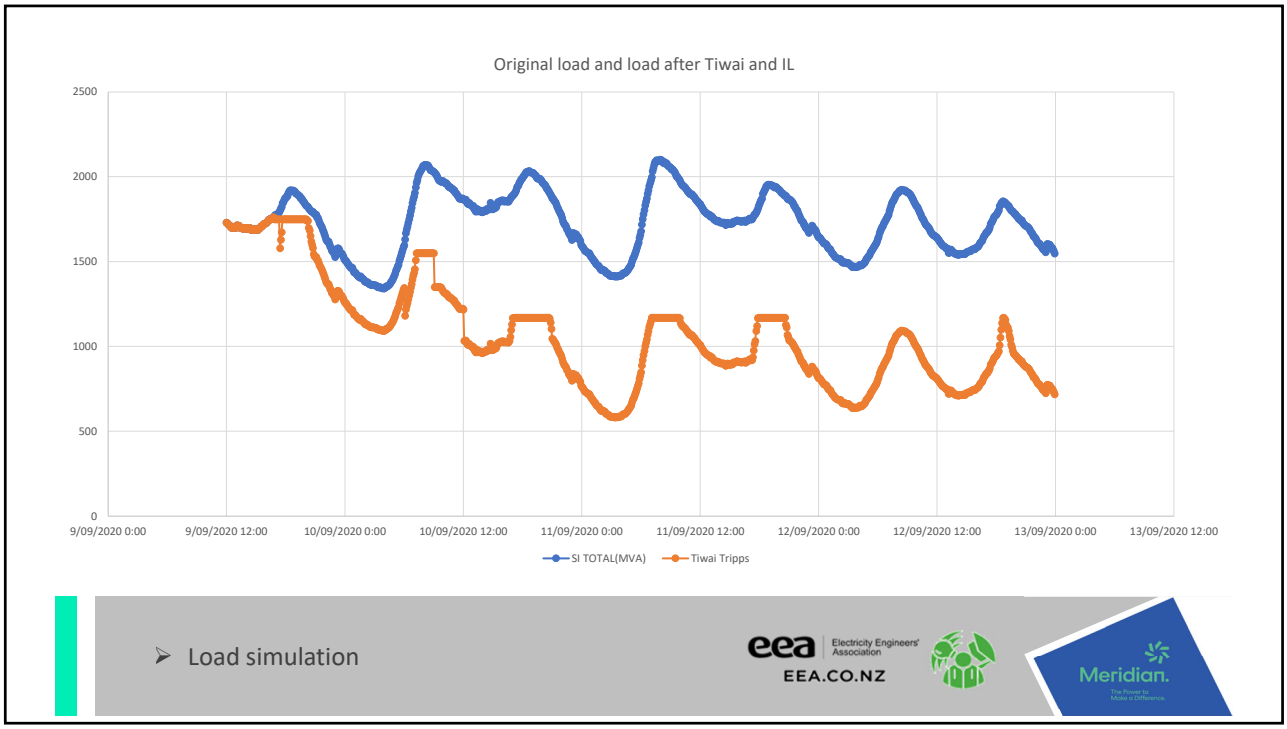
Meridian.

