

Tracing the flow of electricity in New Zealand

EEA Conference - 17th June, 2010

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Electricity Commission of New Zealand

17th June, 2010



Outline

1

Introduction

- Overview of methodology
- General examples
- Market Development examples
- Future work



Conventional wisdom

- ***impossible to trace the flow of power from individual generators to individual loads***

...because one unit of electricity is indistinguishable from all other units, it is impossible to determine which generator produced which electricity.

Australian Energy Market Operator – ‘An introduction to Australia’s National Electricity Market’ – Dec, 2009.



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Unconventional wisdom

- Assumes the *proportional sharing principle* – Bialek
- Is possible to determine which generator produced which electricity:
 - For each load – the generators that provide supply
 - For each generator – the loads supplied
 - For both demand and generation – the usage of transmission assets
- NZ was first – 1993 TPM



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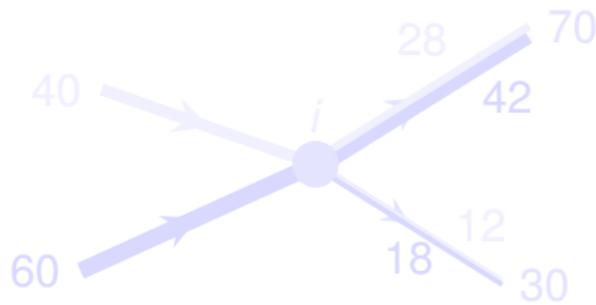


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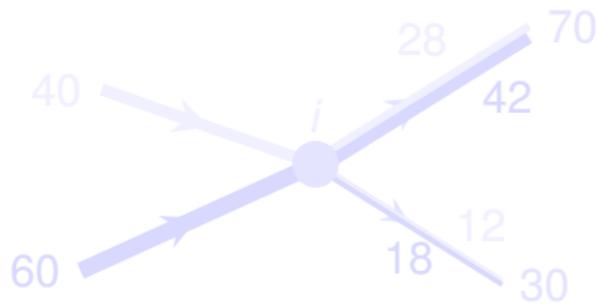
The proportional sharing principle

- At any network node, inflows are distributed proportionally between outflows
- Assumes each bus or node is a perfect mixer



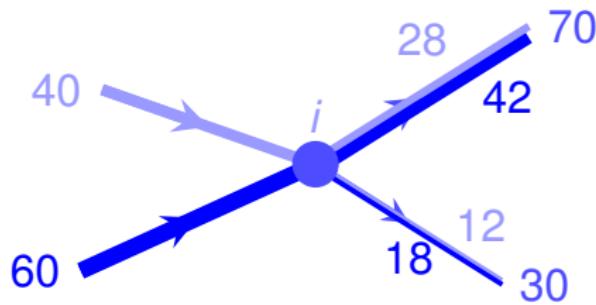
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Why trace the flow of electricity?

- It's interesting!
- Can help 'characterise' grid usage
- Can help inform market participants
- Perhaps most useful as a formulaic allocation methodology
 - Transmission pricing allocation
 - Grid rental allocation (LRA)



