



meridian

## **Release**

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*Stock exchange listings: NZX (MEL) ASX (MEZ)*

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# Meridian Energy investor day presentation

20 November 2017

Attached is a presentation Meridian Energy is making at its investor day today.

## **ENDS**

Mark Binns  
Chief Executive  
Meridian Energy Limited

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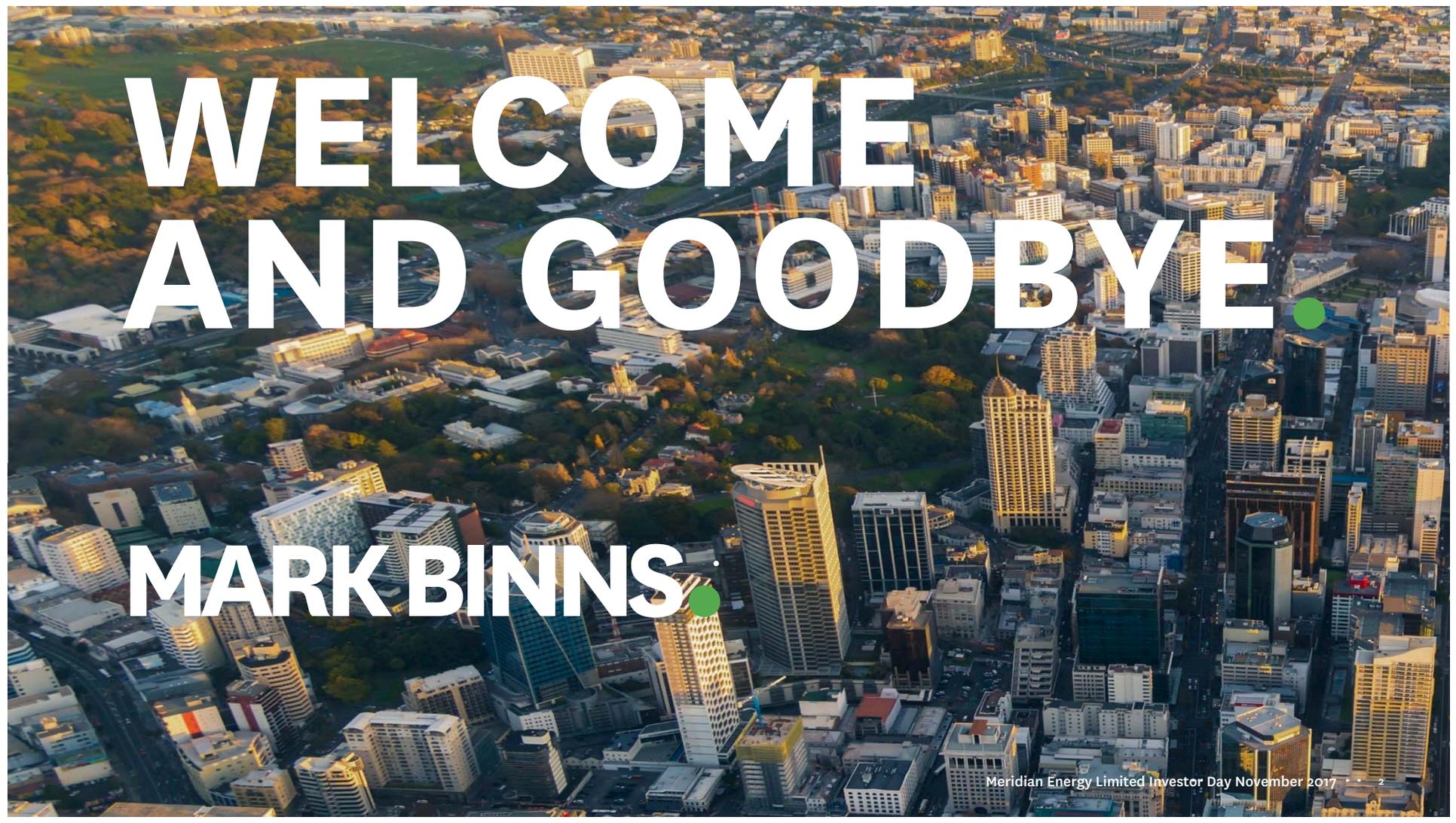
# 2017 INVESTOR DAY.



meridian

MERIDIAN  
ENERGY  
LIMITED  
MANAGEMENT  
PRESENTATION

MEMBER OF  
Dow Jones  
Sustainability Indices  
In Collaboration with RobecoSAM

An aerial photograph of a city skyline at sunset, with the sun low on the horizon, casting a warm glow over the buildings and streets. The text is overlaid in large, white, sans-serif font. There are two small green circular accents: one to the right of the word 'BYE' and one to the right of the word 'BINNS'.

**WELCOME  
AND GOODBYE**

**MARK BINNS**

# INTRODUCTION.

NEAL BARCLAY.

# Today.



**Neal Barclay**  
CEO Designate  
*Our customers*



**Richard Griffiths**  
Strategic Asset  
Manager  
*Strategic asset  
management*



**Geoffry Sams**  
Transmission  
Specialist  
*Transmission*



**Chris Moller**  
Chair



**Paul Chambers**  
CFO



**Mike Roan**  
Wholesale  
Markets Manager  
*Wholesale  
markets*



**Mat Bayliss**  
Asset Maintenance  
Manager  
*Operational  
maintenance*



**Grant Telfar**  
Strategic Advisor  
*Energy efficiency*



**Gillian Blythe**  
Strategy Manager



**Janine Crossley**  
Treasury Manager



**Guy Waipara**  
General Manager  
Markets &  
Production  
*Managing our  
portfolio*



**Jon Spiller**  
Transmission  
Manager  
*Transmission*



**Dr Jen Purdie**  
Portfolio and Fuels  
Advisor  
*Climate variability  
and change*



**Owen Hackston**  
Investor Relations  
Manager

Also attending

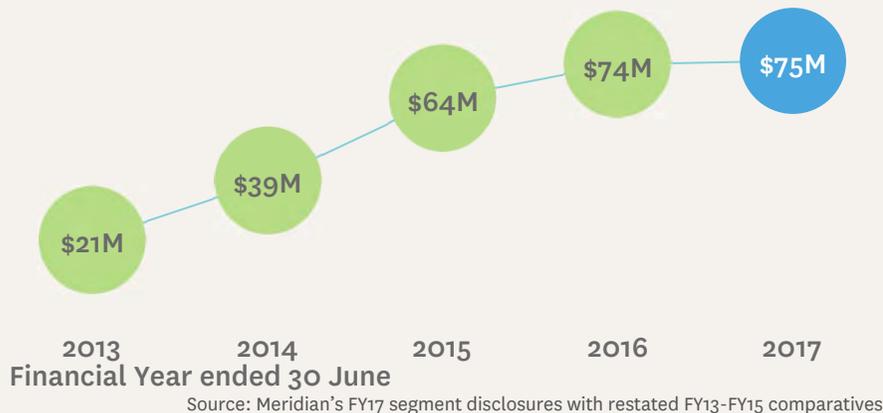


**OUR  
CUSTOMERS.**

**NEAL BARCLAY.**

# Value of our customers.

## RETAIL SEGMENT PROFITABILITY



## Historical earnings growth

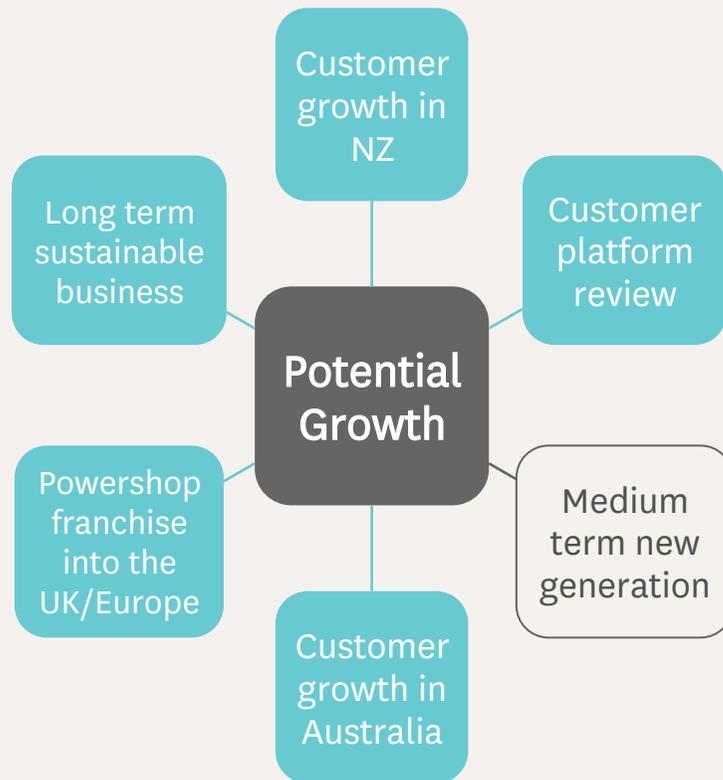
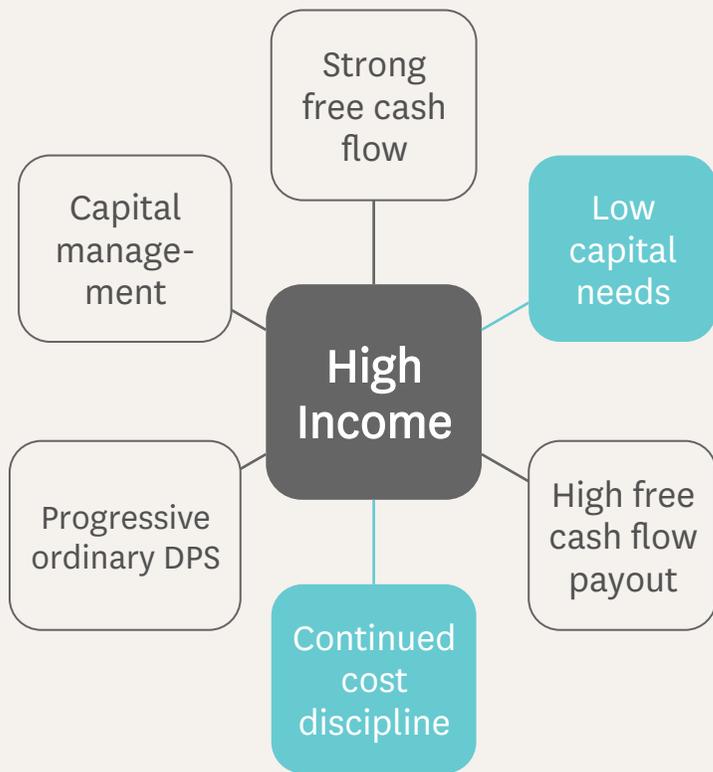
- Source of earnings growth in the low demand growth New Zealand market

## Vertical integration

- Provides wholesale market hedge against spot market variability
- Insulates earnings against unexpected shocks in the wholesale market

# Value of our customers.

## Sources of shareholder value



# Customer brand strength.

High level of awareness relative to market share, authentically sustainable

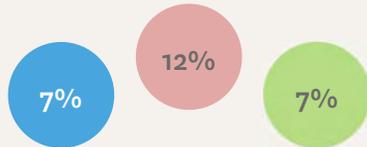


# Customer growth.

- High residential awareness, underweight residential position
- Additional load from back-to-back agreements
- Growth aspirations in all segments including commercial solar
- Examining synergies between Meridian and Powershop platforms
- More integrated go-to-market plan for two brands
- Churn improvement remains a focus

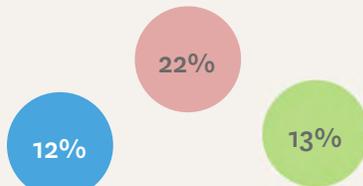
## ICP CHURN

% TRADER SWITCH



Meridian Powershop Industry

## MOVE-IN SWITCH

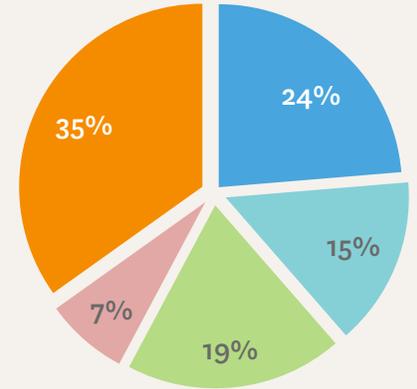


Meridian Powershop Industry

Source:  
Electricity  
Authority

## FY2017 NZ RETAIL SALES EXCL. TIWAI

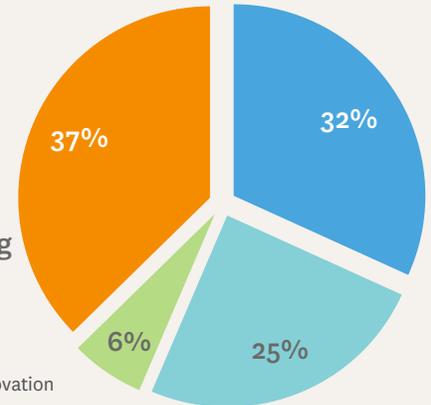
- Residential
- Small/medium business
- Agricultural
- Corporate/large business
- Industrial



Source: Meridian

## FY2017 NATIONAL CONSUMPTION

- Residential
- Commercial
- Agriculture/ Forestry/ Fishing
- Industrial



Source: Ministry of Business, Employment & Innovation

# Australian scale.

## AUSTRALIAN CUSTOMERS



Source: Meridian

- Aspiration to significantly grow Australian customer base
- Needs to be backed by more generation
- PPA process is well advanced
- Direct generation investment possible under the right commercial terms
- Planning dual-fuel offer into Victoria

# Powershop UK.

- Powershop platform and brand franchised to nPower
- 14,000 nPower ICP's through energy only soft launch
- Dual fuel functionality by January 2018
- White label offers launched
- Customer uptake dependent on nPower's sales and marketing
- Exploring mainland Europe opportunities with nPower's parent company, Innogy



# Our approach to innovation.



## Systematic approach

- Significant review and analysis of new technology and customer changes
- Selective scope
- Test and trial approach, quick start and stop (if needed), low investment
- Global insights from three 'natural labs'

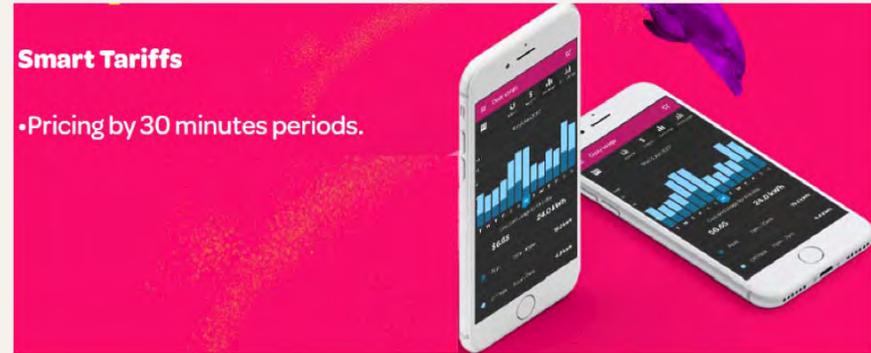


# Innovation in NZ.

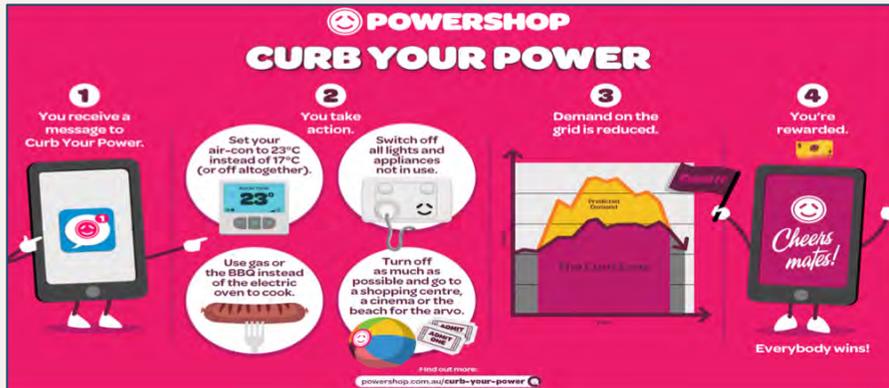
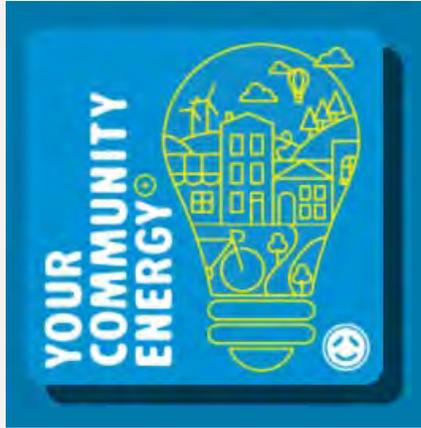
- Separate software development business with international focus



- Significant Meridian digital investment creating a quality customer experience
- Powershop is a true native digital business, well placed for transformation
- SmartHome and Smart Tariffs recent examples to go to market



# Innovation in Australia.



A more disruptive market than New Zealand

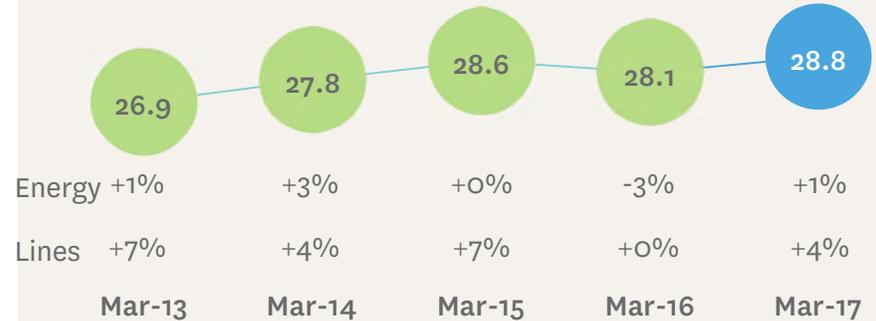
- Powershop is well positioned
- Powershop helping customer participation in neighbourhood generation and community energy projects
- Both through tariff redistribution
- And initiatives incentivising customers to reduce consumption

# The political scene.

## New Zealand

- Positive on the new Government's proposals, plenty of detail to engage on
- Conversion of the Government car fleet to electric by 2025/26 will strengthen EV takeup
- Meridian is highly supportive of an Independent Climate Commission
- Case for fairer transmission charging remains compelling
- Greater focus on water quality
- Resource rentals for water is complex, we are supportive of a holistic, equitable approach
- Retail pricing could benefit from addressing misdirected low user charges

## AVERAGE RESIDENTIAL ELECTRICITY COST c/kWh



Source: Ministry of Business, Innovation & Employment

# The political scene.



Image: Australian Prime Minister Malcolm Turnbull (L) and Leader of the Australian Labor Party, Bill Shorten (R)

## Australia

- Market is slow to commit to new renewables due to the lack of coherent energy policy
- Electricity is highly politicised, with significant potential developments in the near term:
  - VIC Government reponse to Thwaites Review on re-regulation
  - COAG Energy Council meeting on the NEG and AER investigation into NSW generator bidding
  - AGL response to Federal Government on Liddell power station
  - ACCC's continuing enquiry into electricity prices
  - Details on the VIC Government's renewable energy auction

# Summary.

- Greater focus on our customers
- To realise potential growth in multiple countries
- With continued discipline on cost management and customer innovation
- While protecting shareholder value in our core business
- Enduring commitment to sustainability, staff wellbeing, process safety and customer experience



Image: One of Meridian's pure electric Hyuandi IONIQ fleet vehicles



# NZ WHOLESALE MARKETS.

MIKE ROAN.