18



- Load simulation

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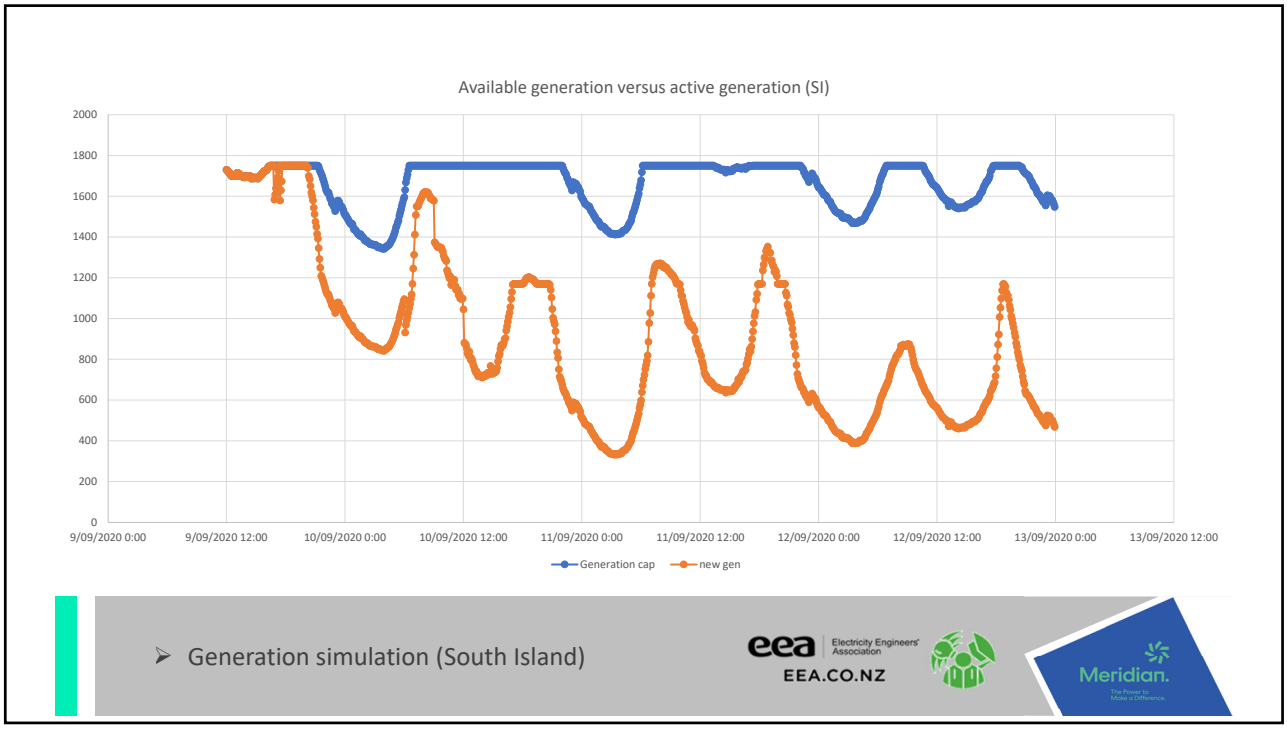
19



- Generation simulation (South Island)