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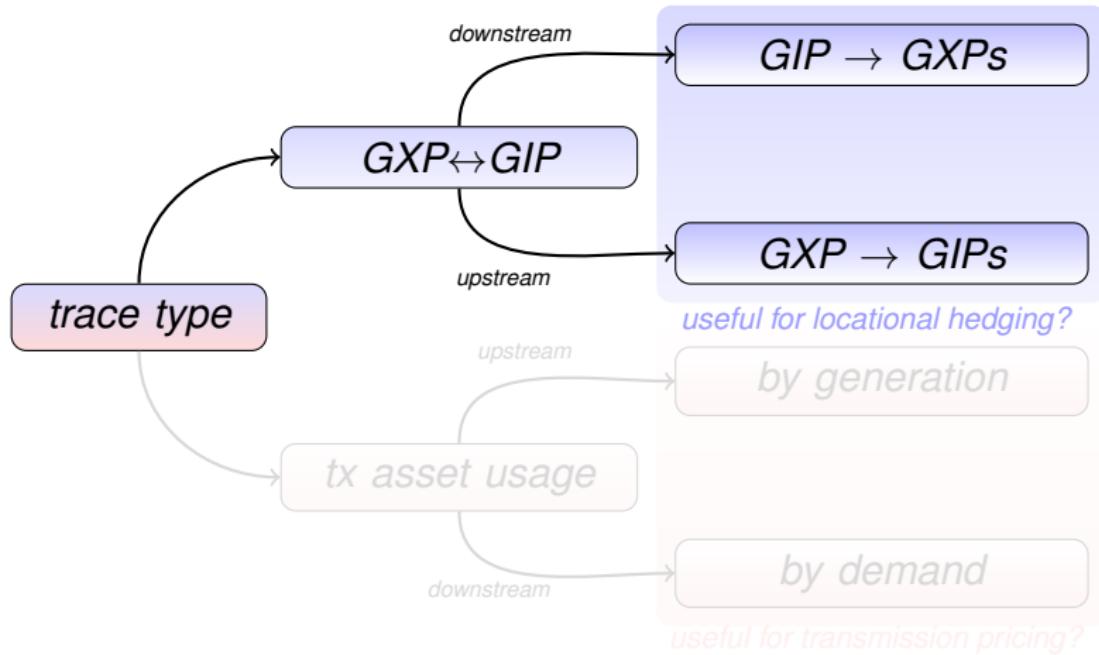


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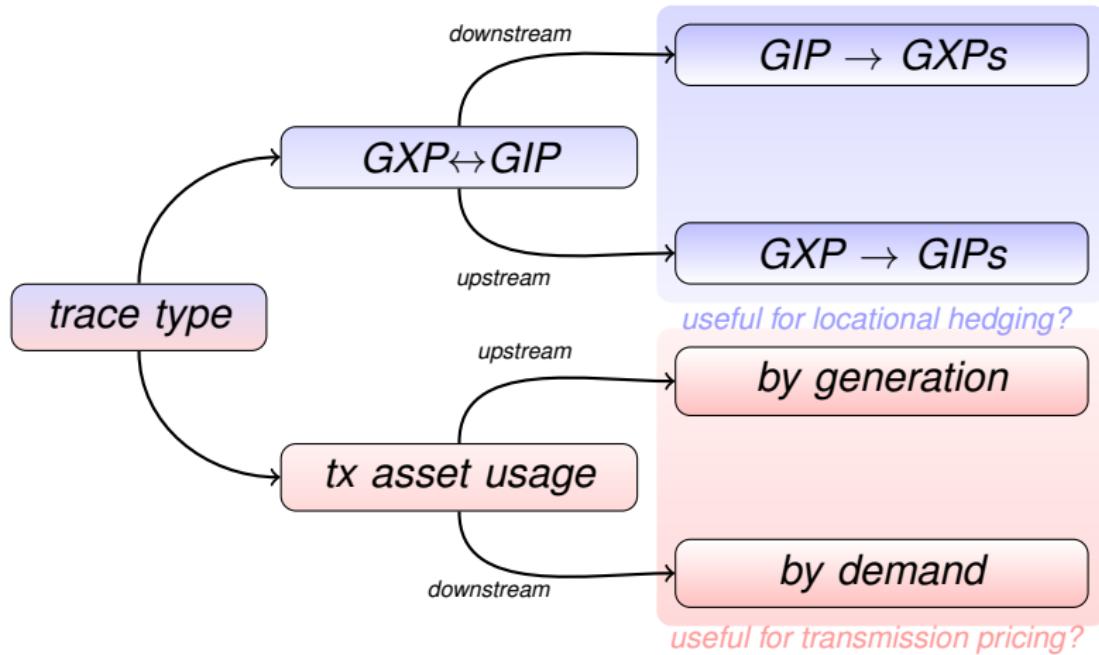
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Types of trace