# Overview.

- “New Zealand is a world leading example of a well functioning electricity market...”  
2017 NZ Energy Policy Review – International Energy Agency
- “...strong improvement across the three key outcomes of competition, reliability and efficiency...”  
2017 Electricity Authority Annual Report



# Key market reforms.

- 2008 'dry year' and subsequent Ministerial Review
- ASX – standardised forward market
- Pole 3 – improved market flexibility & risk management
- Financial Transmission Rights (FTRs)
- ASX Monthly Products – short term standard products to price hydrology
- Spot Market Gate reduces from 2hrs to 1 hr
- Today: 35 retail brands  
Security of supply  
Very competitive retail market  
25 generating companies  
47 traders participating

## ASX Commences – April 2011

- Liquidity

## Pole 3 Commissioned – May 2013

- NZ-wide competition emerges

## FTRs – June 2013

- Emergence of basis products

## ASX Monthly Products Arrive – Dec 2013

- Additional liquidity (in prompt months)

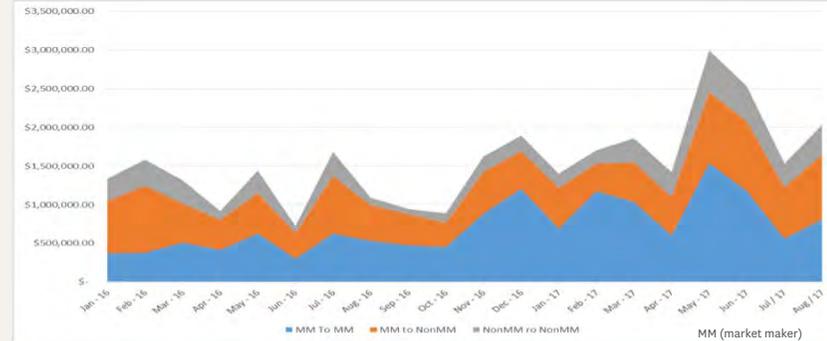
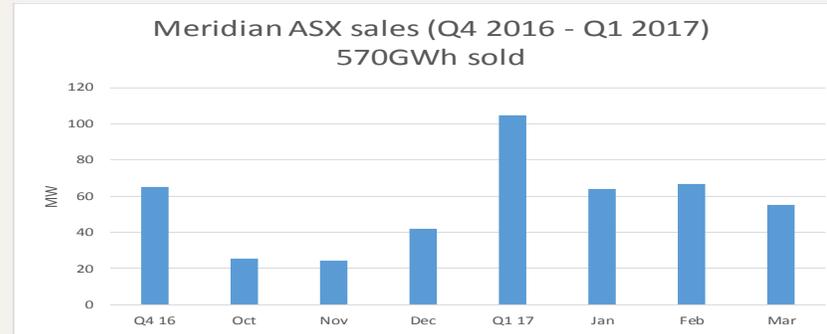
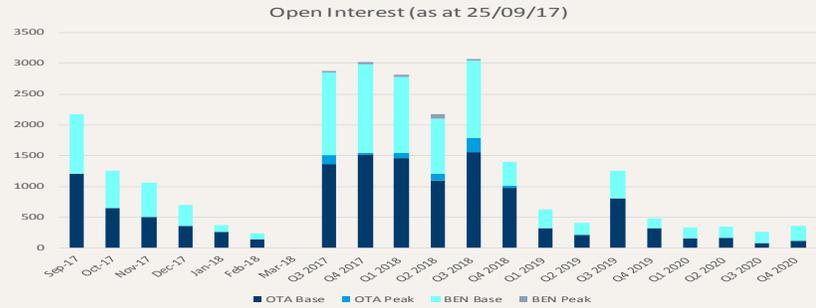
## Gate Closure to 1 Hour – June 2017

- Spot market price efficiency improves

# ASX forward market.

The forward market is very effective

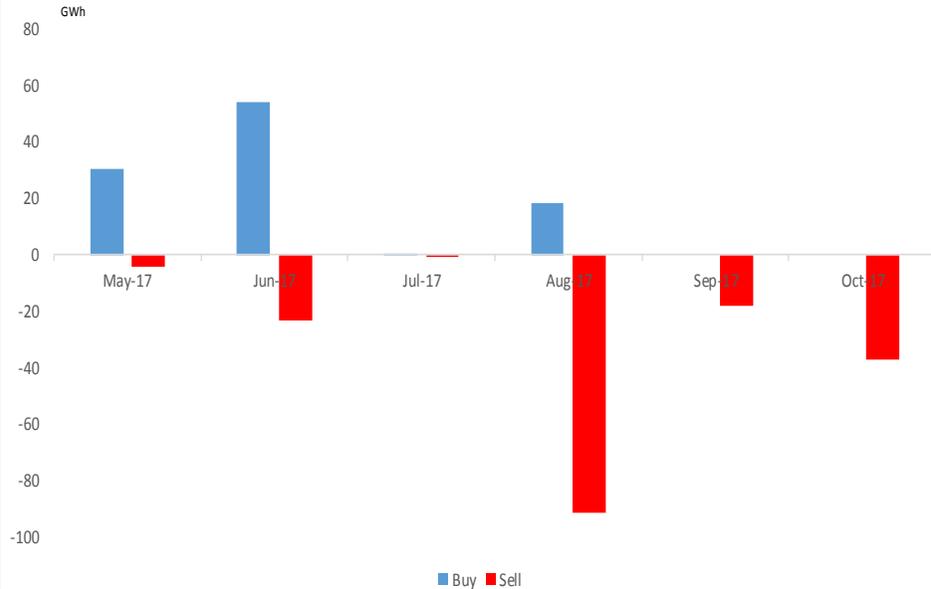
- Liquidity exceeds initial targets
- Monthly products provide ability to hedge seasonal shapes (and enhance liquidity)
- Meridian has sold over 100MW on ASX in various quarters
- Others use this market to hedge effectively as well



Source: ASX

# Over the Counter (OTC) market.

OTC Sale/Purchase Volume - May-Oct17



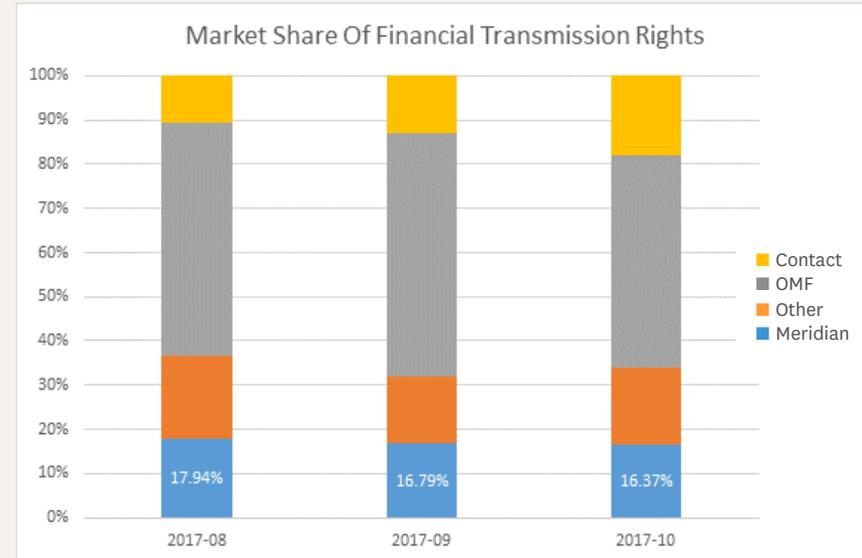
Source: Meridian

OTC market emerged following ASX

- Used for short term hedging
- Brokered and bilateral (direct)
- Products are typically bespoke
  - Large hedging transactions (i.e. 10MW +)
  - Unit outage hedges
  - Shaped retail hedges
  - Specific risk instruments like our swaption with Genesis

# Financial Transmission Rights (FTRs).

- Instrument that manages price risk between nodes
- Meridian is one of the largest participants
  - Should not be a surprise with our South Island hydro generation and distributed customer base
- FTRs are effective baseload products
  - FTRs manage underlying basis risk
  - FTRs do not manage peak or other basis risks, OTC (and spot) market products are designed to do this



Source: Meridian

# 20 years of spot market trading.



Image: Meridian's Wellington trading room

- Spot market prices provide an index for most contracts
- Efficiency and reliability of these prices builds support for contracting
- Enabling changes to offers/bids as close to real time as possible improves price formation
  - Spot market is the central market
  - Spot market flexibility allows participants to adjust positions
  - The move from 2 hours to 1 hour went very smoothly
- We will ask the EA and System Operator to consider reducing it further to 30 minutes

# Summary.

- Wholesale markets are competitive and effective
- The addition of ASX, OTC and FTR markets in particular drive greater competition
- Meridian participates in all markets to manage its portfolio
- The Electricity Authority is acknowledged internationally as an effective market operator



Image: Meridian's Wellington trading room



# MANAGING OUR PORTFOLIO.

# GUYWAIPARA.

# Overview.

## Generation and sales portfolio

- Bowtie framework
- Modified to cover observed behaviour
- Optimising real time hydro dispatch

## 2017 review

- Statistics
- Managing risk and storage
- “Hindcast” results
- What did we learn?

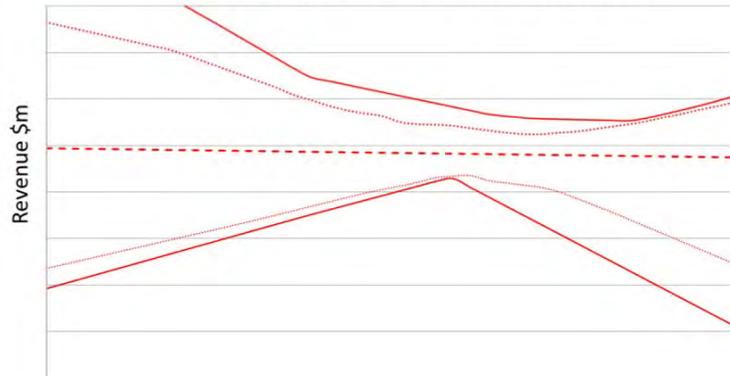


Image: Lake Pūkaki and Genesis Energy's Tekapo B station, June 2017

# Bowties.



Profile of revenue distribution vs contract position



Contract Book GWh

Source: Meridian

## Whole of NZ construct

- Demand (including demand response)
- Supply (including plant reliability)
- Hydrology
- A simplified regional transmission system

## Our objective

- To find the portfolio or contract position that delivers the maximum revenue, with the minimum distribution, across the hydrology outcomes we expect to experience
- Guides our three-year portfolio planning and is integrated across all of our wholesale and retail sales channels

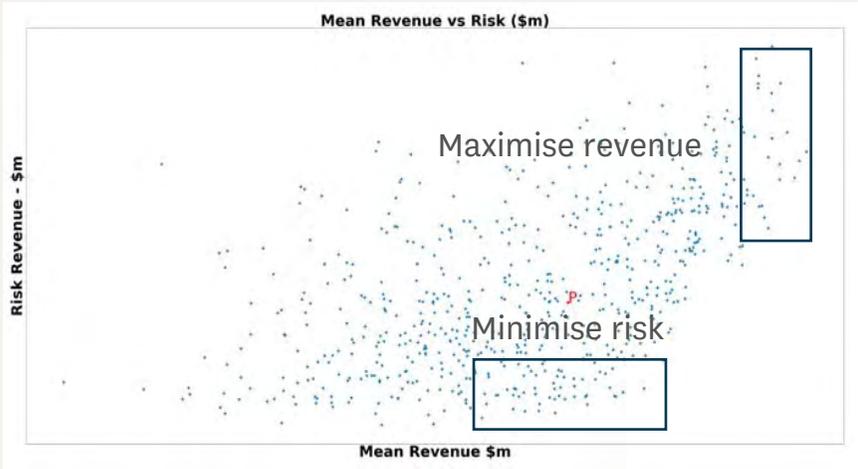
# Reflecting market behaviour.

## Impact of contract positions

- Observations are that parties' behaviour is affected by their respective contract positions
- Have developed our models to include the best information we have on our and others' contract positions
- Still includes an opportunity cost of water to ensure that hydro storage is managed efficiently within its full operating range (from spill to shortage)



# Next evolution.



Source: Meridian



Image: NZAS  
aluminium smelter,  
Tiwai Point

The bowtie neck has a reasonable range

- So there are a number of “optimal” contract positions
- Doing more work to test what position(s) deliver improvements in mean revenues while minimising variability
- Early results look like we have more capacity to sell above our current contract position without incurring more risk
- The NZAS back-to-back contracts have also created more sales headroom

# Moving closer to real time.

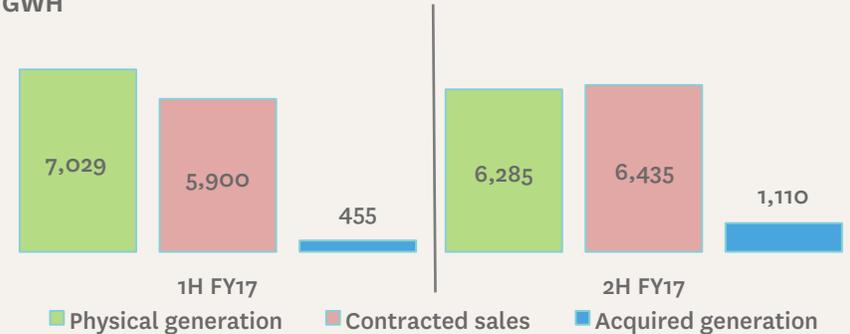
How we adjust the portfolio to reflect near-term conditions

- Even with what may look like a conservative portfolio, we can find ourselves long generation (first half of 2017) or short generation (second half of 2017)

When average doesn't show up...

- It is important that all wholesale and retail sales are well co-ordinated
- Models are run weekly with weekly energy targets delivered to our traders. Pricing guidance is provided to retail C&I sales
- Executive portfolio committee meets monthly to oversee execution of the plan
- During times of hydro stress this committee is updated weekly

## GENERATION AND CONTRACTED SALES GWH



Source: Meridian

# Within a week, up to real time.

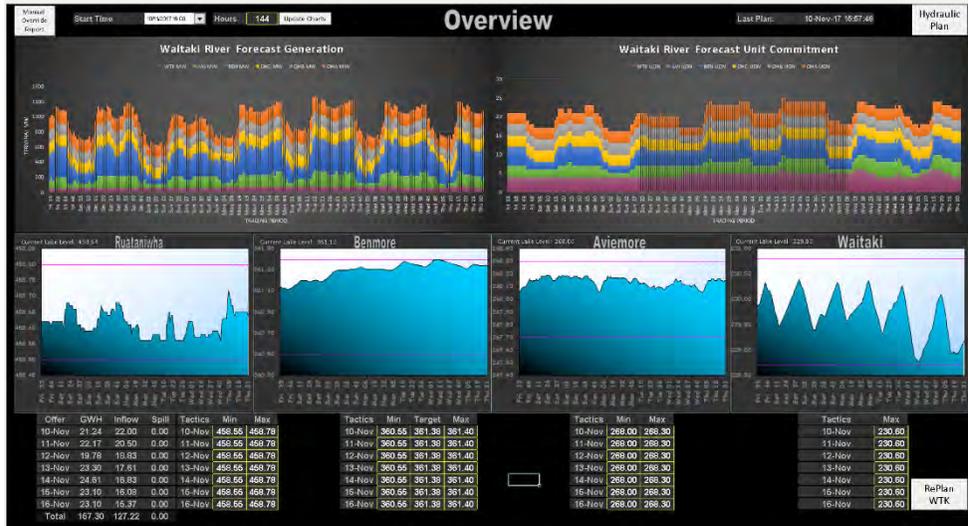
Hydro optimisation continues right up to real time

- Waitaki is block dispatched
- Optimising lake levels across the chain means you can get the best water to wire efficiency (remember  $E_p = mgh$ ?)

What we have achieved

- Developed in-house tools to optimise hydro production to deliver weekly targets across a range of inputs, including:
  - Weekly energy, outages, generation efficiency, ramp rates, lake levels, flow and lake level constraints, expected inflows
- Estimated \$3m pa improvement
- Also delivers consistency in operations across all Generation Controller staff

Source: Meridian's hydro optimisation tools





# 2017 IN REVIEW.

# 2017 key statistics.

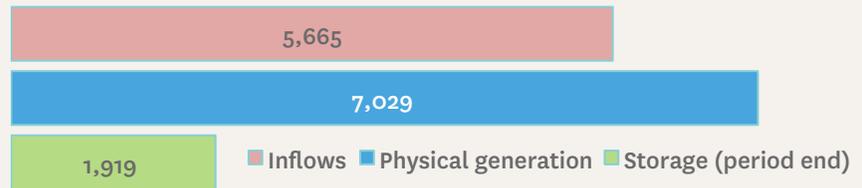
## First half FY17

- Inflows 96% of average
- Generation 3% above FY16
- \$44/MWh average generation price
- Storage 118% of average at end of December 2016

## Second half FY17

- Inflows 78% of average
- Generation 8% below FY16
- \$59/MWh average generation price
- Storage 55% of average at end of June 2017
- February to June 2017 were the lowest same-period inflows on record

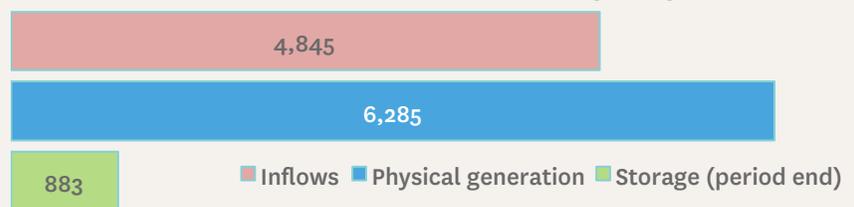
### INFLOWS, GENERATION, STORAGE 1H FY17 (GWH)



### MERIDIAN'S WAITAKI STORAGE 1H FY17 (GWh)



### INFLOWS, GENERATION, STORAGE 2H FY17 (GWH)

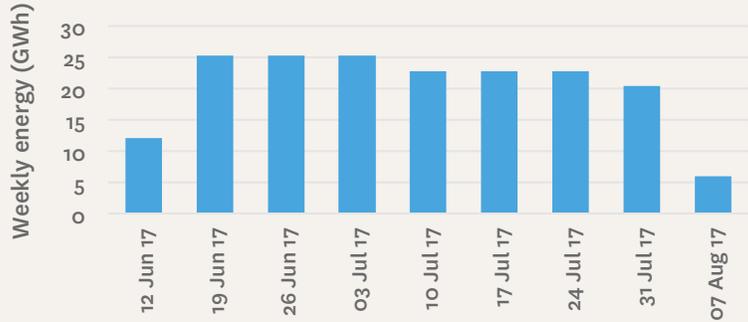


### MERIDIAN'S WAITAKI STORAGE 2H FY17 (GWh)



# Managing risk.

## GENESIS SWAPTION VOLUMES



Source: Meridian

## BENMORE ASX FUTURES SETTLEMENT PRICE



Source: ASX

## Commercially

- Called the Genesis Swaption between June and August 2017
- Were able to delay calling this as we had better offers available earlier on
- ASX and OTC liquidity meant we had a range of options
- Still had the smelter demand response available to call if necessary
- Swaption flexibility significantly improved our risk management tool set. Benefit to having 50 MW tranches with relatively short call periods
- NZAS backing contracts plus the swaption has significantly reduced Meridian's risk position

# Storage management.

## Even at the end of the dry period

- Portfolio could still be covered with minimal risk of hitting the bottom of Pūkaki
- At 21 July still 10x more likely to spill (34 sequences) than to even use contingent storage (3 sequences)
- The effect of the Swaption is to reduce the risk significantly (200 GWh lift in 5<sup>th</sup> percentile)

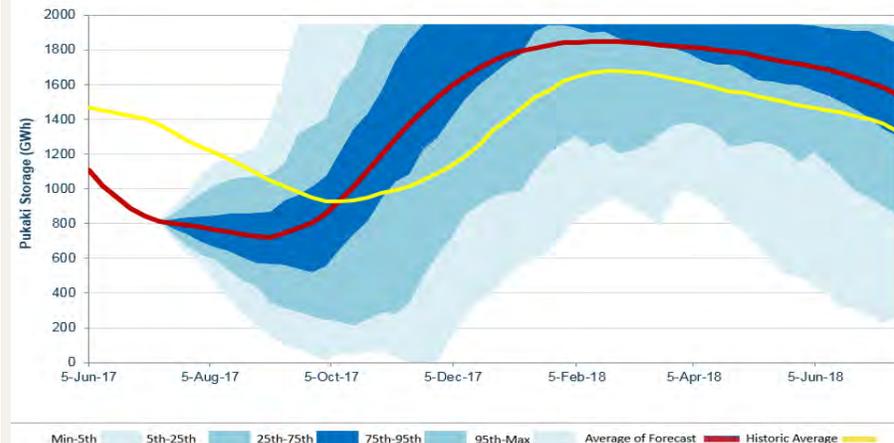
## Take outs

- Portfolio is robust and has changed with NZAS contracts
- Still had more insurance options over and above the Swaption
- These facts seemed to surprise some stakeholders
- Ongoing information sharing was key

## Theoretical storage energy balance

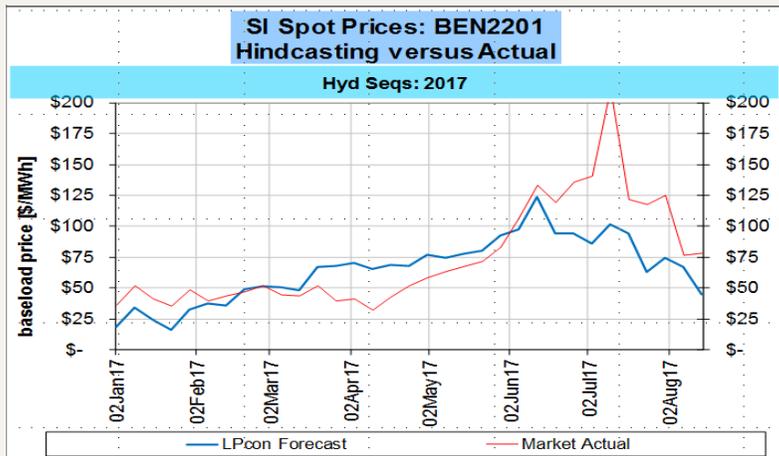
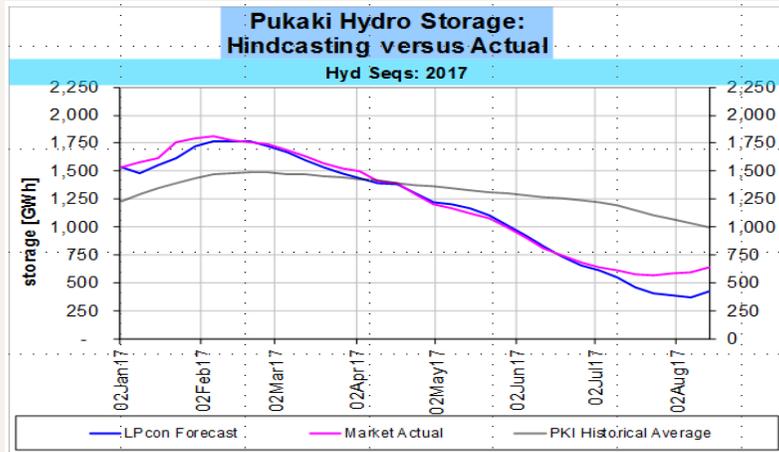


Source: Meridian Lake Pūkaki projected storage from July 2017 without Swaption volumes



Source: Meridian Lake Pūkaki projected storage from July 2017 with Swaption volumes

# A “Hindcast” comparison.



## What is a Hindcast?

- A comparison of what occurred with what perfect competition would have delivered

## Why is it important?

- Provides an analytical framework to test whether the market has delivered an efficient outcome for consumers
- Is a good proxy for a regulatory test and informs questions such as:
  - Is a company using storage too conservatively or aggressively?
  - Do market prices reasonably reflect scarcity?