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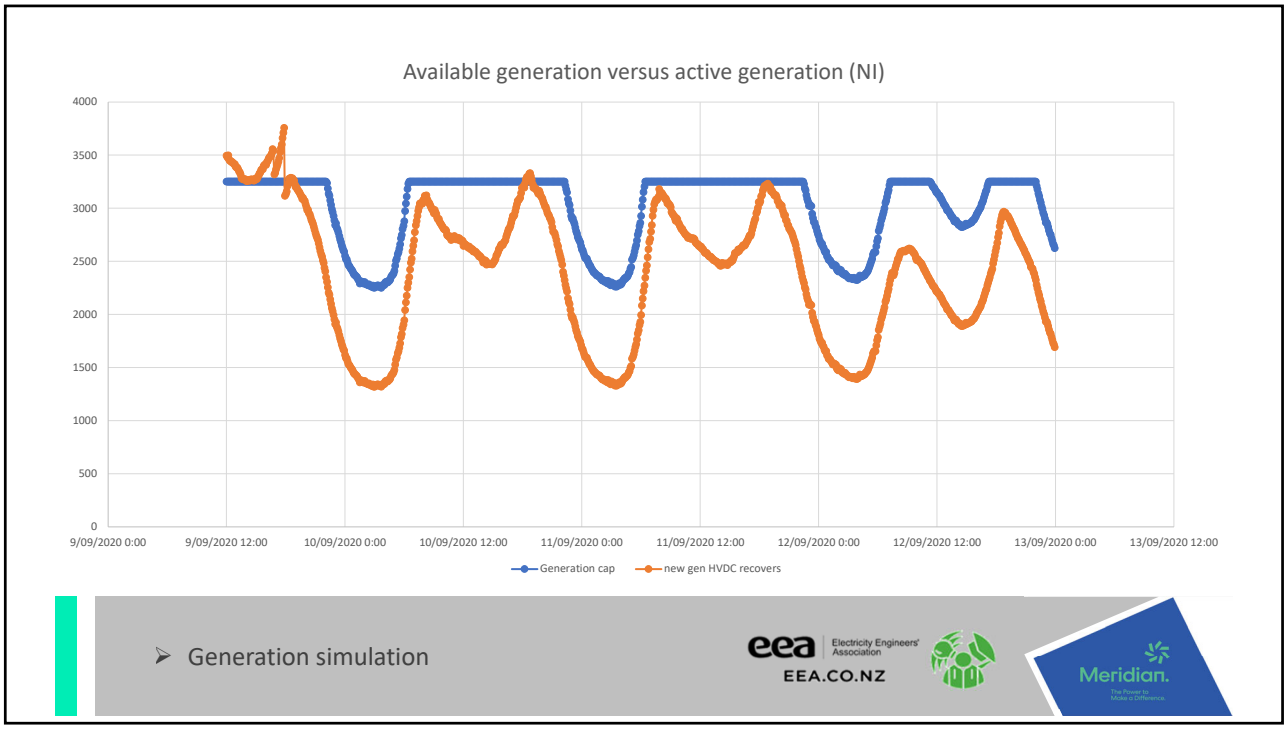
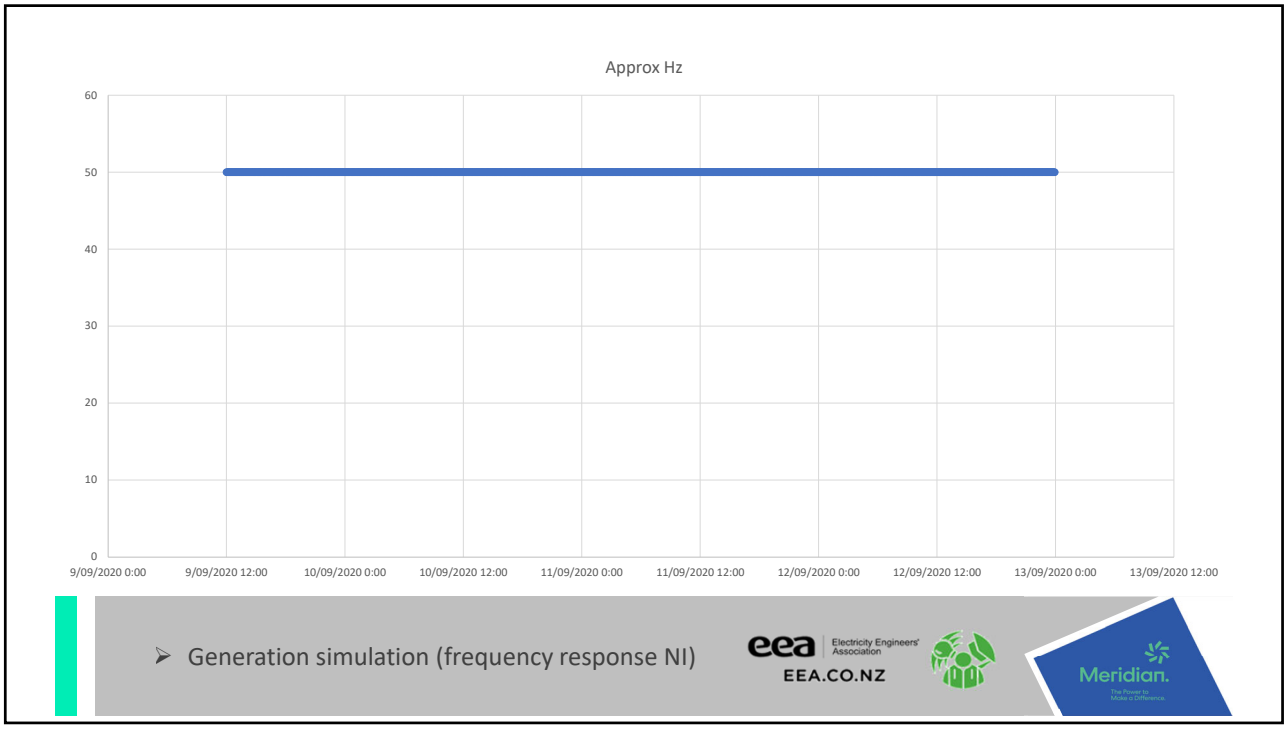
20