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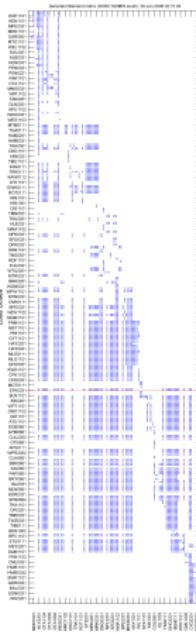
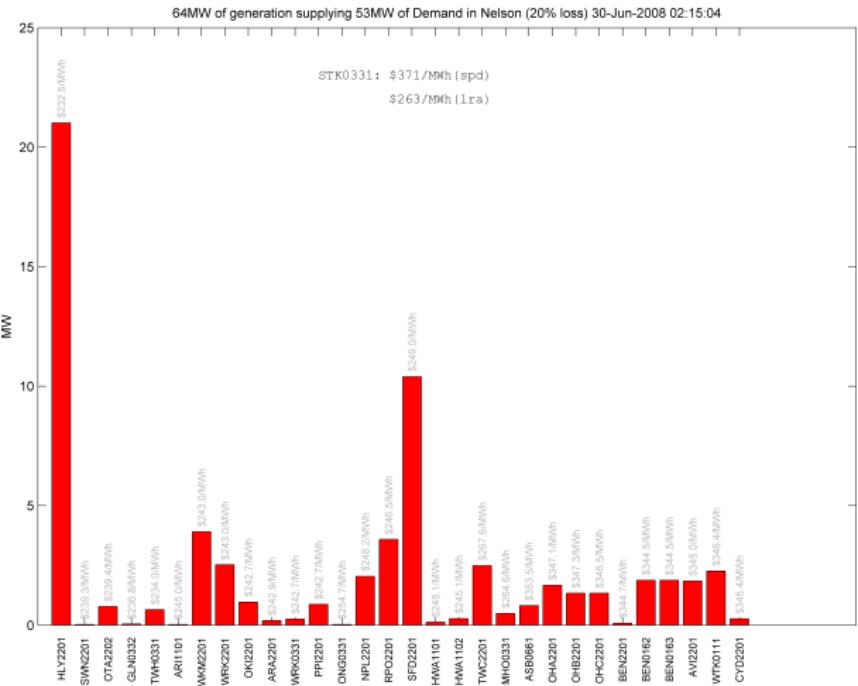