## Results

- Hydro storage and market prices consistent with expected outcomes from a perfect market
- If anything, slight risk aversion in our storage use

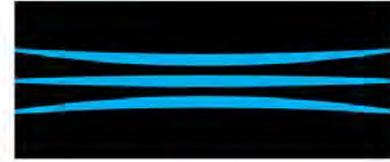
# Engaging with stakeholders.

## Transpower

- Engaged early to discuss hydrology, water values and plans
- Considered a change to contingent storage – but decided to put off until a review was completed
- Reviewing their security of supply policy

## Electricity Authority

- Engaged early as above
- Received some complaints from others but these lacked quantitative analysis
- EA 2017 Annual Report “...electricity market has once again worked effectively to manage the dry conditions.”
- Will complete a formal review of 2017



**T R A N S P O W E R**

**ELECTRICITY  
AUTHORITY**  
TE MANA HIKO

The logo graphic for the Electricity Authority, featuring a stylized sunburst or fan shape composed of multiple horizontal stripes in red, blue, and yellow.

# What did we learn from this year?

**“Assumptions are  
the termites of  
relationships.”  
(Henry Winkler)**

## Market maturity

- Continued to learn and evolve over dry year experiences
- The improved liquidity in the ASX and OTC markets helped manage risk

## Stakeholder engagement

- No such thing as engaging too early. There is significant information asymmetry
- Having an analytical framework like hindcasting is extremely helpful
- Testing the system operator’s security policy (in particular their modelling of contingent storage) was done too late

## Others perceptions of risk and behaviour

- Is potentially based on historical assumptions which have not been tested, given the changes to our portfolio



# STRATEGIC ASSET MANAGEMENT.

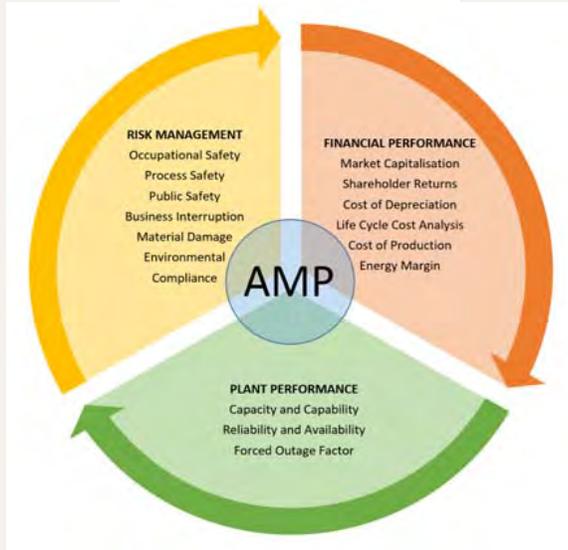
RICHARD GRIFFITHS.

# Content.

- Approach and philosophy
- Our 20-year asset management plan
- Expenditure forecasts
- Major projects
- Process safety
- Benchmarking



# Asset management principles.



We are committed to:

- Protecting the value of Meridian's assets
- Maintaining the safety, performance and capability of these assets over their projected economic life, and
- Meeting our asset management obligations in a manner that is demonstrably world class

Performance is founded on:

- Total Asset Management – people, process, plant
- AMP based on balancing risk, financial and plant performance
- Best practice reliability centred maintenance practices and processes
- Conformity with ISO55001

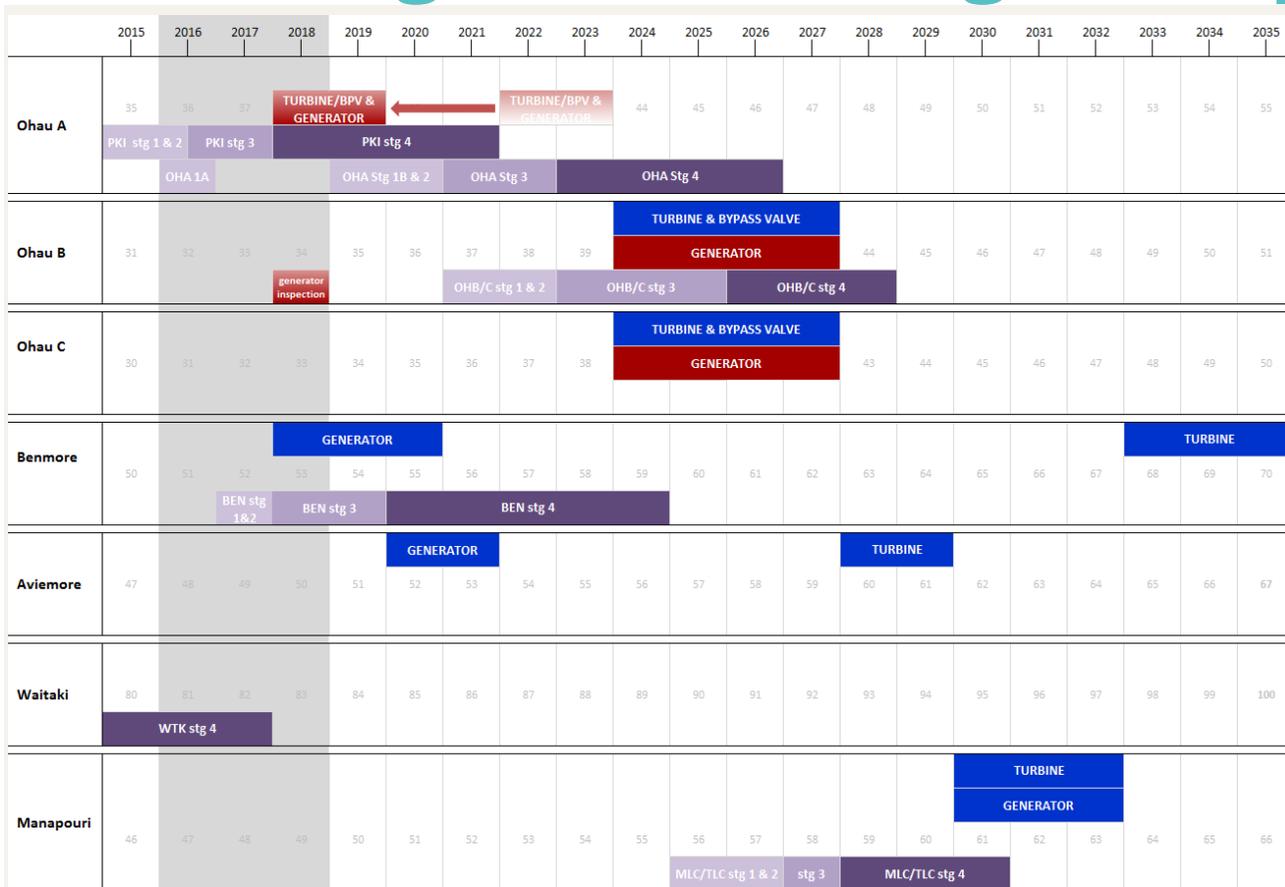
# Strategic asset management plan.

Major turbine and generator works set the primary timing of the 20-year plan

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
<b>Ohau A</b>	inspection	36	37	TURBINE/BPV & GENERATOR				TURBINE/BPV & GENERATOR		44	45	46	47	48	49	50	51	52	53	54	55
<b>Ohau B</b>	31	32	33	34	35	36	37	38	39	TURBINE & BYPASS VALVE	GENERATOR			44	45	46	47	48	49	50	51
<b>Ohau C</b>	30	31	32	33	34	35	36	37	38	TURBINE & BYPASS VALVE	GENERATOR			43	44	45	46	47	48	49	50
<b>Benmore</b>	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
<b>Aviemore</b>	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
<b>Waitaki</b>	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
<b>Manapouri</b>	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	TURBINE	GENERATOR				

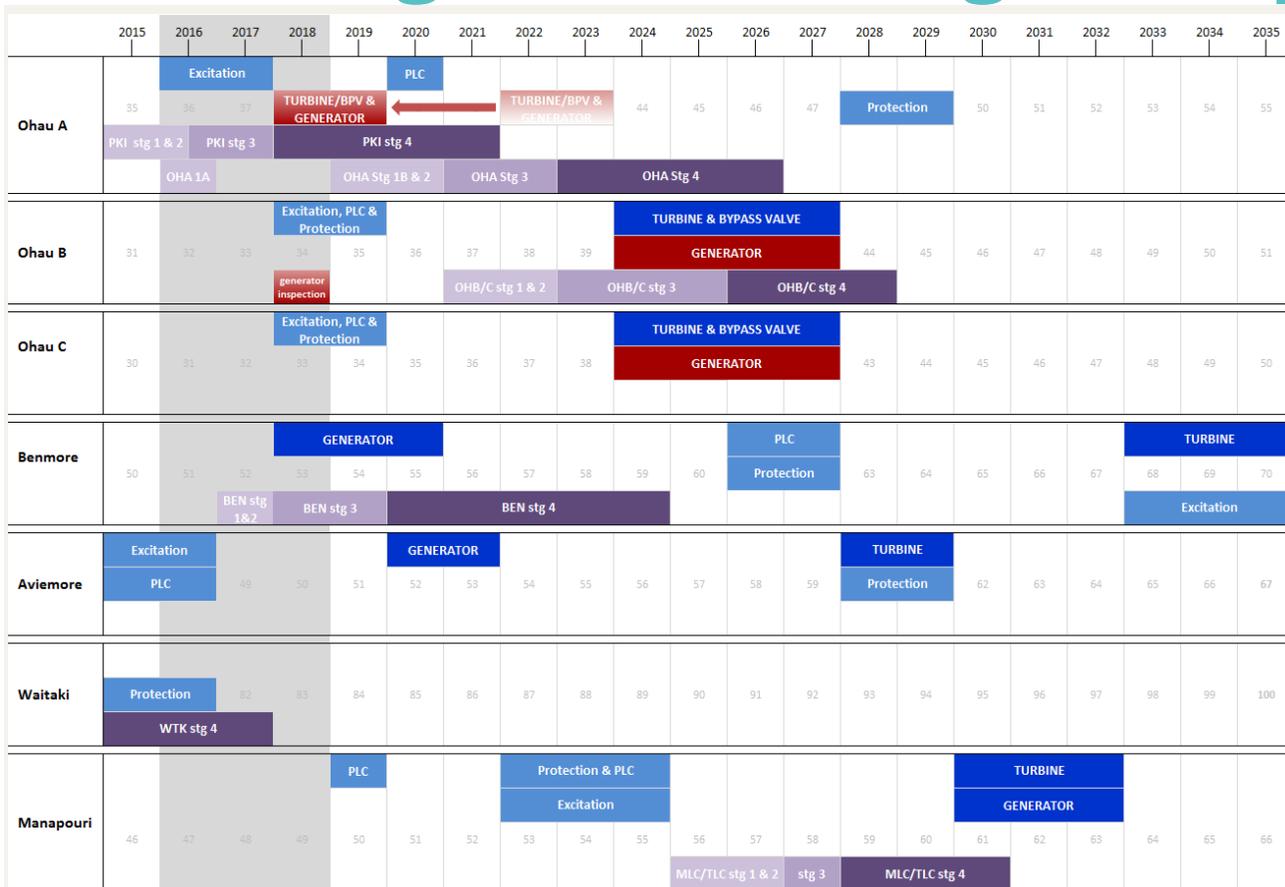
# Strategic asset management plan.

Long-term commitment to the Structural Safety Evaluation Programme



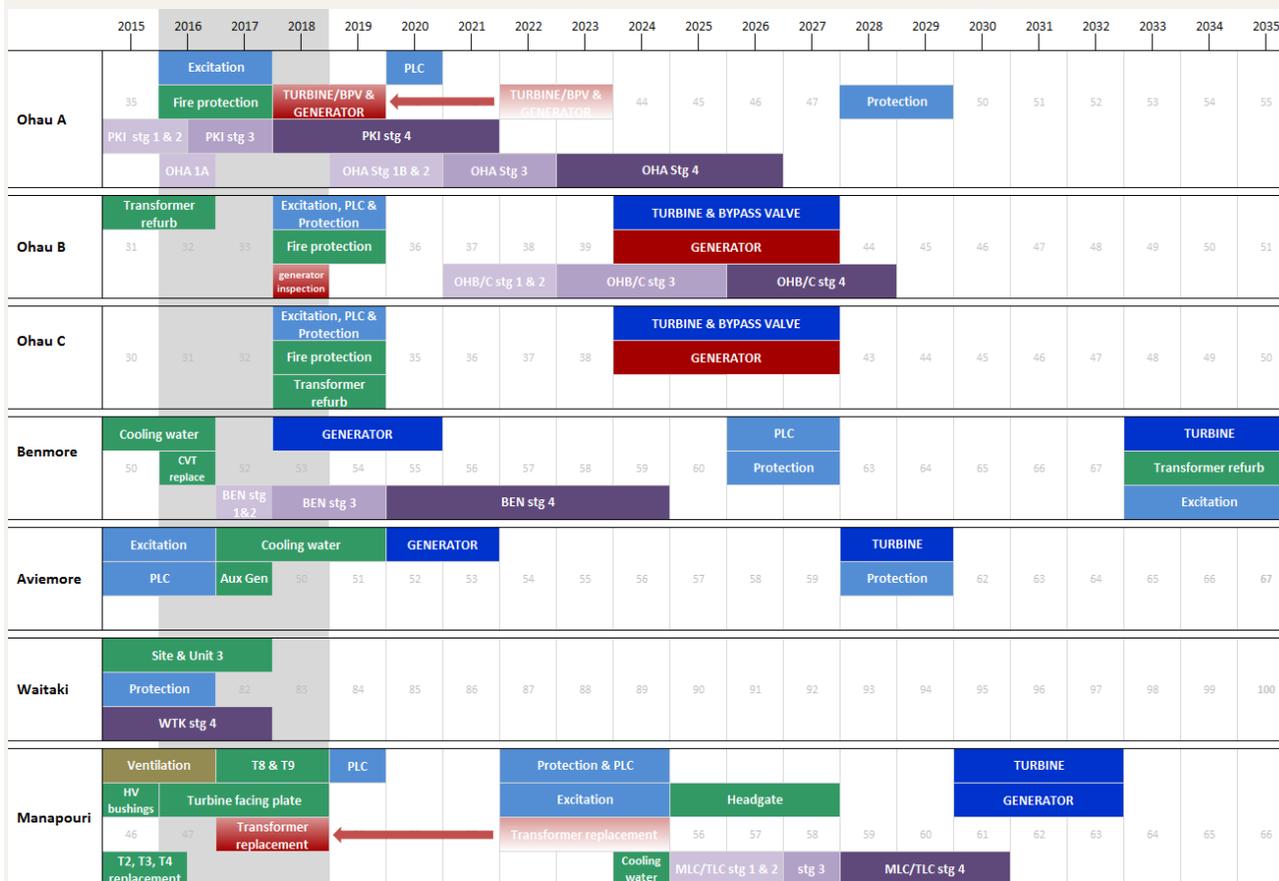
# Strategic asset management plan.

Control systems, excitation & protection replacements are best fit



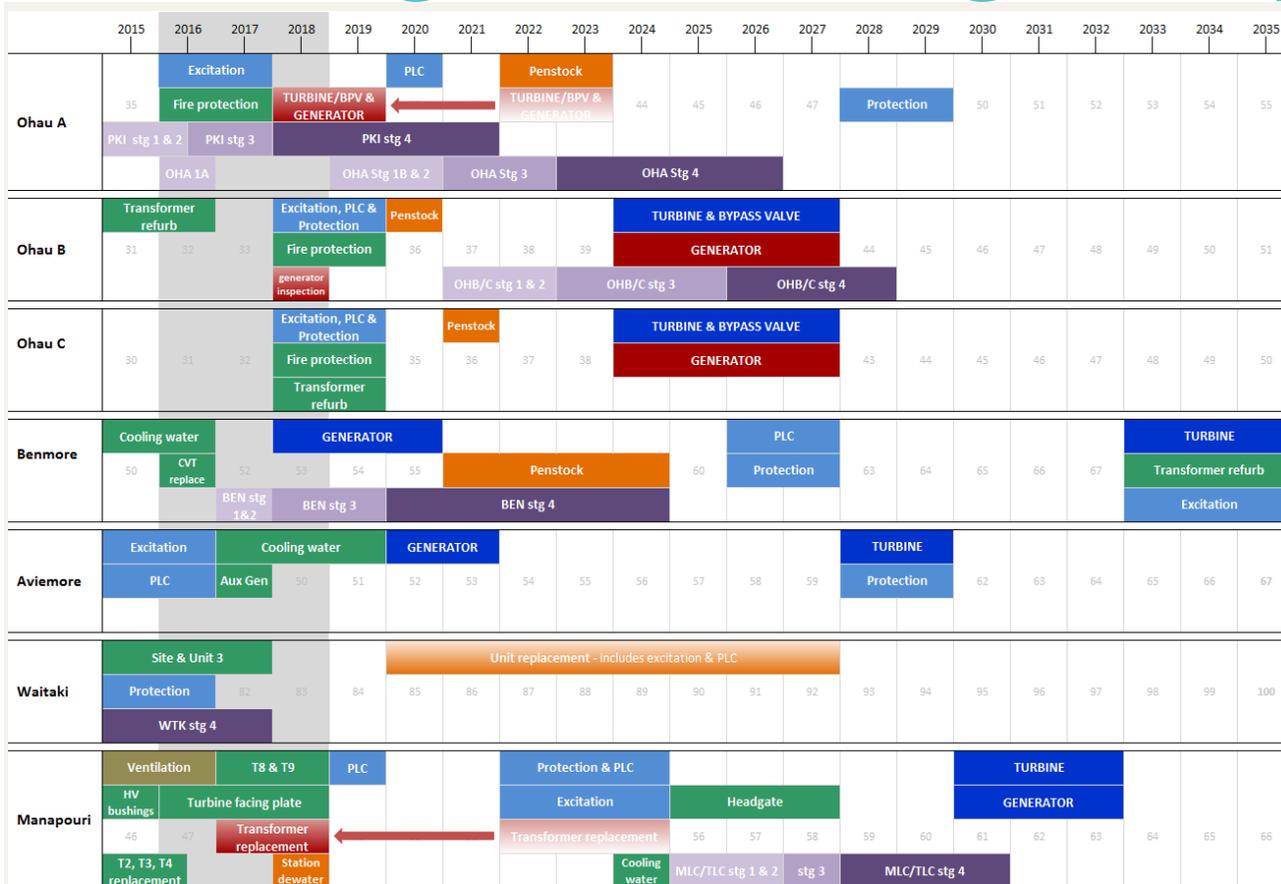
# Strategic asset management plan.