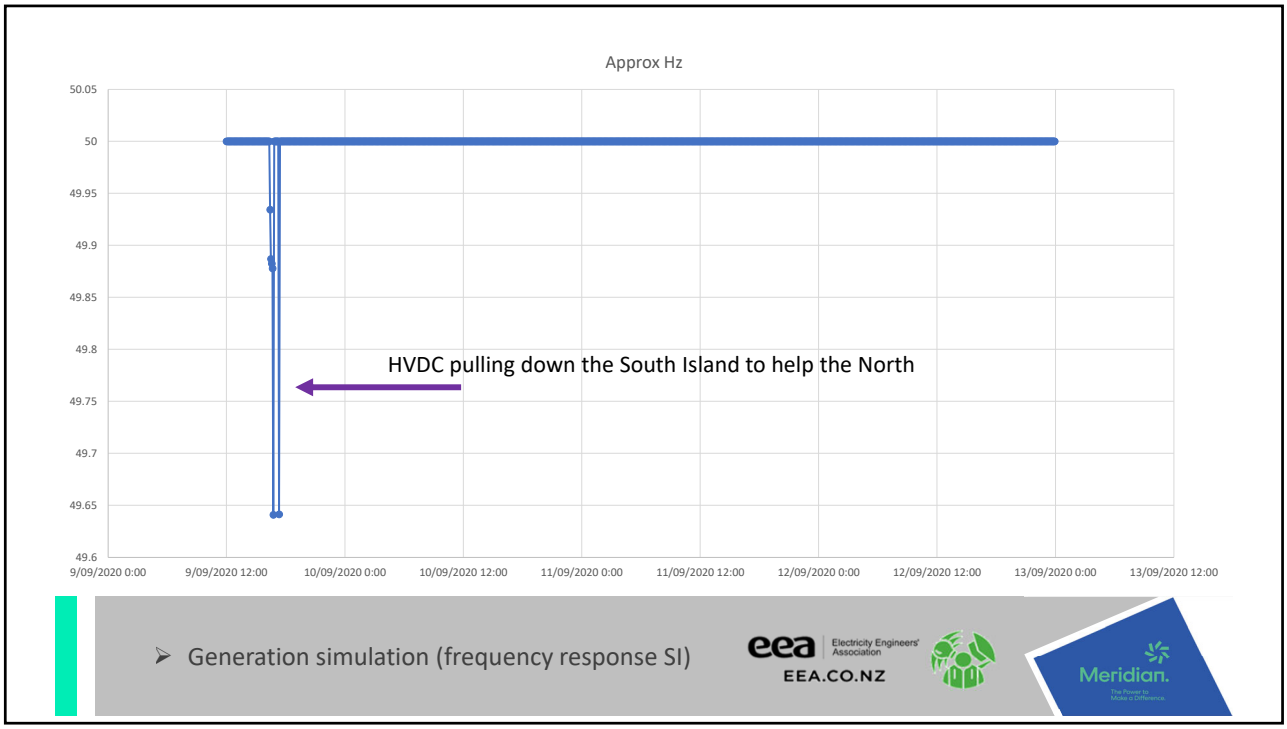
- Generation simulation

21



- Generation simulation (frequency response NI)

22



- Generation simulation (frequency response SI)