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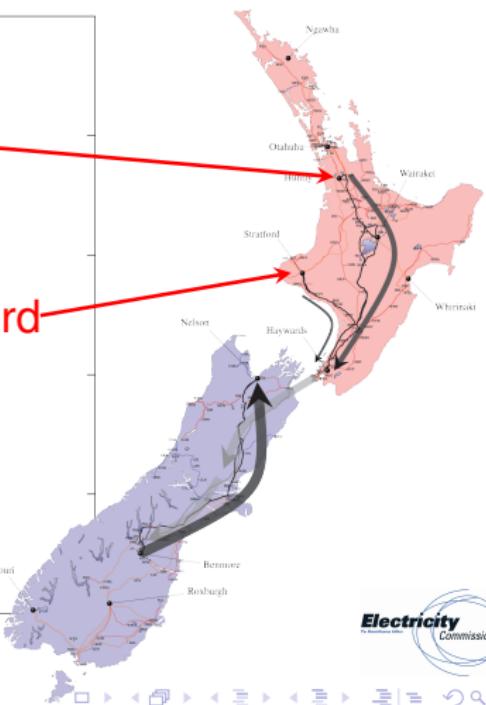
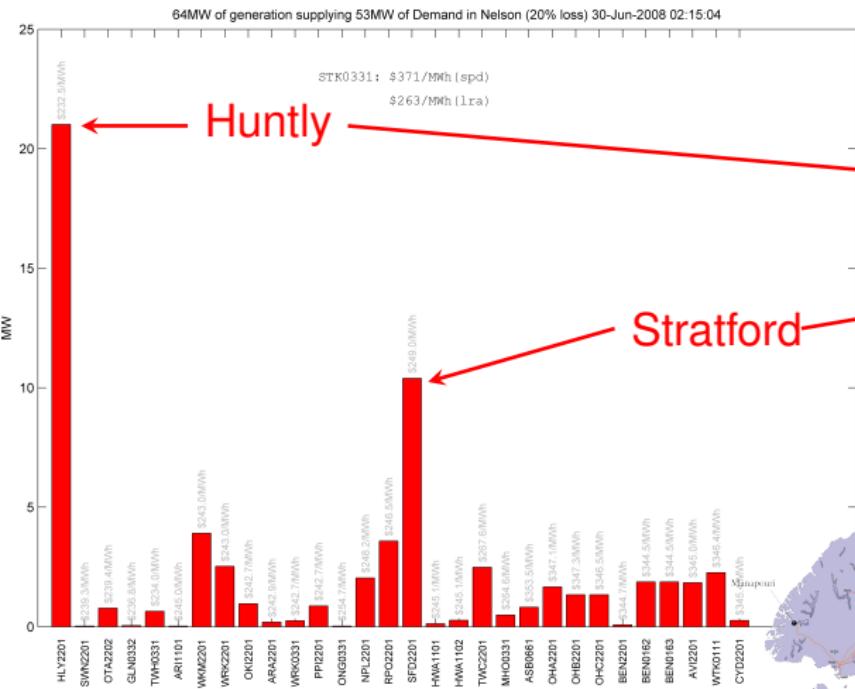
Example: Generation supplying Nelson