Fit other projects in at optimum timing



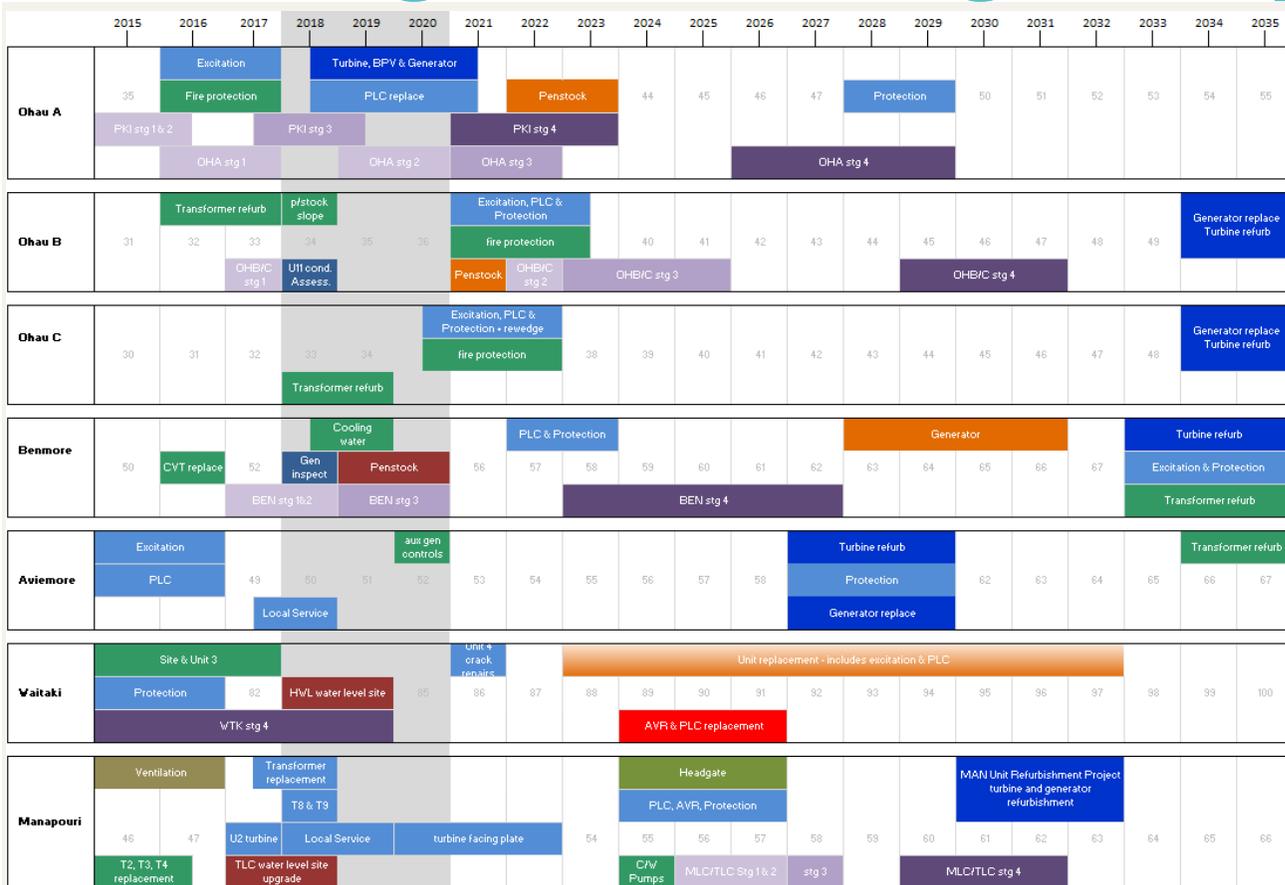
# Strategic asset management plan.

Waitaki Stage II, civil works, contingent works

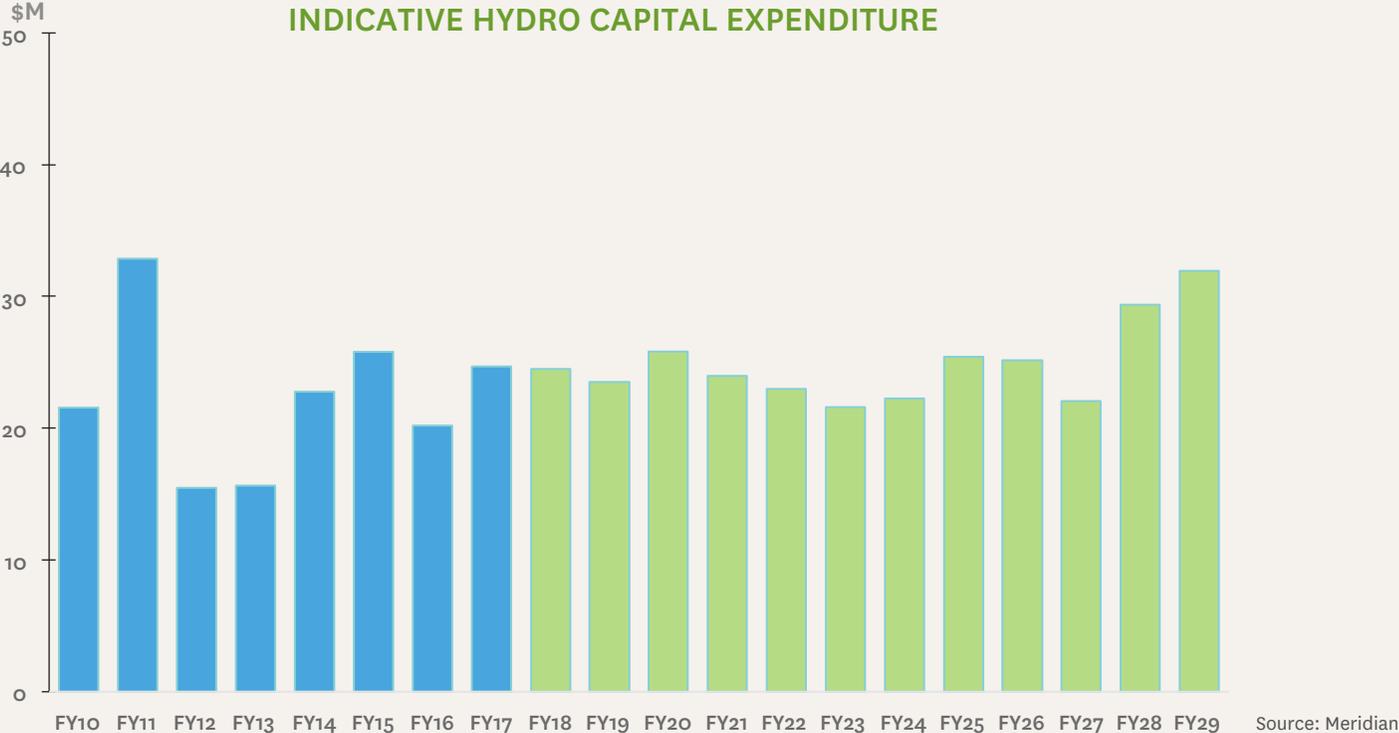


# Strategic asset management plan.

## Current plan



# Hydro capital expenditure forecast.



Excludes Stage II Waitaki generator refurbishment – a 10-year programme, as yet unconfirmed, with peak annual spend of around \$15m

# Waitaki refurbishment.

## Overview

- Waitaki was first commissioned in 1935 and is the final power station on the Waitaki River
- Reliability and performance is important for managing consent flows
- Annually generates ~\$30m in energy revenues

## Capital Deferral Enabling Works (complete)

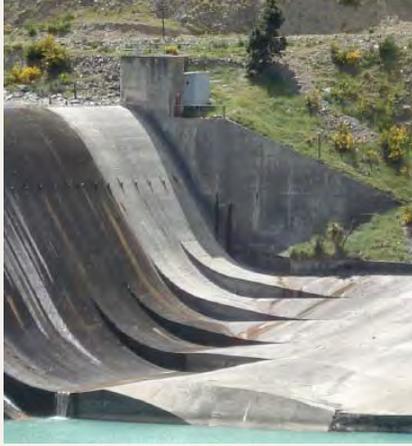
- Stator cleaning on Units 1 & 2
- Unit 3 re-commissioned
- Upgraded unit protection and fire suppression
- Sluice gate control upgrades

## General Upgrades (complete)

- Mechanical & electrical plant refurbishments
- Seismic strengthening of power house
- Upgrade of transformer fire walls
- Upgrade of station cranes



# Waitaki refurbishment.



Images: Meridian's  
Waitaki power station

## Dam Safety Upgrades (complete)

- Repairs to left bank abutment
- River bank erosion protection works
- Piezometers upgraded
- Uplift drainage upgraded and extended

## Dam Safety Upgrades (work in progress)

- Inundation protection of the Hornell Gallery
- Manifolding of the uplift drainage system

## Stage II Generator Upgrades (planned)

- Ongoing commitment to maintenance and condition monitoring to extend life and maintain reliability
- Upgrade timing driven by condition as we operate the machines in a “manage to end-of-life” mode
- While the actual timing is uncertain, the plan assumes this will initiate in 5-10 years
- Comprises complete replacement of four of the seven turbines/generators

# Manapōuri transformers.

## Overview

- Manapōuri commissioned in 1967
- Underground power station
- Generates ~\$250m per annum

## Main Unit Transformers

- T2, T3 and T4 were replaced in 2015 following failure of the oil coolers
- T1, T5, T6, T7 currently being manufactured by Wilsons
- All four will be delivered to Deep Cove in late November 2017

## Local Service Transformers

- T8 & T9 manufacturing underway
- Mitsubishi SF6 transformers
- SF6 eliminates environmental risks and fire hazards from switchyard
- Delivery expected end of FY18



Image: Transformer haulage  
Manapōuri power station

# Ōhau chain upgrade programme.



Image: Meridian's  
Ōhau A power station



Image: Meridian's  
Ōhau B power station

## Overview

- Ōhau chain comprises Ōhau A, B & C
- Controls flow from Lakes Pūkaki & Ōhau
- Collectively generate ~\$220m pa

## Programme

- \$48m business case approved in October 16
- Programme extends through to 2023

## Scope comprises:

- Ōhau A unit refurbishments
- Ōhau A, B & C control upgrades
- Ōhau B & C protection, excitation and transformer firewall upgrades
- Ōhau B & C generator refurbishments

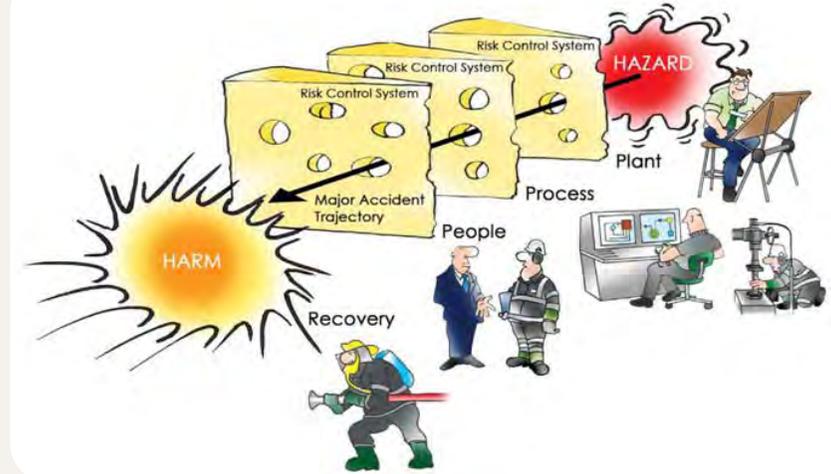
## Current status

- Unit G11 stator inspection completed
- Design and procurement well underway

# Process safety.

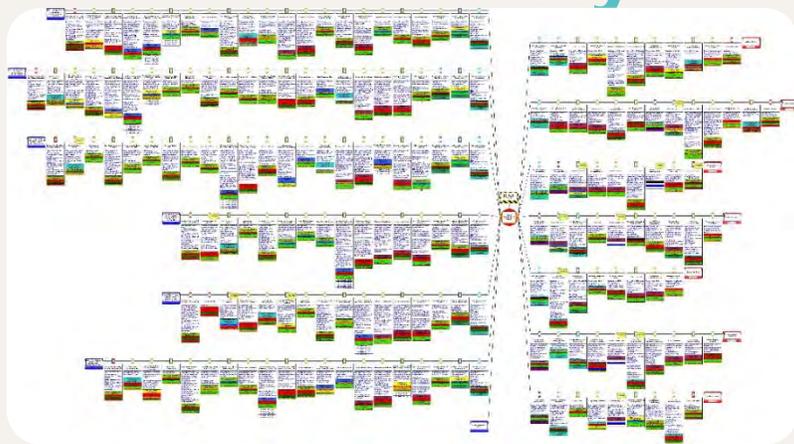
## Overview

- Meridian initiated a review of its process safety risks in 2014
- Lockheed Martin and Scottish Power were engaged in 2015 to facilitate risk bowtie workshops and undertake a gap analysis
- Meridian established a programme to implement the recommendations
- In 2016 a ramp-down event at Manapōuri occurred. DuPont were invited to undertake a post-incident review
- DuPont endorsed the workstreams that were underway and recommended an additional focus on the interface between ICT and generation plant
- The outcome has also seen an increased level of management focus and commitment



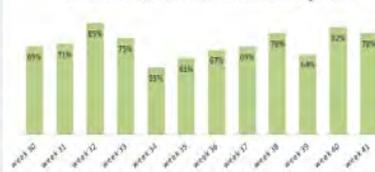
1. Understanding what can go wrong
2. Knowing what systems we have to prevent things from going wrong
3. Having information to assure ourselves that these systems are working effectively

# Process safety.

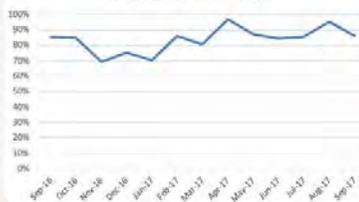


Bowtie Actions			
	Outstanding	Completed	Total
High Priority	77	4	81
Medium Priority	150	3	153
Low Priority	41	0	41
Uncategorised (pre-prioritisation)	2	64	66
<b>Total</b>	<b>270</b>	<b>71</b>	<b>341</b>

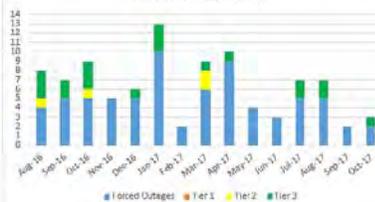
Last 12 Weeks Overall Schedule Compliance



Maintenance Critical Work



Process Safety Events



Images:  
Meridian's risk  
bowties and  
reporting

## Key Workstreams:

- Develop **Risk Bowties** for all sites and integrate into AMP
- Undertake an **Alarm Management** and rationalisation programme
- Undertake a **Risk Management** review
- Review the **Plant Change Control** process
- Process safety **Training and Awareness** programme
- Review the management of **Controlled Documents**
- Address defects with the **Generation Control System**
- Develop a suite of **Process Safety KPIs** and dashboard

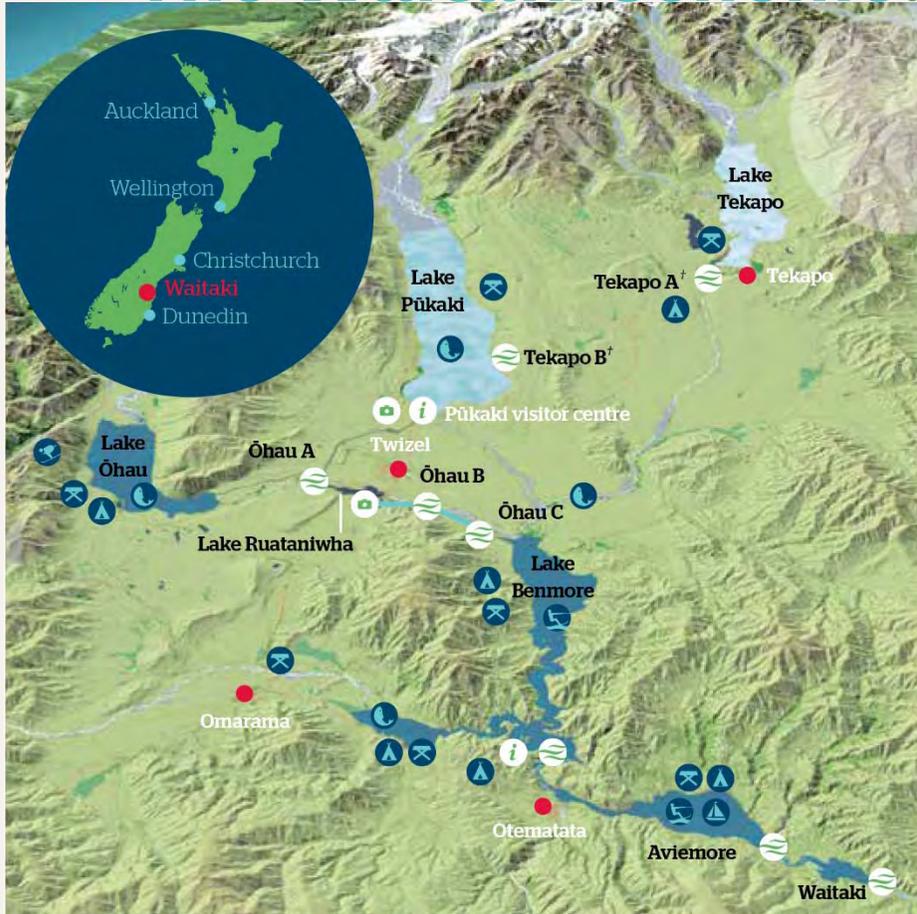


A high-angle, top-down photograph of a worker in a yellow safety vest and dark pants performing maintenance on a large, complex industrial machine. The worker is positioned on a metal grate platform, reaching towards a central cylindrical component. The machine is composed of various white and blue parts, with numerous yellow cables and hoses running across the scene. The overall environment is industrial and brightly lit.

# OPERATIONAL MAINTENANCE

MAT BAYLISS

# The Waitaki scheme.



## Some facts

- Eight hydro stations in the Waitaki Scheme
- Tekapo A and B are owned by Genesis Energy
- The six hydro stations from Lake Pūkaki to Waitaki, owned by Meridian

# The Waitaki scheme.

## Condensation

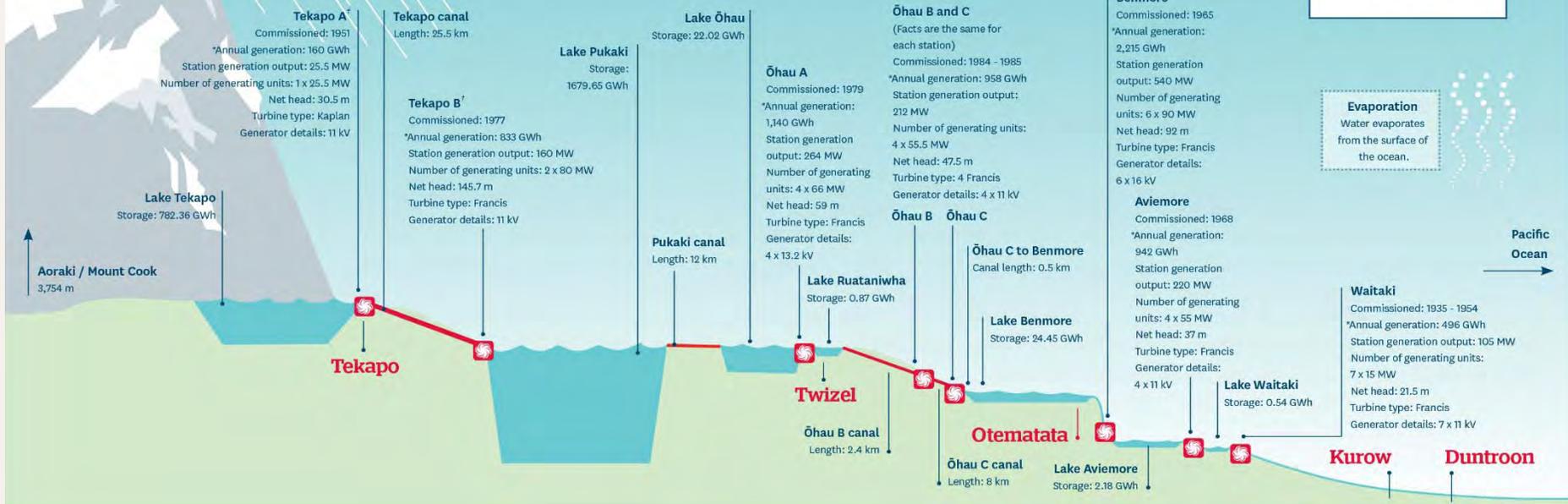
As the vapour rises, it cools and changes to droplets.

## Precipitation

Water falls to the earth in the form of rain, snow, sleet or hail.

## How the Waitaki system works

Facts about electricity generation from Aoraki/Mount Cook through the Waitaki System.



### FACT

One cubic metre of water passing through the eight power stations of the Waitaki system generates 2,500 kWh – about 30% of an average household's annual power needs.

### KEY

-  LAKE
-  GENERATION
-  CANAL
- \* AVERAGE ANNUAL GENERATION
- † OWNED BY GENESIS ENERGY

### ENERGY EXPLAINED

**Cumec** one cubic metre of water flowing past a given point every second.

**kW** 1,000 watts.

**MW** 1,000 kW.

**GWh** 1,000 MW passing through a given point over an hour.

### Evaporation

Water evaporates from the surface of the ocean.