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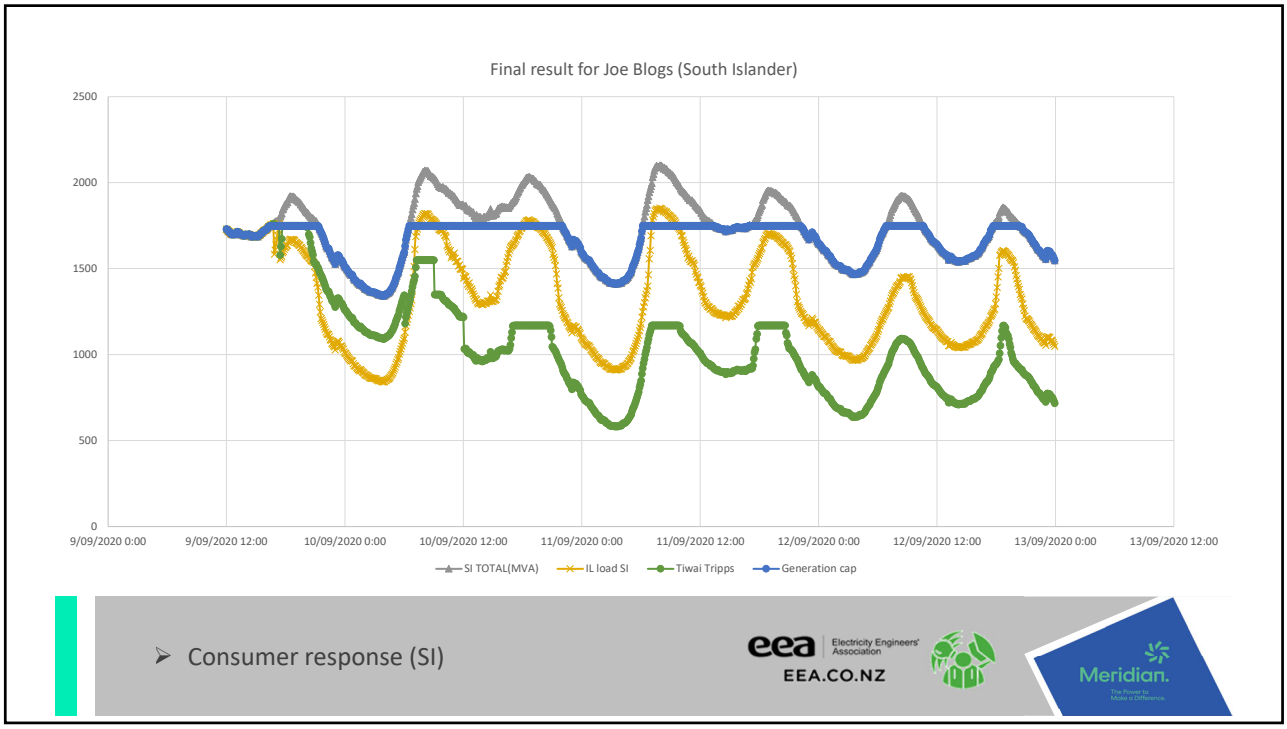
23



- Consumer response (SI)