Single trading period early in the morning on the 30th June, 2008



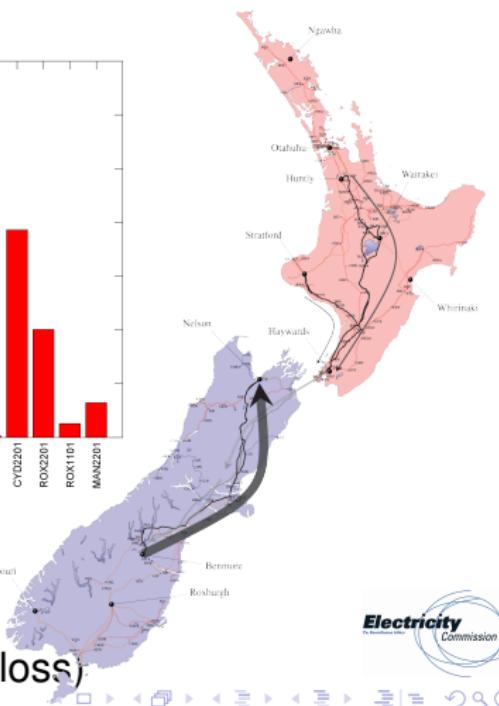
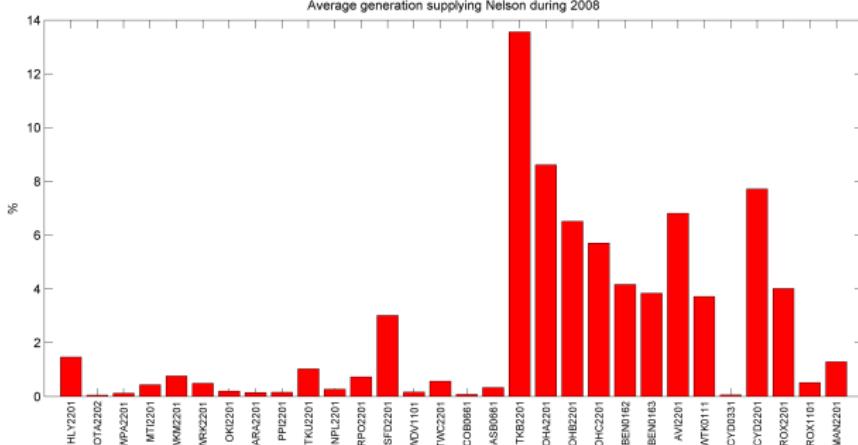
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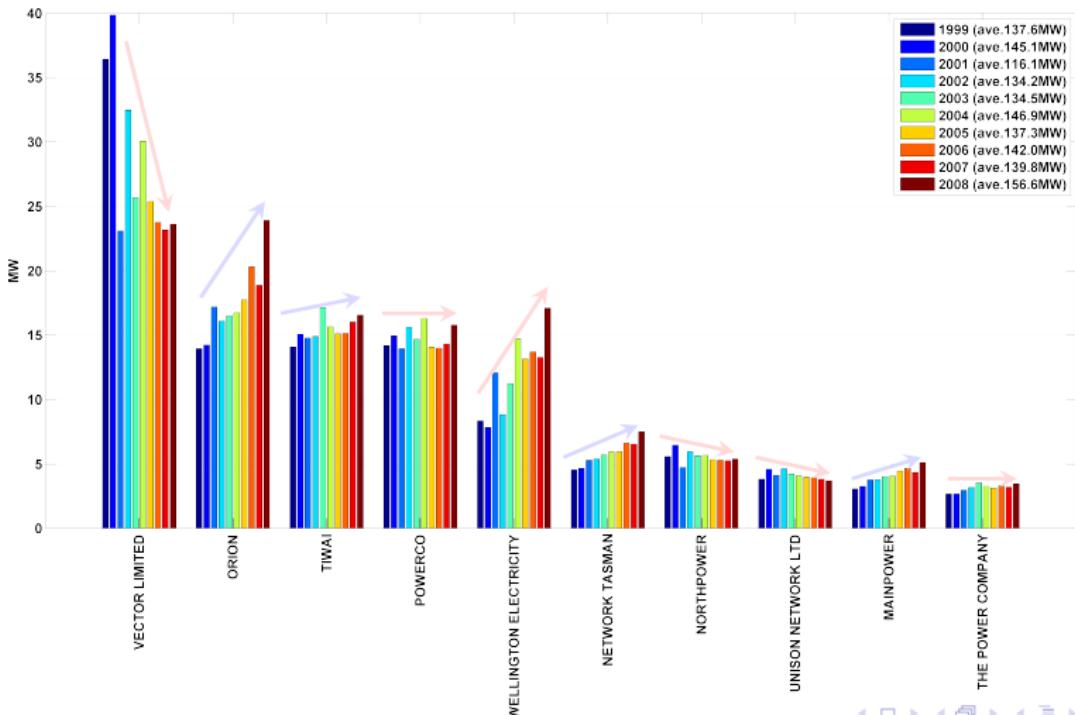
Average over all trading periods during 2008



- Loss across grid can be calculated
- \sum generation – demand
- $78.8\text{MW} - 72.5 \text{ MW} = 6.3\text{MW}$ (8.9% loss)