### Benmore

Commissioned: 1965  
 \*Annual generation: 2,215 GWh  
 Station generation output: 540 MW  
 Number of generating units: 6 x 90 MW  
 Net head: 92 m  
 Turbine type: Francis  
 Generator details: 6 x 16 kV

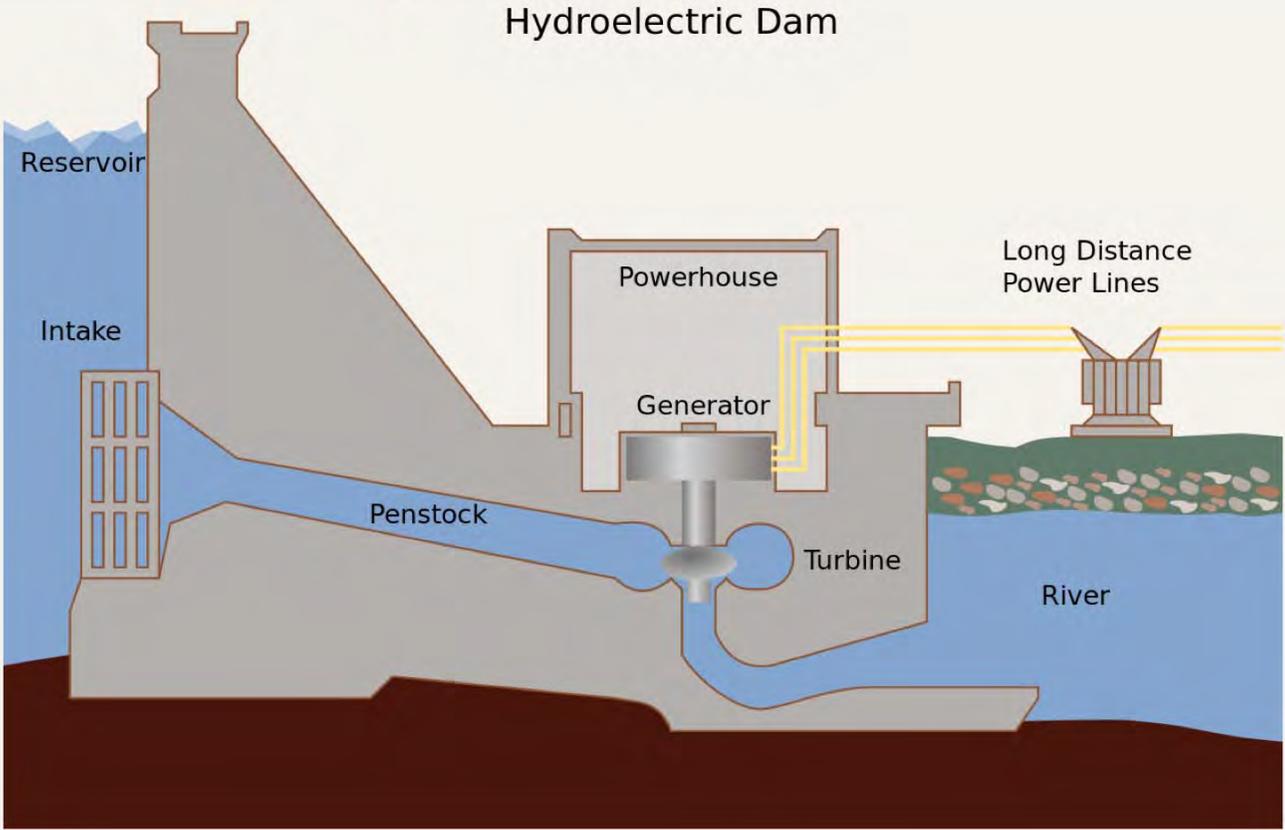
### Aviemore

Commissioned: 1968  
 \*Annual generation: 942 GWh  
 Station generation output: 220 MW  
 Number of generating units: 4 x 55 MW  
 Net head: 37 m  
 Turbine type: Francis  
 Generator details: 4 x 11 kV

### Waitaki

Commissioned: 1935 - 1954  
 \*Annual generation: 496 GWh  
 Station generation output: 105 MW  
 Number of generating units: 7 x 15 MW  
 Net head: 21.5 m  
 Turbine type: Francis  
 Generator details: 7 x 11 kV

# Hydroelectric power.



# Hydro Asset Maintenance.

## How we are organised

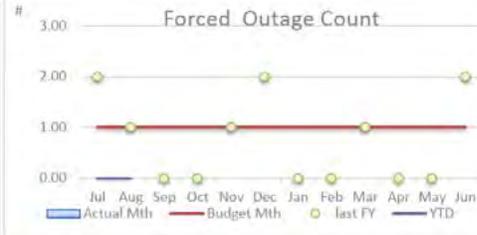
- Engineers, trades staff, technicians, operators, maintenance planners
- Dedicated maintenance teams for three asset portfolios
- Ōhau Chain, Mid-Waitaki and Manapōuri
- Including graduates and apprentices, 70 staff in three locations
- Augmented by contractors

## What do we do

- Planned maintenance, defect and fault response
- Maintenance projects include civil, mechanical, electrical and automation repairs and upgrades



# Performance.



Source: Meridian

## Hydro plant performance measures

- Availability (% of time)
- Operational Unit Cost \$/MWh
- Forced Outage Factor (% of cap)
- Forced Outage Count (# events)

## Maintenance process measures

- Multiple live measures
- Extensive use of maintenance management system (Maximo)
- Targets reset annually to reflect focus areas, continuous improvement
- Remuneration linked to outcomes for all staff
- Periodic benchmarking using external service

# Health and safety.

## Our Approach

- Lead role in industry collaboration forums (StayLive, EEA etc)
- Safety & Sustainability Board Committee
- Dedicated H&S team reporting to MaP GM
- Competent workforce, strong safety culture
- Incident reporting and investigation
- Safety performance of contractors



# Community.



Image: Haast kiwi release, Rona Island, Lake Manapouri

## Our Community Engagement Strategy

- Significant footprint in multiple small rural communities
- Goodwill important when operating large assets, lakes and rivers
- Multiple engagement mechanisms & channels
  - Power Up – Meridian community fund
  - Community sponsorships
  - Staff involvement
  - Collaboration
  - National sponsorships
- Meridian held in high regard

# Twizel.

## History

- Built in 1968 as a temporary service town
- Saved from demolition in 1983
- Today is the largest town in the MacKenzie

## Meridian

- Large employer in the area, now including a retail call centre
- Direct contributor to the community



Source: Electricity Authority

Image: Twizel, late 1960s

# MANAGING TRANSMISSION.

GEOFFRY SAMS  
AND  
JON SPILLER

# Getting energy to customers.

## Meridian's power stations

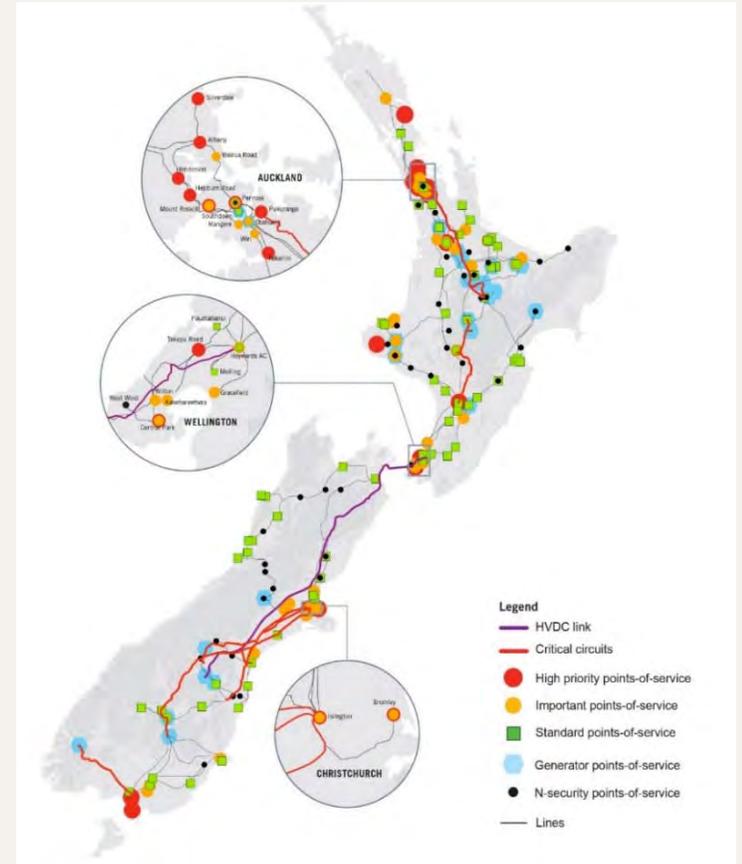
- 2,762MW installed capacity
- 32% of New Zealand's generation
- 89% located in South Canterbury and Southland

## Meridian's customer base

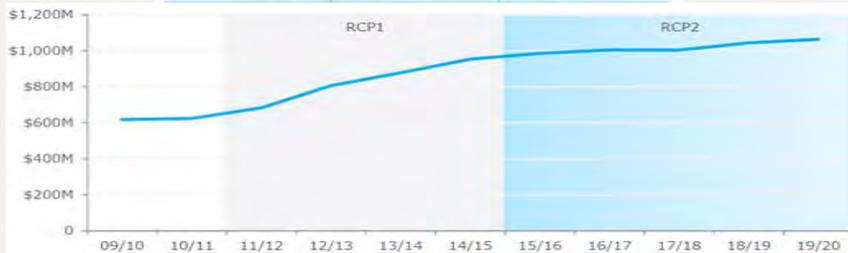
- 280,000 customers all across New Zealand
- Connected through 29 lines networks
- Geographically distant from our generation

## New Zealand transmission system

- Owned and operated by Transpower
- 11,238km transmission lines connecting generation to customers
- High voltage backbone running from Southland to Auckland



# Transmission backbone.



Source: Transpower's RCP2 Submission

## The transmission system is robust

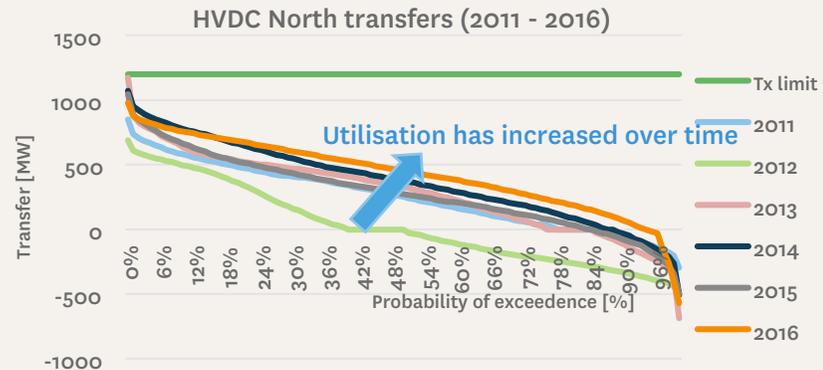
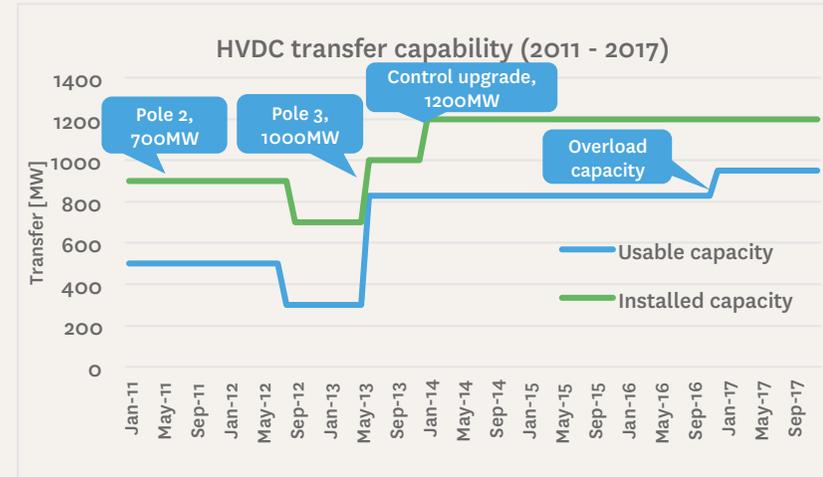
- Transpower backbone consists of high voltage (220-110kV) AC transmission lines
- North and South Islands connected via 350kV HVDC link between Haywards in Wellington and Benmore in South Canterbury
- Transpower's investments in the following projects over the last five years has removed most bottlenecks:
  - North Island Grid Upgrade Programme 400kV (capable) line from Whakamaru to Pakuranga in 2012 (\$824m)
  - HVDC Pole 3, replacement of Pole 1 2013 (\$672m)
  - North Auckland and Northland reinforcement for upper North Island 2013 (\$473m)
  - Ōtāhuhu substation diversity 2010 (\$99m)
  - Wairakei ring 2013 (\$141m)

# HVDC Pole 3.

Investment in the HVDC link has greatly improved Meridian's generation flexibility

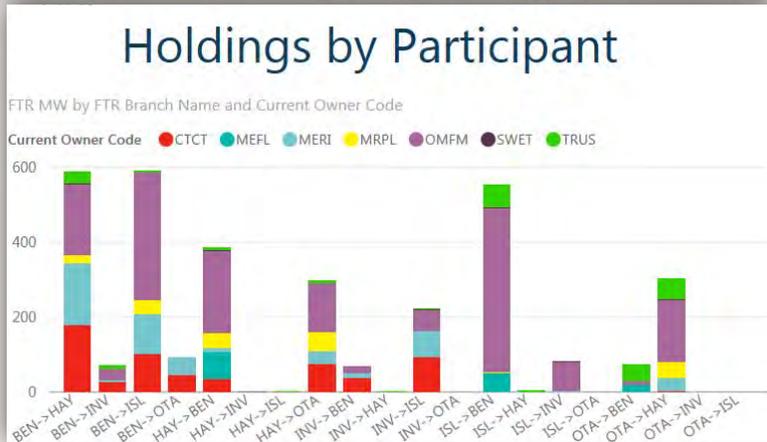
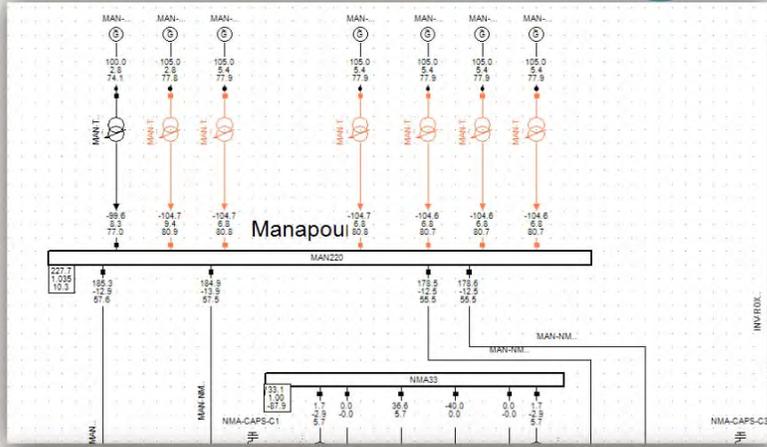
- Following the decommissioning of Pole 1 in 2011, total HVDC capacity reduced from 1,000MW to 700MW
- New HVDC Pole 3 was then commissioned in 2013, increasing total HVDC capacity to 1,200MW
- Usable capacity<sup>1</sup> is often significantly lower, dependant on a number of market conditions, primarily NI reserves
- Meridian has been working with Transpower to enable greater utilisation of the full HVDC capacity
- As part of this effort, the overload capability was increased in 2016, which enabled usable capacity of ~950MW

1: Usable capacity calculated assuming 300MW of NI reserves offered to the market



Source: Meridian

# Constraint management.



Meridian has a number of tools and processes to manage transmission constraints

- Simulations from power system modelling
- Historical event analysis
- Knowledge capture of constraints and outages

We also manage exposure through a number of market mechanisms

- Financial Transmission Rights (FTR's)
- Over the counter financial arrangements
- Collaborating with the System Operator on risk assumptions
- Implementation of “special protection schemes”
- Plant maintenance scheduling

# Catalyst for transmission investment.

## Two primary drivers

- Meridian perceives the biggest possible catalysts of change to the transmission system as:
  - Potential Tiwai Point smelter shutdown
  - Potential Huntly Rankine unit retirement
- Both these scenarios would require new transmission investment by Transpower
- Meridian believes our current tools and capabilities would enable us to continue to manage our portfolio, if the transmission investment projects were progressed



Image: NZAS aluminium smelter at Tiwai Point



Image: Genesis Energy's Huntly Power Station

# Potential Tiwai Point smelter shutdown.



Image: NZAS smelter at Tiwai Point

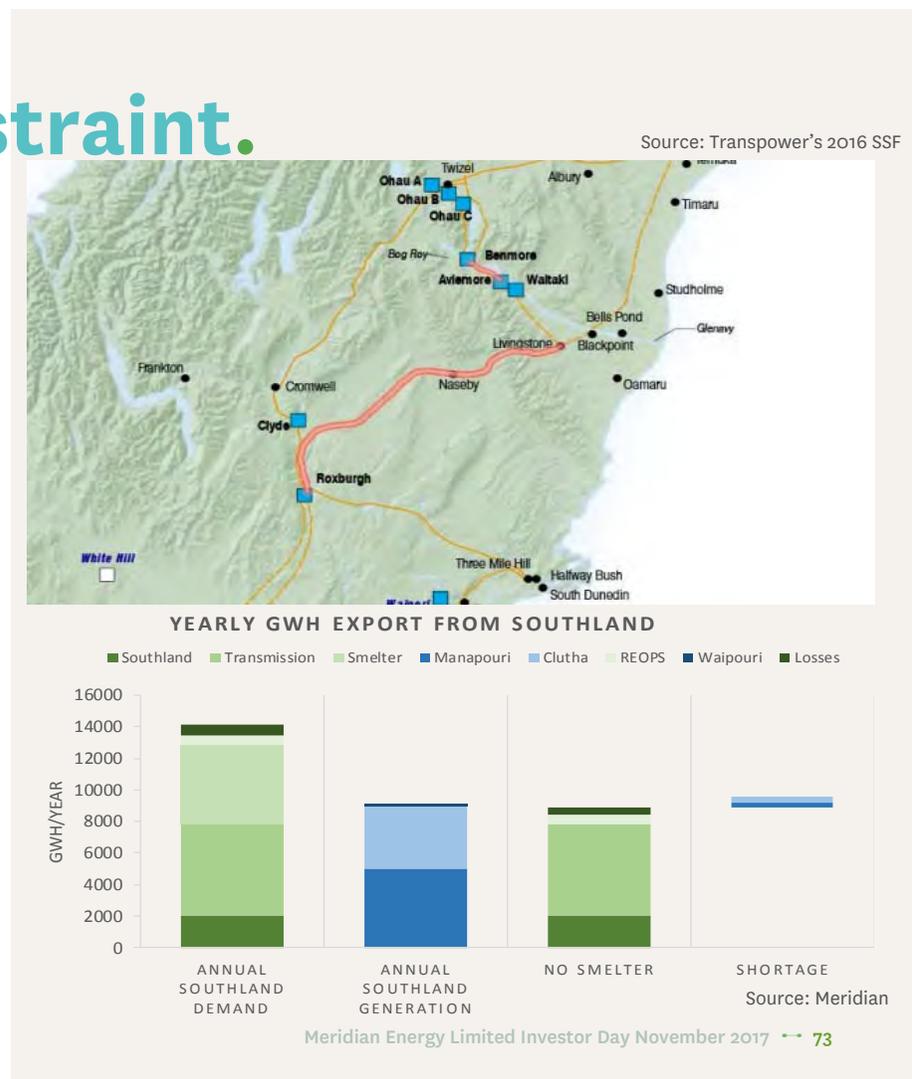
## Three significant restrictions

- If an exit of the Tiwai Point smelter occurs, a number of transmission constraints have been identified by Transpower that would impede energy transfer across the transmission system:
  - 1. Southland export constraint
  - 2. HVDC north export constraint
  - 3. Lower North Island transfer constraint

# 1. Southland export constraint.

Constraints can be managed while investment programme is completed

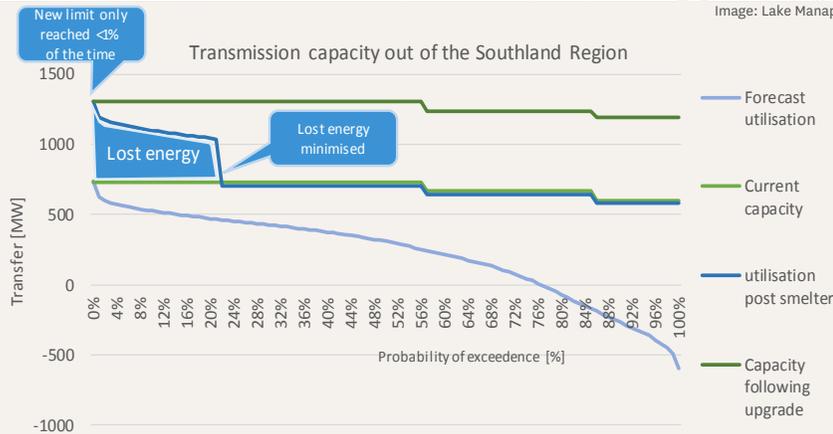
- A potential Tiwai Point smelter exit will release an additional 5,000GWh of energy into the market
- This generation is predominately supplied from our Manapouri power station and Contact Energy's Clutha power scheme
- We are currently investigating options with Transpower to maintain the current transmission capacity during the subsequent investment program
- Peak generation capacity within the region will be constrained
- In order to minimise lost energy we will need to manage storage until transmission is built out