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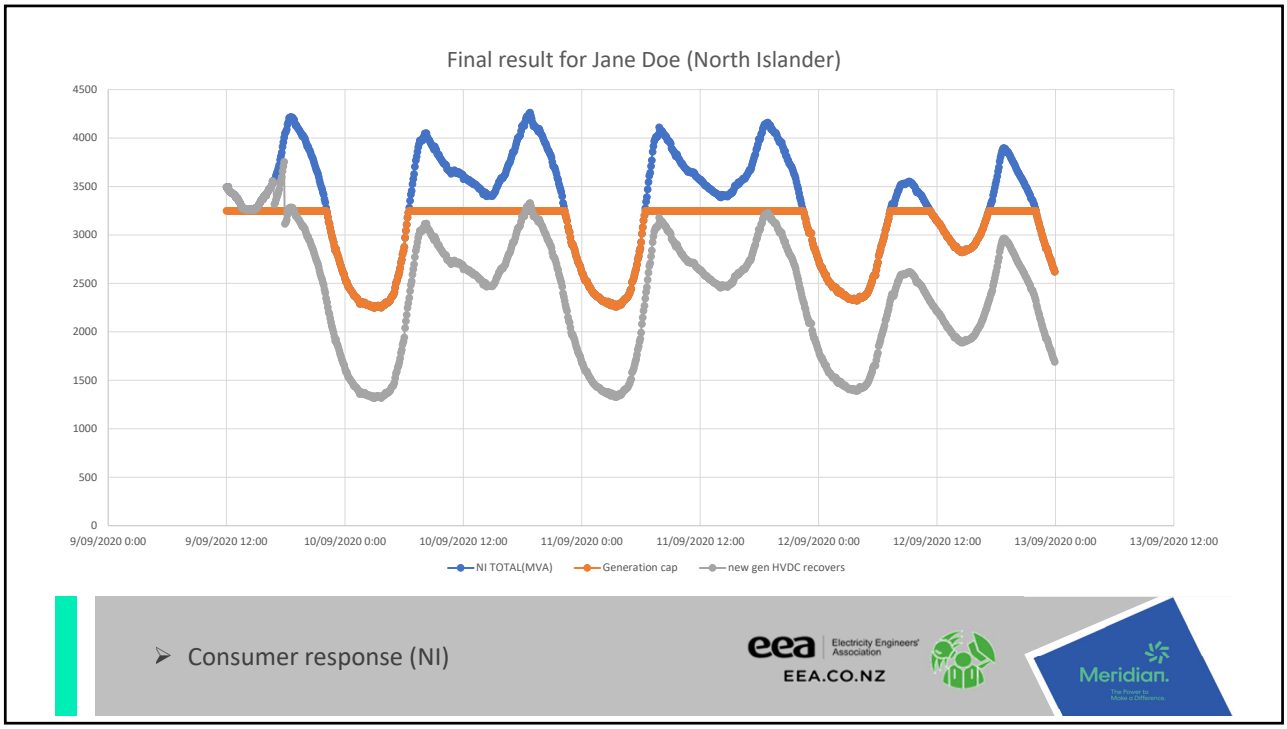
Final result for Jane Doe (North Islander)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
NI TOTAL(MVA)
Generation cap
new gen HVDC recovers
➢ Consumer response (NI)
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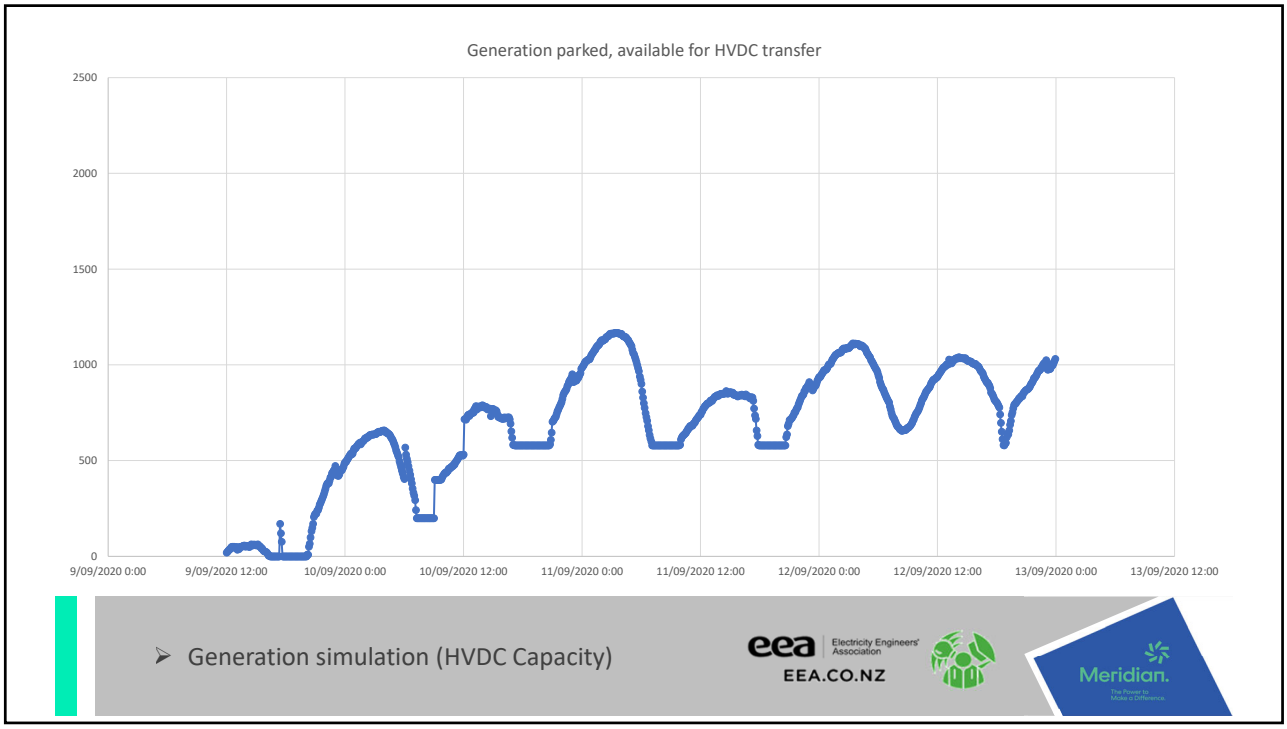
25