# Southland improvements.



Image: Lake Manapōuri



Source: Meridian

Project ready to initiate following a smelter announcement

- Transpower have a fully costed and approved project to resolve the Southland export issue; the Clutha Upper Waitaki Lines Project<sup>1</sup>:
  - Two sections already commissioned
  - Three years to complete remaining two sections
- Detailed designs for remain projects completed and majority of land access rights obtained
- Fully costed at \$110m<sup>2</sup>
- Once complete will enable full generation export capability

1: <https://www.transpower.co.nz/clutha-upper-waitaki-lines-project-and-tiwai-future-faqs>

2: Transpower's Grid Upgrade Plan 2009 Instalment 3

## 2. HVDC north export constraint.

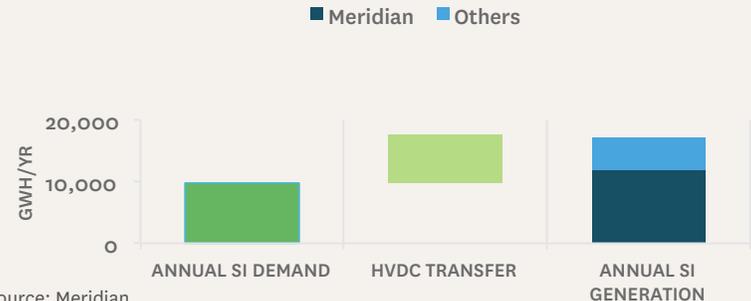
Current HVDC capacity is sufficient to manage greater transfer to North Island

- HVDC capacity has been substantially increased
- Current peaking capacity of 950MW has only been utilised 2% of the time
- Any potential Tiwai Point smelter exit will have no impact to current HVDC peaking capacity into the North Island
- The additional energy released if the Tiwai Point smelter was to exit can be transferred to the market under the current HVDC capacity, provided storage is managed across the year

Image: Transpower's Pole 3, Benmore



YEARLY GWH TRANSFER TO NORTH ISLAND POST SMELTER EXIT

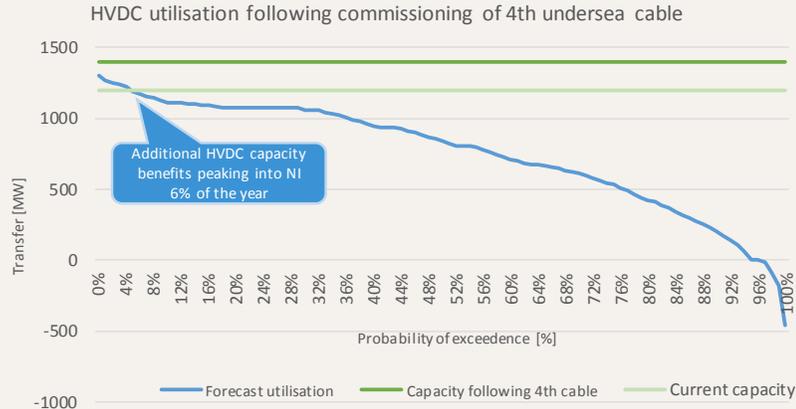


Source: Meridian

## 2. HVDC improvements.



Image: Transpower's Pole 3, Benmore



### Increasing usable capability

- Transpower have started detailed investigation into undersea cable replacement project
- Current cable asset end of life between 2023-2025
- Installing a fourth cable would increase HVDC capability to 1,400MW and could increase usable capacity to 1,150MW
- Cost of installing an additional 500MW cable is ~\$55.8m<sup>1</sup>
- Adds an additional 200MW of peaking capacity into the North Island
- With flexible hydro assets able to respond quickly, we are well positioned to utilise the additional HVDC peaking capacity to support North Island demand

1: Assuming it is installed as part of the undersea cable replacement project. If project precedes in isolation, expected cost is \$150m

# 3. Lower North Island transfer constraint.

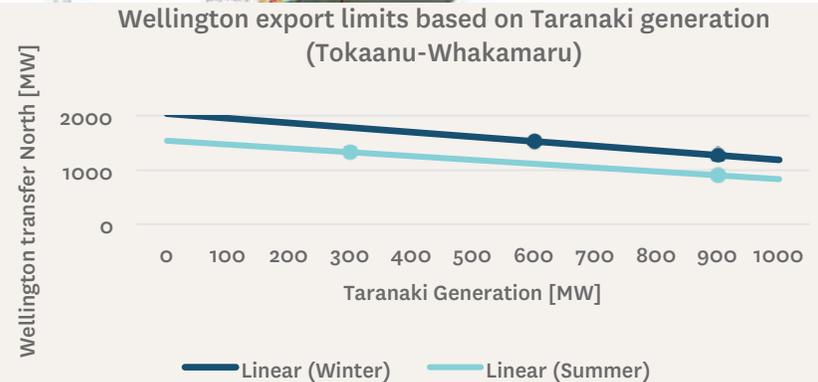
Source:  
Transpower's  
2016 SSF

## Current transmission issues

- Limited transfer from Bunnythorpe through to Whakamaru
- Limits lower North Island and Taranaki generation into the upper North Island

## No planned improvements

- Constraint when competing with Taranaki generation
- Expect to see lower cost generation dispatch ahead of higher cost peaking thermal



Source: Transpower's 2016 SSF  
Meridian Energy Limited Investor Day November 2017 77

# Huntly Rankine unit retirement.



Image: Genesis Energy's Huntly Generation Station

## Investigation is underway

- A separate issue is the potential decommissioning of Huntly Rankine units
- There is sufficient generation in the market to cover demand into the upper North Island
- 94% of upper North Island generation is currently sourced from outside region
- Transmission investment will be required ahead of the Rankine unit retirement to enable sufficient energy to be transferred into the region
- This investment would be independent of any Tiwai Point smelter outcome



# Summary.



Image: Meridian Energy's Benmore Power Station

Meridian is well placed to manage its portfolio through future uncertainty

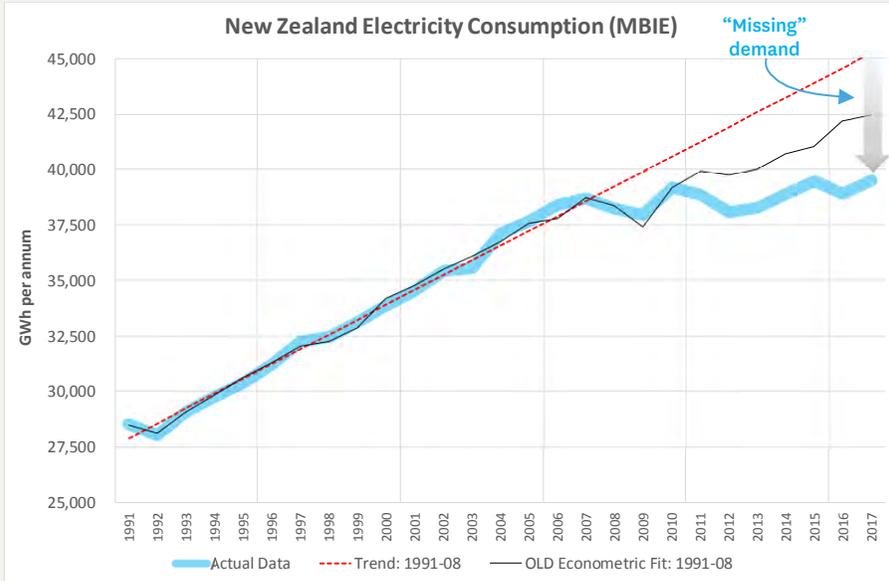
- Transmission upgrades are more critical for lower South Island and reduce as you move north
- Key projects are well developed
- Flexibility of storage will allow Meridian to manage lost energy during investment phase
- Our transmission team continue to work with the industry to improve the current capability of the transmission system



# ENERGY EFFICIENCY.

## GRANT TELFAR.

# Forecasting demand.

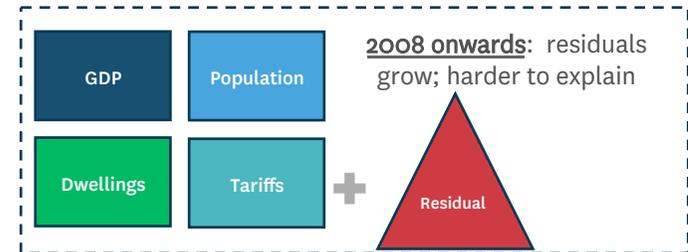
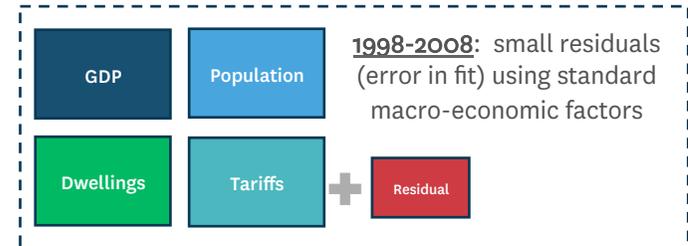


Source: Meridian, Ministry of Business, Innovation & Employment

## What is the problem

- Very poor data on energy usage
- Demand has been flat for some time
- Traditional econometric modelling approach has increasingly struggled to explain demand

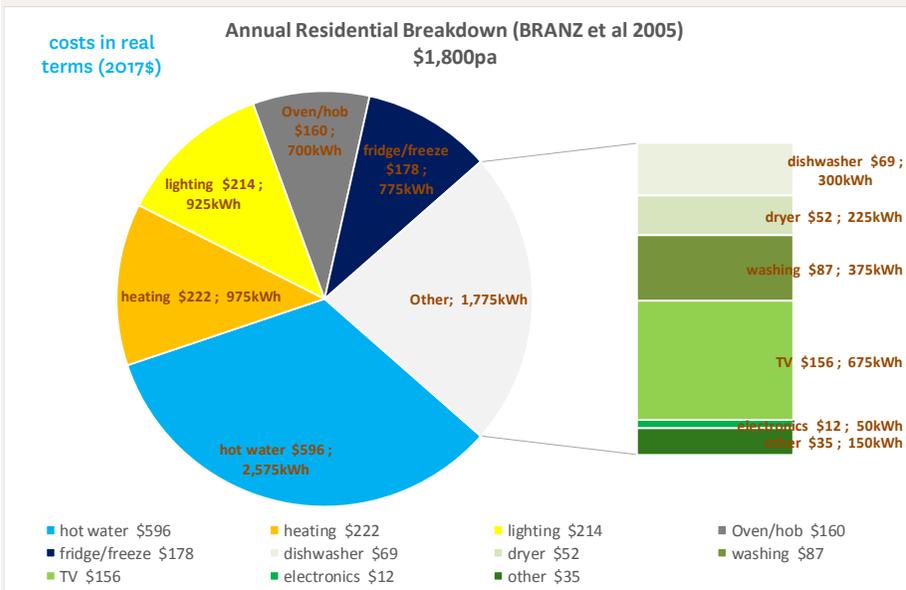
## outcomes



# Usage as at 2008.

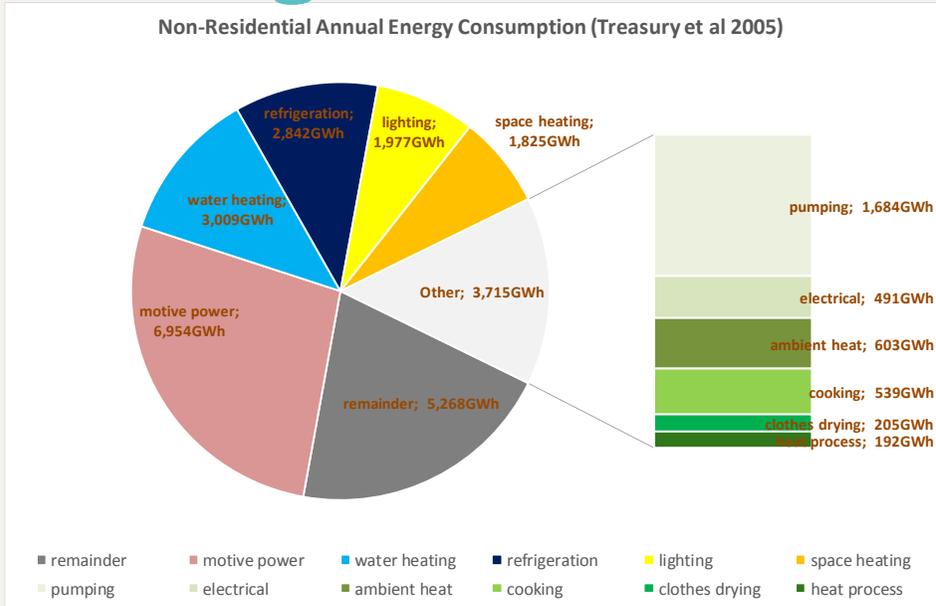
## NZ household usage

- Very poor data on energy usage
- BRANZ HEEP study (2002-2005) last comprehensive nationwide survey
- Insights:
  - Electrical heating spend is low (on average)
  - Biggest spend is on hot water



Source: BRANZ, Meridian

# Usage as at 2008.



Source: Treasury, Meridian

## NZ non-household usage

- Even worse data
- BRANZ HEEP plus 2005 Treasury study are both useful
- Insights:
  - NZ business use a lot of motors (motive and pumping)
  - Combined lighting, refrigeration, and heating similar scale to residential

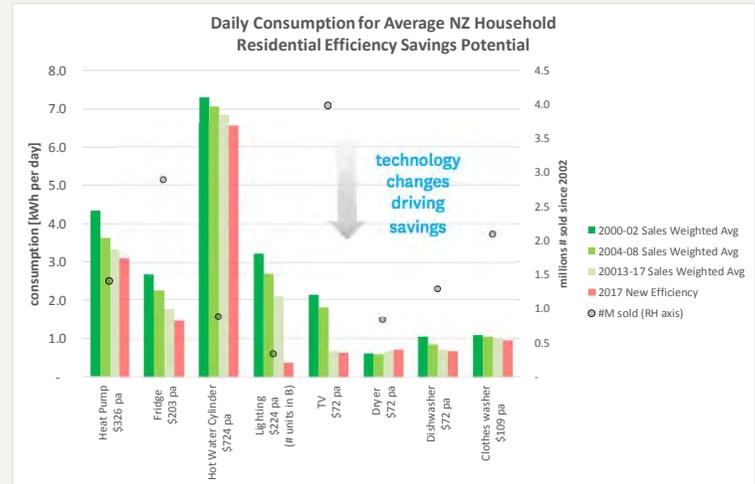
# What has changed?

## NZ households

- Kiwis love buying appliances
- TV efficiency has improved dramatically
- 2017 lighting efficiency reflects slow LED uptake
- Room for further efficiency improvements
- Technology driven rather than price responsive

## NZ non-household

- Hard to know
- Motive power, lighting and water heating have significant potential to reduce energy demand
- Total efficiency potential up to 25%
- Likely to free-ride on technology changes
- More likely to trade-off costs (eg LEDs)

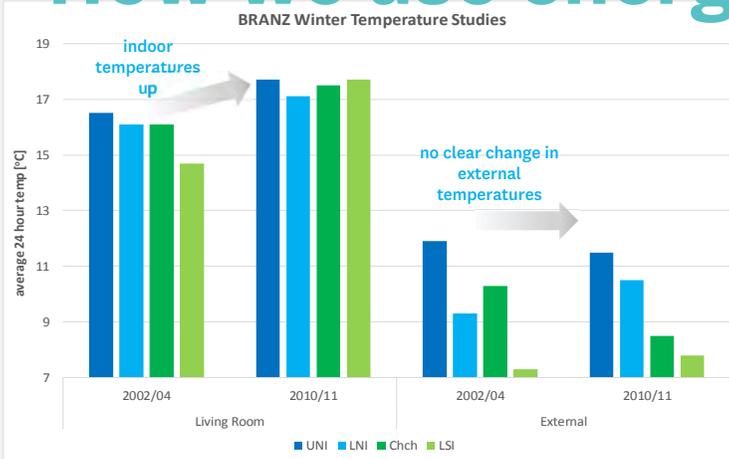


Source: EECA, Meridian



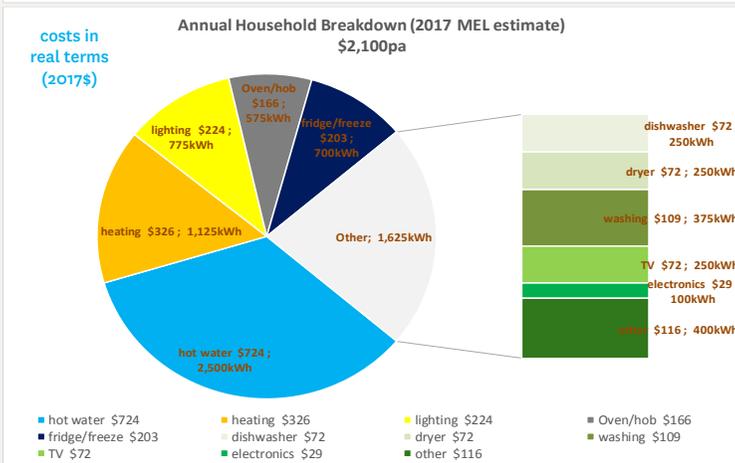
Source: Treasury, Meridian

# How we use energy now.



## Efficiency is only one part of the puzzle

- Greater efficiency does not necessarily mean a reduction in overall consumption, e.g:
  - NZ houses appear warmer than they were 15 years ago (not hard)
  - Replacing an incandescent light bulb with an LED implies an 85% saving in energy use – but how many do LEDs do we install? What incandescent ‘waste’ heat now needs replacing?



## Household energy usage as at 2017

- Not a lot of change proportionally
- Heating consumption has likely increased
- TV consumption has dropped markedly
- Incremental improvements in appliances ...except dryers!

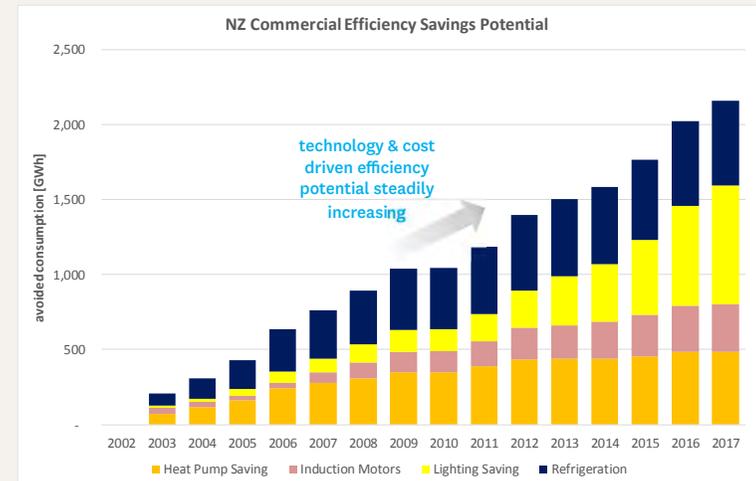
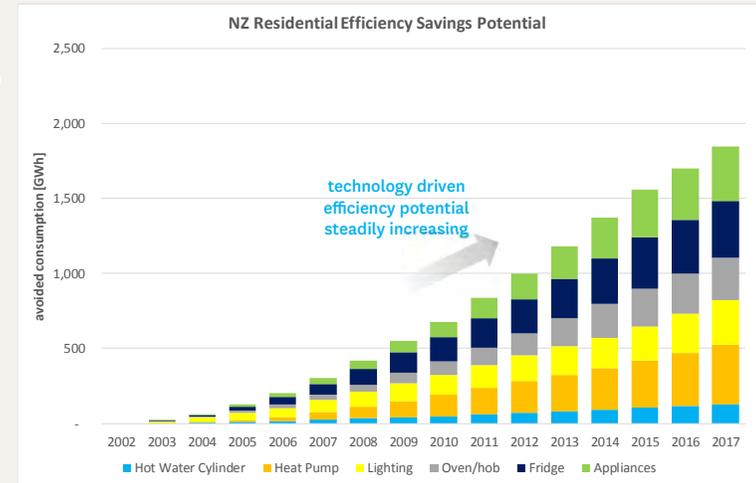
# Better efficiency potential?

## NZ households

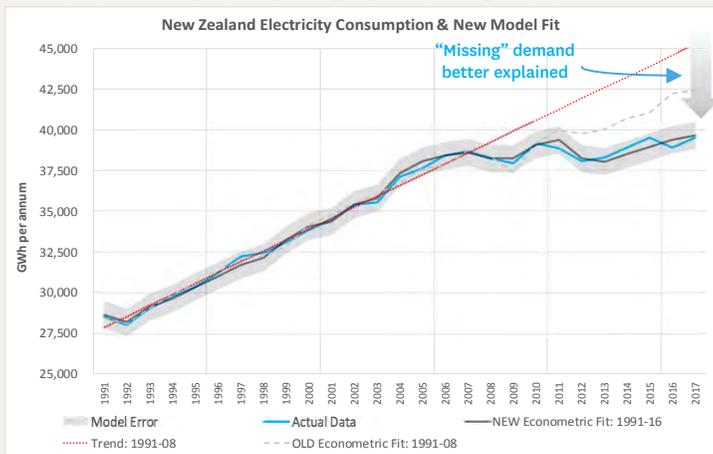
- Increase seen in potential household efficiency related savings since 2002
- Hot water shown least improvement
- Scale of implied savings ~500MW of new wind generation (\$1.2B+ worth) in last 15 years

## NZ non-household

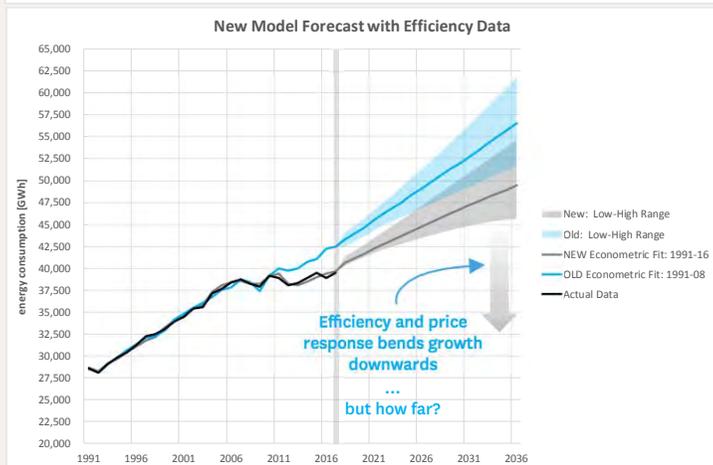
- Increase seen in potential commercial efficiency related savings since 2002
- Equipment life cycle (age and replacement) is critical
- Higher uptake of LEDs than residential (probably)
- Scale of implied savings is another ~500MW of new wind generation in the last 15 years



# Where to now?



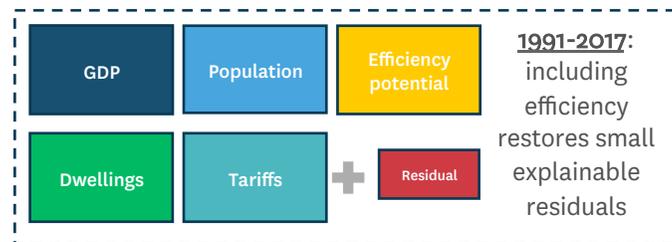
Source:  
MBIE,  
Meridian



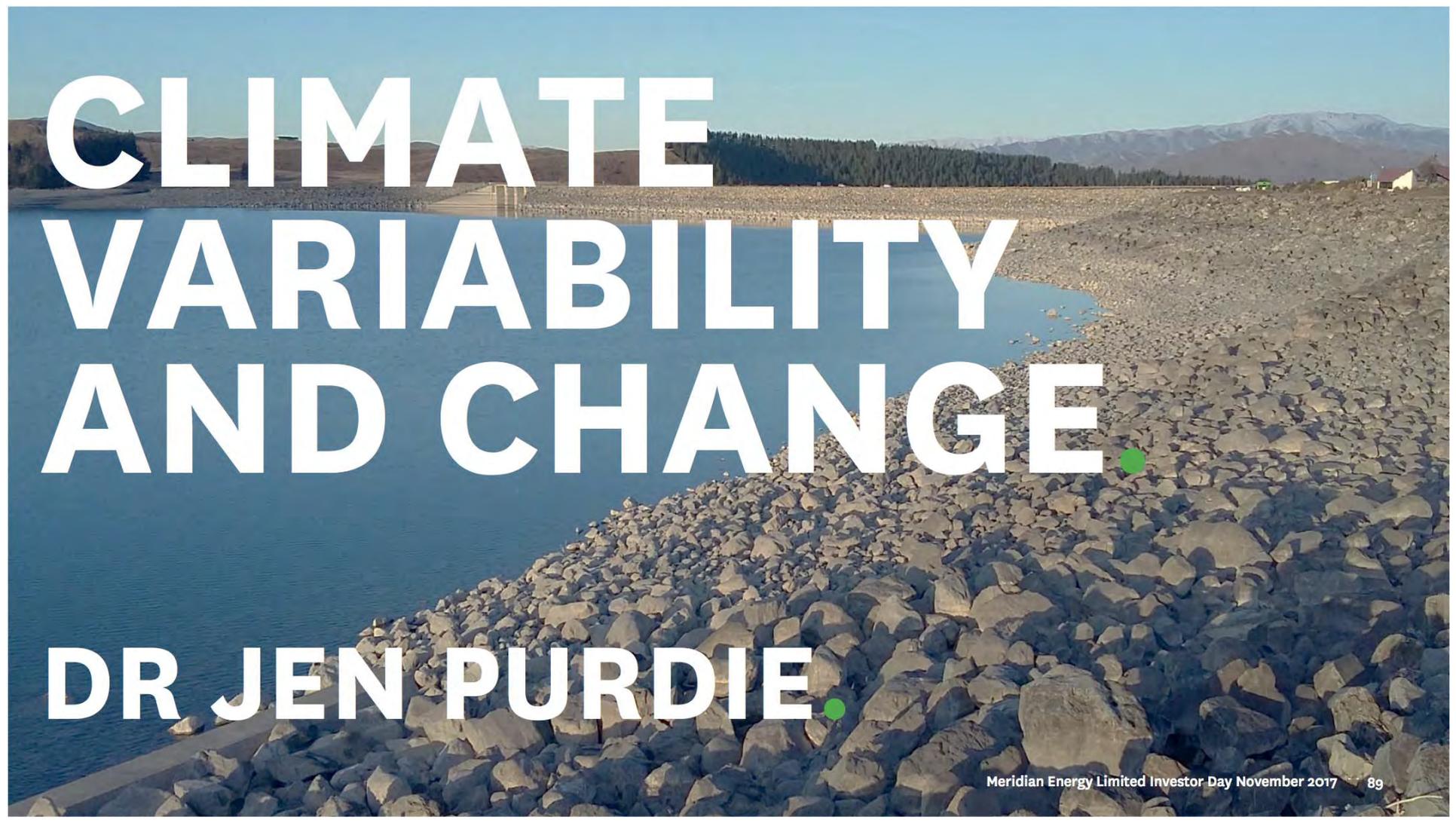
Source:  
Meridian

## Improved demand forecast

- Including efficiency potential alongside other economic variables dramatically improves model
- But early days! Careful of monkeys & typewriters



- Assessing future efficiency is challenging
  - Forecast efficiency data and customer usage is not readily available – but we *can* examine
    - Remaining efficiency potential by usage
    - Views on consumption/ICP trajectories
    - Economic energy intensity improvements
- Growth of 0.5% - 1.0% pa seems likely – with plant retirement adding to the system need for new power

A large reservoir with a rocky shoreline and mountains in the background. The water is blue, and the sky is clear. The foreground is dominated by a large pile of grey rocks.

# CLIMATE VARIABILITY AND CHANGE.

DR JEN PURDIE.

# We rely on the timely arrival of our fuel.

We forecast and plan on different time scales:

- Days to weeks:
  - plan generation and offers into the market to use intermittent wind and to move water through the river chain
- Months to years:
  - plan generation and contract position, and manage risk through financial instruments
- Years to decades:
  - We make long term projections of generation and new plant

We are always walking the tightrope between:

- Running out, and

**...OVERFLOWING!**

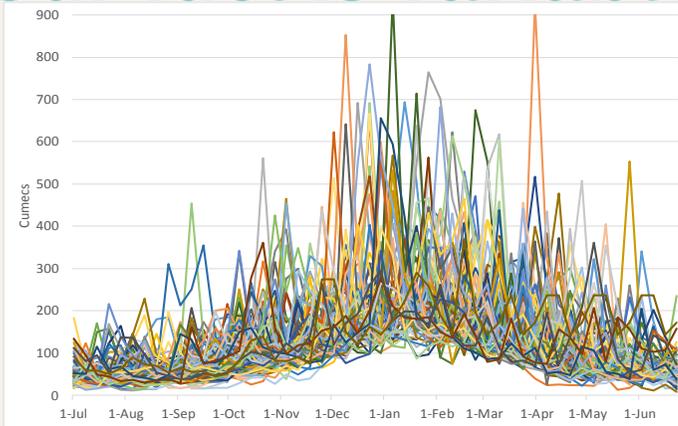


Image: Genesis Energy's Tekapo B station

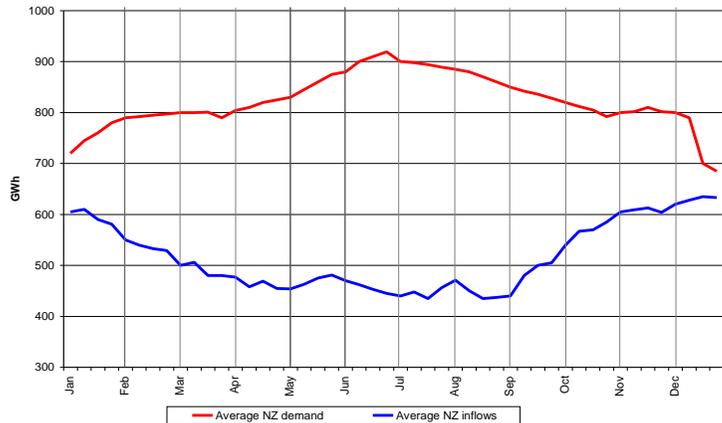


Image: Contact Energy's Clyde Dam

# Our fuel is variable.

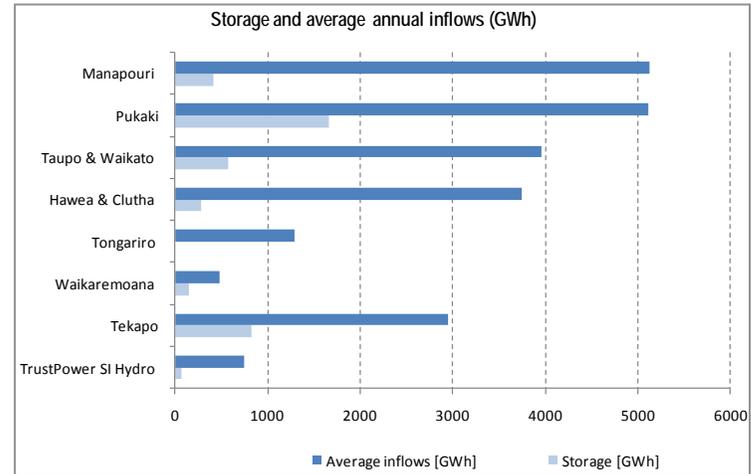


Lake Pukaki weekly average inflows 1931-2013



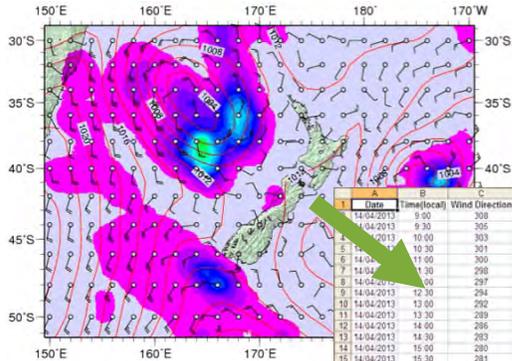
New Zealand hydro inflows vs electricity demand

- Our fuel arrival varies from year to year
- It's arrival is anticorrelated with electricity demand
- We have limited ability to store it
- We have to plan the number of customers/contracts that we take on ahead of time
- We can offset some of our fuel variability with planning and financial instruments



Sources:  
Meridian

# Predictability – short term.

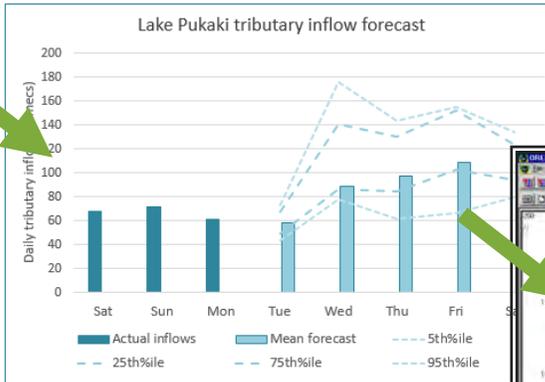


Weather forecast

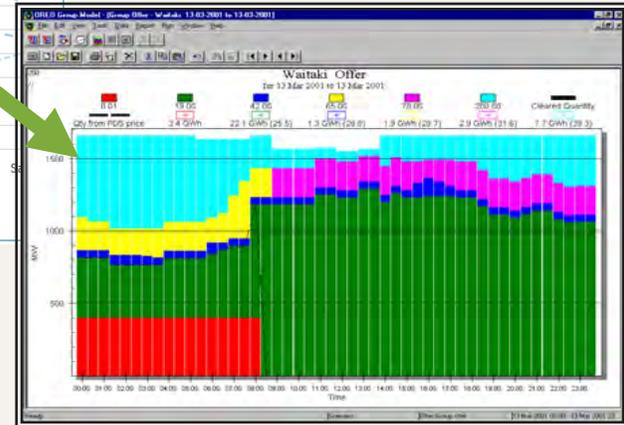
Date	Time(local)	Wind Direction	Wind Speed	5thPercentile	10thPercentile	25thPercentile	50thPercentile	75thP
14/04/2013	9:00	308	9.1	4.9	5.9	7.3	8.9	-
14/04/2013	9:30	305	9.1	5	6	7.4	9	-
14/04/2013	10:00	303	9.2	5.1	6.2	7.5	9	-
14/04/2013	10:30	301	9.1	5.1	6.1	7.5	9	-
14/04/2013	11:00	300	9	5.1	6.1	7.4	8.9	-
14/04/2013	11:30	298	8.9	5	6.1	7.4	8.9	-
14/04/2013	12:00	297	8.8	5	6.1	7.4	8.9	-
14/04/2013	12:30	294	8.8	5	6.1	7.4	8.8	-
14/04/2013	13:00	292	8.8	5	6.1	7.5	8.8	-
14/04/2013	13:30	289	8.9	5.1	6.1	7.5	8.9	-
14/04/2013	14:00	286	8.9	5.1	6.2	7.5	8.9	-
14/04/2013	14:30	283	8.7	4.9	6	7.4	8.9	-
14/04/2013	15:00	280	8.6	4.8	5.8	7.2	8.8	-
14/04/2013	15:30	281	8.3	4.6	5.6	6.9	8.6	-
14/04/2013	16:00	281	8.1	4.5	5.4	6.6	8.4	-
14/04/2013	16:30	282	7.8	4.3	5.3	6.4	8.1	-
14/04/2013	17:00	283	7.6	4.2	5.1	6.2	7.9	-
14/04/2013	17:30	286	7.5	4.2	5	6.1	7.8	-
14/04/2013	18:00	289	7.3	4.1	5	6	7.6	-
14/04/2013	18:30	294	7.4	4.2	5.1	6.1	7.7	-
14/04/2013	19:00	298	7.5	4.3	5.2	6.3	7.9	-
14/04/2013	19:30	302	7.5	4.1	5.1	6.2	7.8	-
14/04/2013	20:00	306	7.4	3.9	4.9	6.0	7.6	-
14/04/2013	20:30	308	7.5	3.9	4.9	6.2	7.7	-
14/04/2013	21:00	310	7.6	3.9	4.8	6.2	7.8	-
14/04/2013	21:30	310	7.4	3.6	4.6	6	7.6	-
14/04/2013	22:00	310	7.3	3.4	4.3	5.8	7.5	-
14/04/2013	22:30	311	7.3	3.4	4.4	5.8	7.5	-
14/04/2013	23:00	313	7.3	3.4	4.4	5.7	7.4	-
14/04/2013	23:30	307	7.2	3.5	4.4	5.7	7.4	-

Quantified half-hourly rainfall and wind forecast

Inflow forecast



Offer into electricity market



# Predictability – medium term - cycles.

## El Nino – Southern Oscillation (ENSO)

- Periodical variation in winds and sea surface temperatures over the tropical Pacific Ocean
- 2-5 year cycle
- Significant impact on our inflows and wind

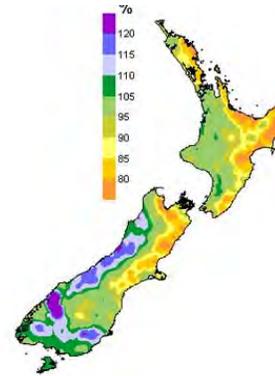
## Southern Annular Mode

- Ring of climate variability that encircles the South Pole and extends out to the latitudes of New Zealand
- 6-week cycle wet-dry

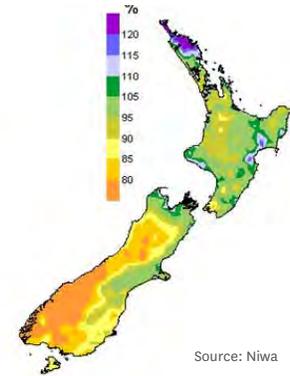
## Interdecadal Pacific Oscillation (IPO)

- Long term oscillation of the Pacific Ocean
- 20-year cycle
- 1977-99 was wet, 2000– now dry

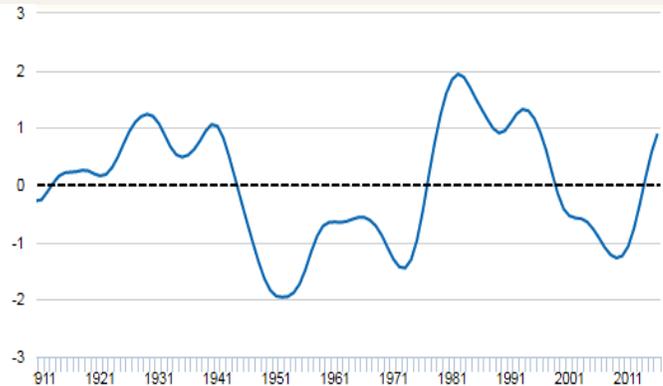
Summer El Nino rainfall anomaly (%)



Summer La Nina rainfall anomaly (%)



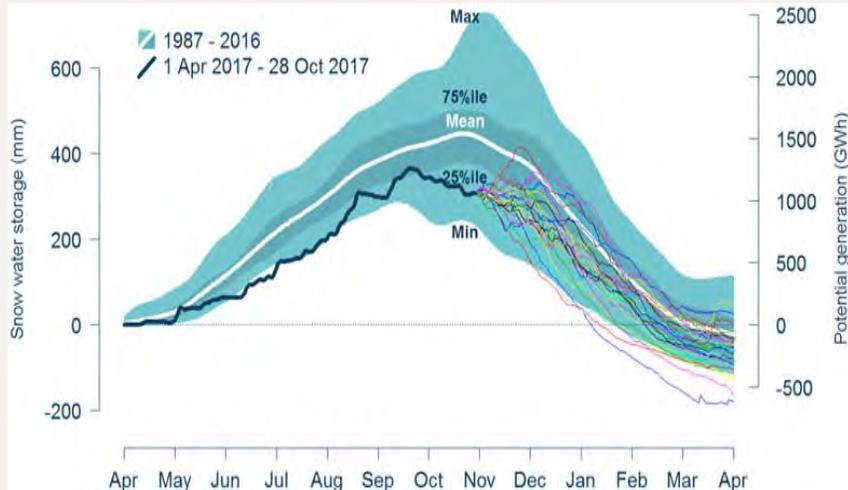
Source: Niwa



Source: Met Office, Hadley Centre for Climate Change

Inter-decadal Pacific Oscillation (IPO) index 1911-2016

# Predictability – medium term – snow



- Snowmelt contributes half of our summer inflows in the Waitaki catchment
- Difficult to measure in a mountainous catchment
- Several high-altitude measurement sites
- A snowpack simulation model estimates GWh stored as snow
- Useful in spring/summer inflow forecasting

# Predictability – long term climate change.



Image: Upsala glacier, Argentina



Image: Mt Hood, Washington

The climate is changing

- Glaciers are retreating
- Seasonal snow is disappearing
- Sea level has risen by 20cm in the past century



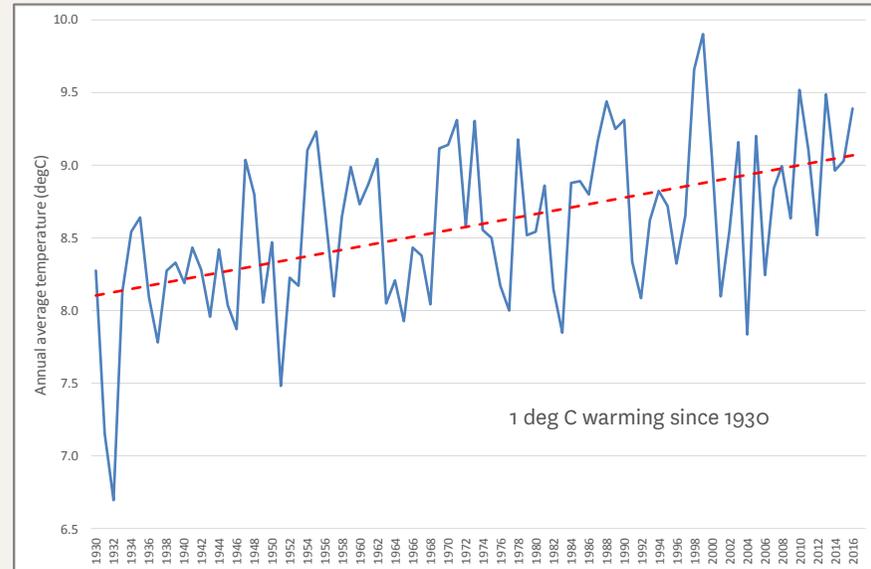
- A 1 metre sea level rise is predicted to make 15 million people in Bangladesh homeless