Generation parked, available for HVDC transfer
2500
2000
1500
1000
500
0
9/09/2020 0:00
9/09/2020 12:00
10/09/2020 0:00
10/09/2020 12:00
11/09/2020 0:00
11/09/2020 12:00
12/09/2020 0:00
12/09/2020 12:00
13/09/2020 0:00
13/09/2020 12:00
➢ Generation simulation (HVDC Capacity)
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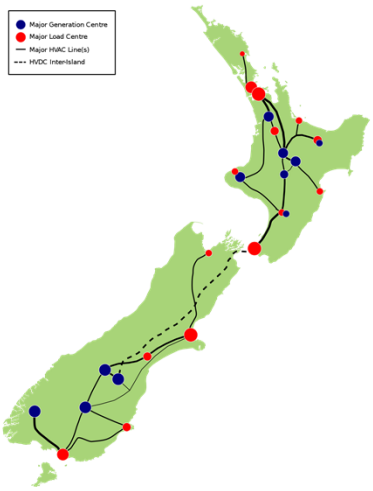
26



Lower south island stability

Voltage collapse

Frequency is proportional to rate of change of power

Thermals running out of fuel

- Model Limitations

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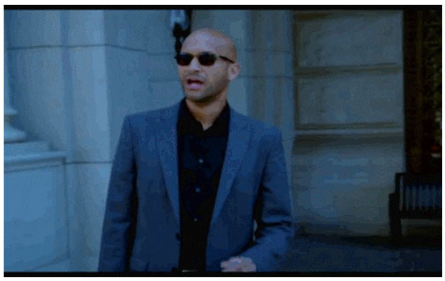
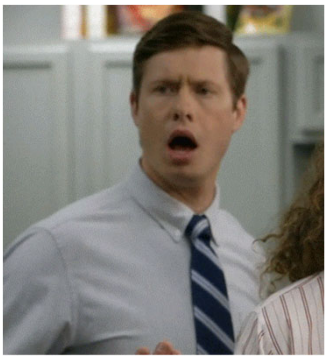
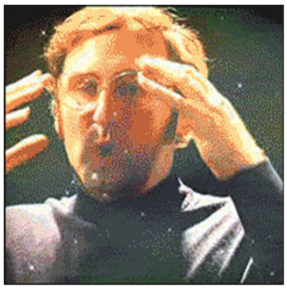
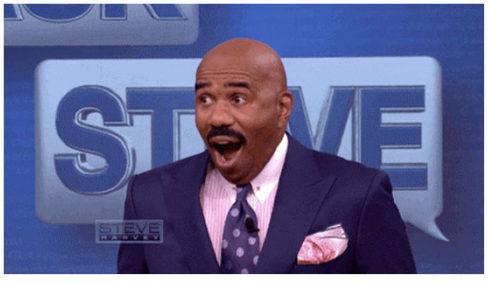
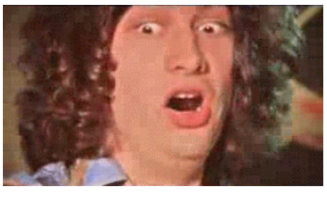
27











- Conclusions

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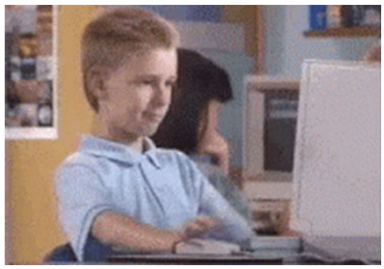
28



Rhys Bailey – Meridian GC/Trader
Rex Holmes – Ex Tiwai Operator

EIPC Documentation, “The Code” - EA
Review of instantaneous reserve markets project – EA

Data - Transpower

- References

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29

- Questions

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30