# Climate change - local changes.



Images: Glacial retreat at Mt Cook National Park – Tasman Glacier

- Warming trend at local climate stations
- Snow and ice recession in our headwaters

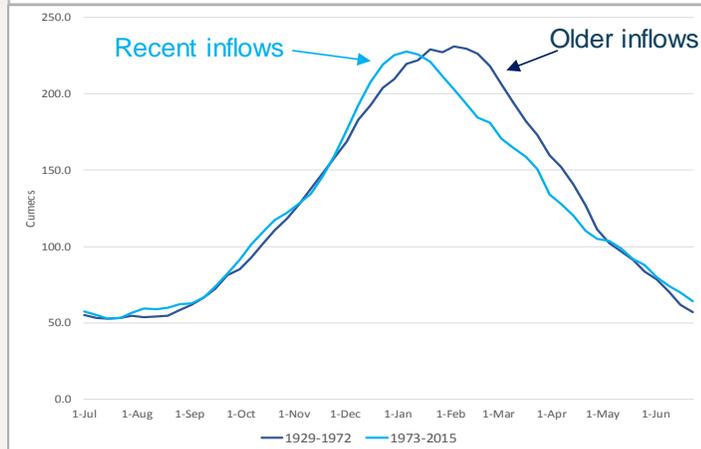
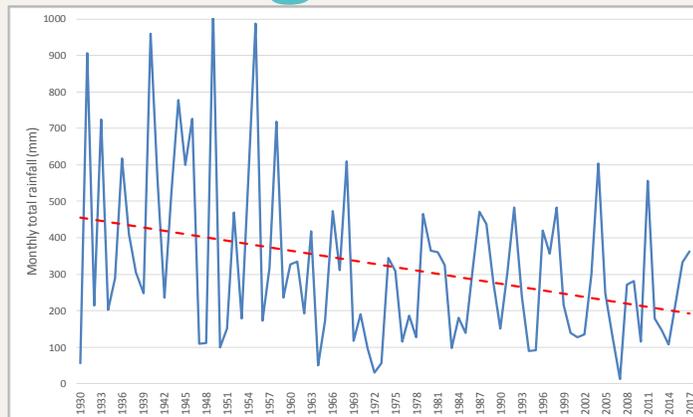


Hermitage annual average temperature 1930-2017

Meridian Energy Limited Investor Day November 2017 → 96

# Climate change – local changes.

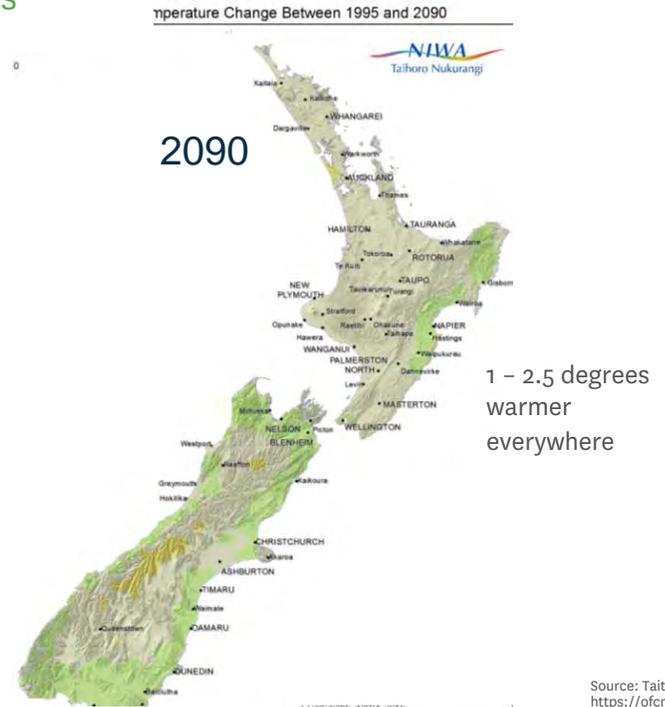
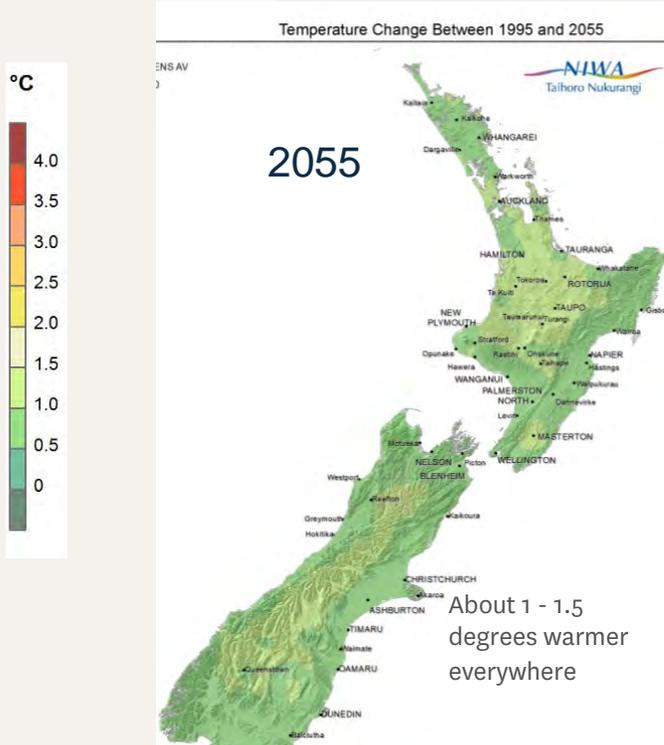
- Annual rainfall and inflow totals have not changed significantly over the 90 years of record...
- but the seasonality of our rainfall and inflows *has* changed significantly over the past 90 years
- Autumns have become up to 20% drier over time
- Mid-summer has become slightly wetter
- We have incorporated these changes into our generation modelling and planning



# What can we expect in the future?

Niwa take global climate model (GCM) projections and regionally downscale them to predict what climate changes we can expect in NZ

## Temperature changes



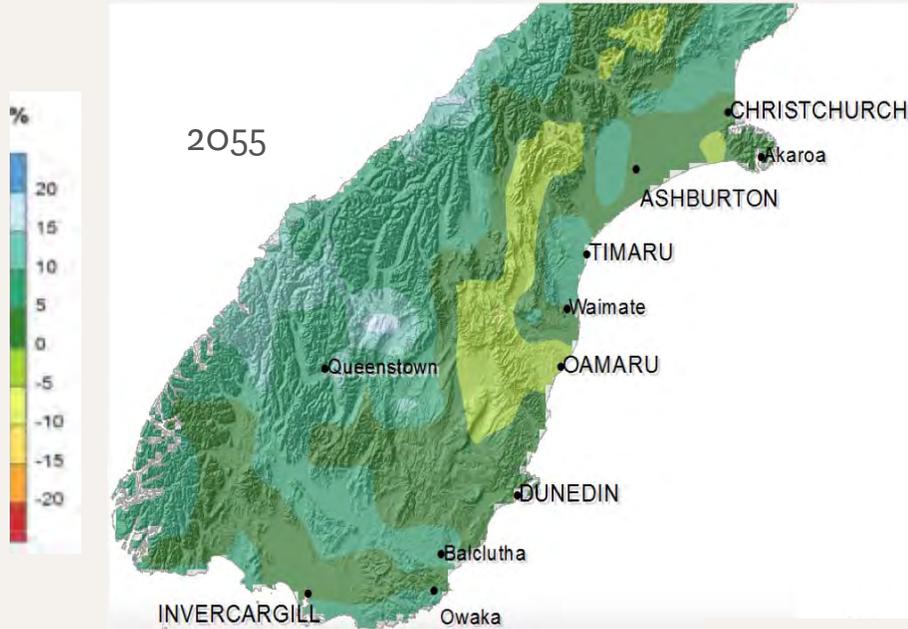
# Rainfall changes – annual



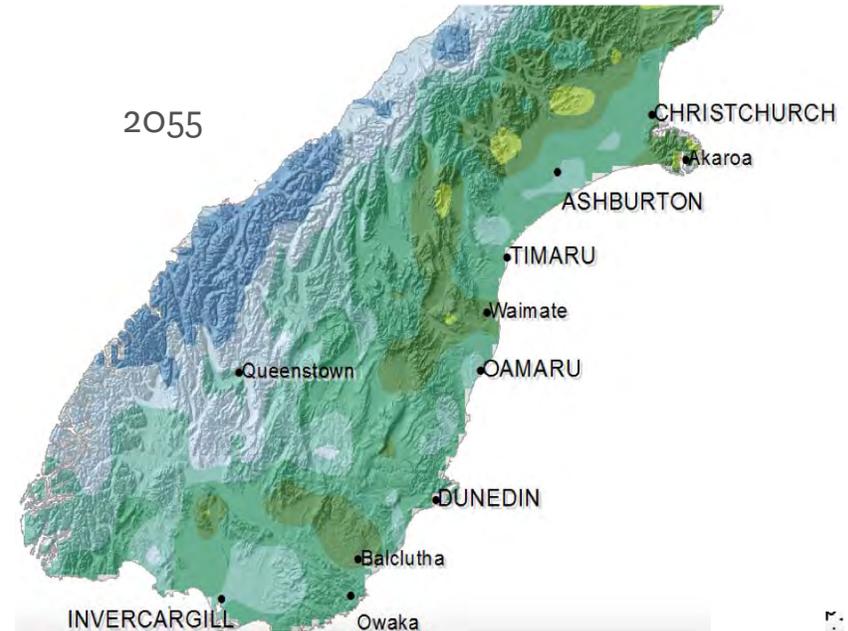
Projected annual rainfall changes in NZ by 2050 and 2090 under a “middle of the road” emissions scenario

Source: Tait et al 2016, <https://ofcnz.niwa.co.nz>

## Rainfall changes – seasonal



Summer rainfall is projected to increase 5-15% in our catchment headwaters



Winter rainfall is projected to increase 15-25%

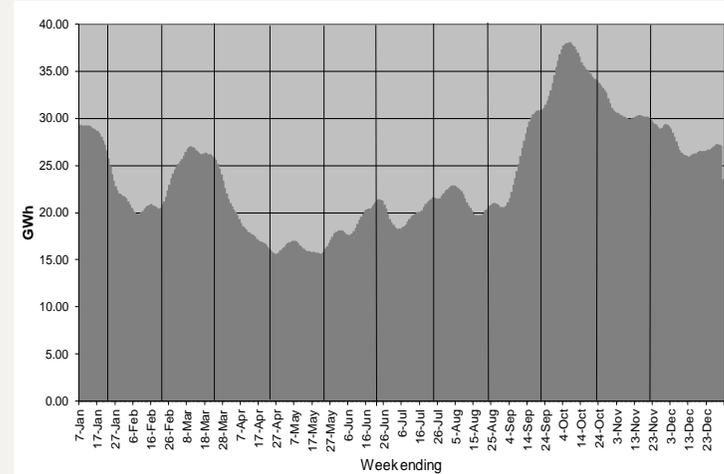
Source: Tait et al 2016, <https://ofcnz.niwa.co.nz>

## Wind

- The frequency of extreme winds over New Zealand is likely to;
  - Increase in almost all areas in winter
  - Decrease in summer

## Heavy rainfall

- Larger heavy rainfall events are projected to occur in NZ
- Partly because of increased westerly winds (more and stronger fronts)
- And also because warmer air can carry more moisture (about 8% more moisture for every 1 degC warming)
- Studies suggest a 100-year return period peak river flow in NZ will become a 20-year return period event by 2100 (Gluckman P.D 2013, Lawrence et al 2013)

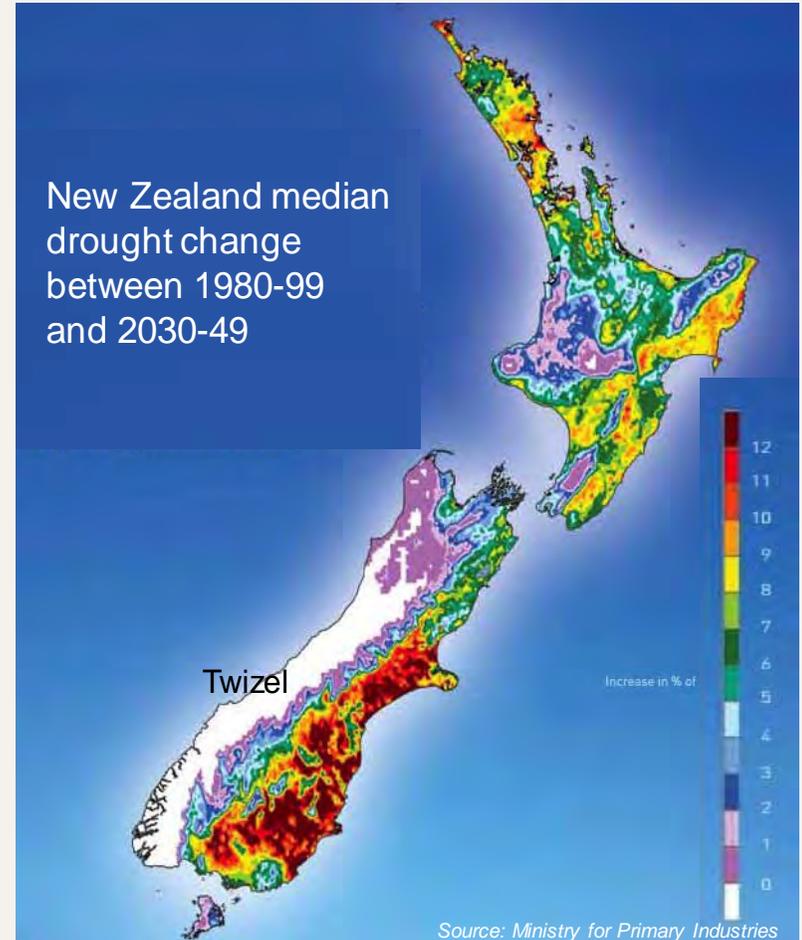


Long term average wind generation at Meridian wind farms



## Drought

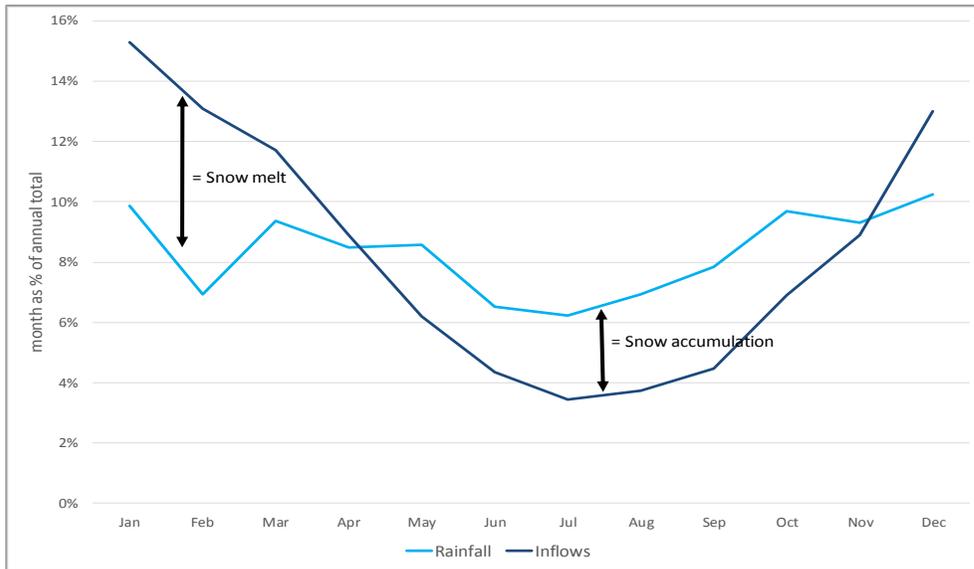
- No change to drought frequency is predicted in our catchments over the next 50 years
- Approx. 10-12% more time in drought is predicted for the East Coast of the South Island
- An increase of 10% corresponds to about 35 more days in drought per year, on average
- This is likely to increase irrigation demand



## Snow

- Snow amounts are predicted to decrease and snowlines rise under climate change
- 80-90% of current snow depths by 2040
- 50-80% of current snow depths by 2090

Source: Niwa

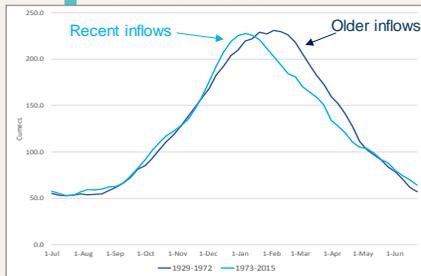
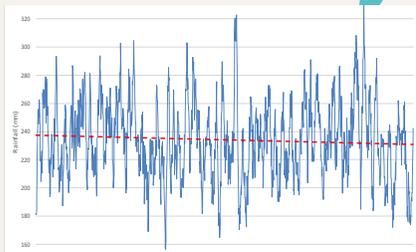


Lake Pukaki inflows vs Hermitage rainfall: monthly totals as % of annual total

- 50% of Waitaki summer inflows = snow melt
- So future inflows will be lower in summer and higher in winter...
- (but are predicted to be higher overall)



# Summary of predicted changes in climate.



We have seen:

- No significant change to hydro catchment rainfall and inflows over the last 100 years, but...
- Significant seasonal shifts in inflow regime
- Snowpack and glaciers getting smaller over time

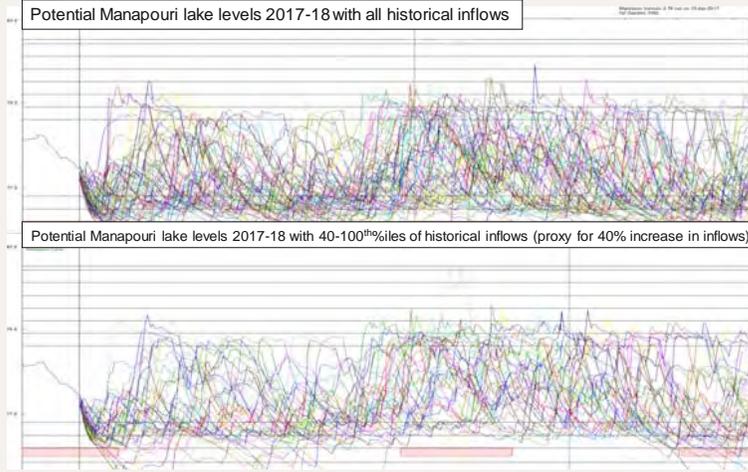


Projected to get:

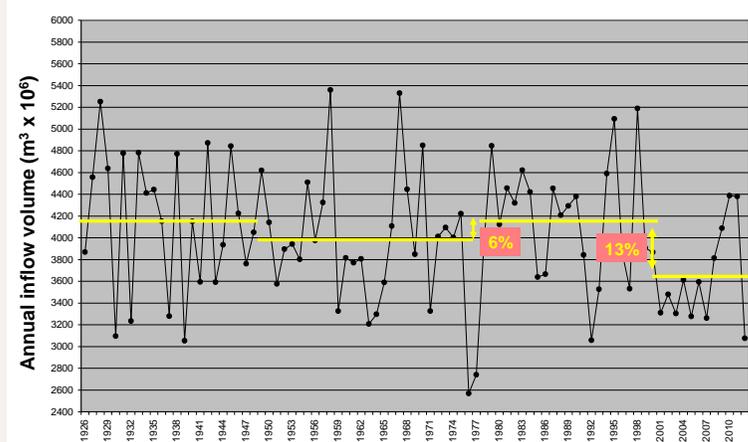
- Wetter in our catchments
- Drier in current irrigation areas
- Warmer everywhere
- Windier at our wind farms, especially in winter
- Better match between fuel and demand



# Impacts on Meridian of predicted changes in climate.



Manapōuri forecast lake levels under current inflows (top) and a projected 20% increase in rainfall (bottom)



## These changes may result in:

- Inflow regime better matching demand
- Higher summer electricity demand (irrigation) and lower winter demand (heating)
- Higher lake levels generally, particularly at Manapōuri
- Bigger individual rain storms
- More wind generation

## Changes relative to our current operations:

- We already work with fuel variability
- ENSO and the IPO move our inflow regime 10% to the wet or dry already
- We regularly reassess our probable maximum flood estimate for dam safety already

# Thank you.



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[www.meridianenergy.co.nz/investors/](http://www.meridianenergy.co.nz/investors/)

All currency amounts are in New Zealand dollars unless stated otherwise.