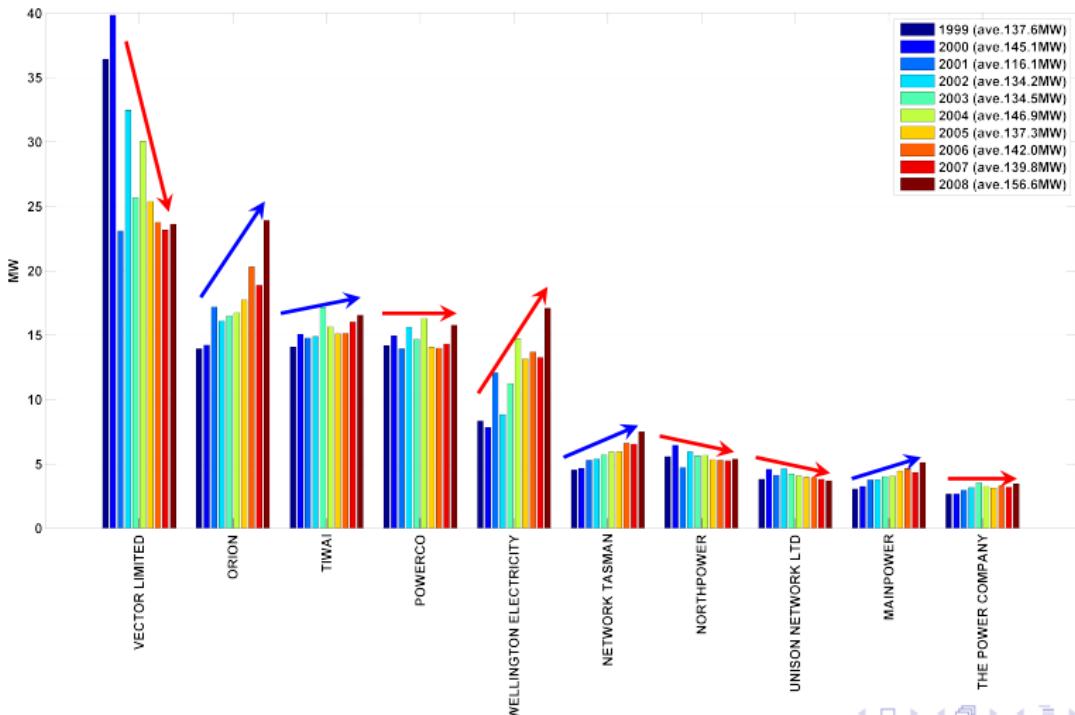
Transpower grid losses

Year-on-year average losses incurred on Transpower's network by customer



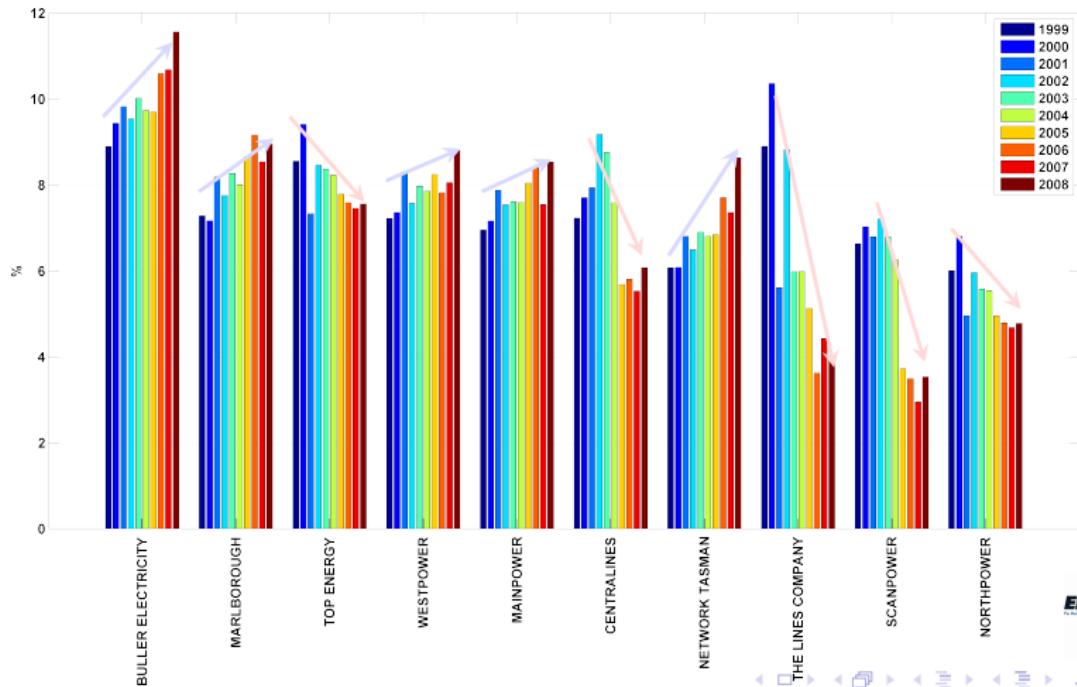
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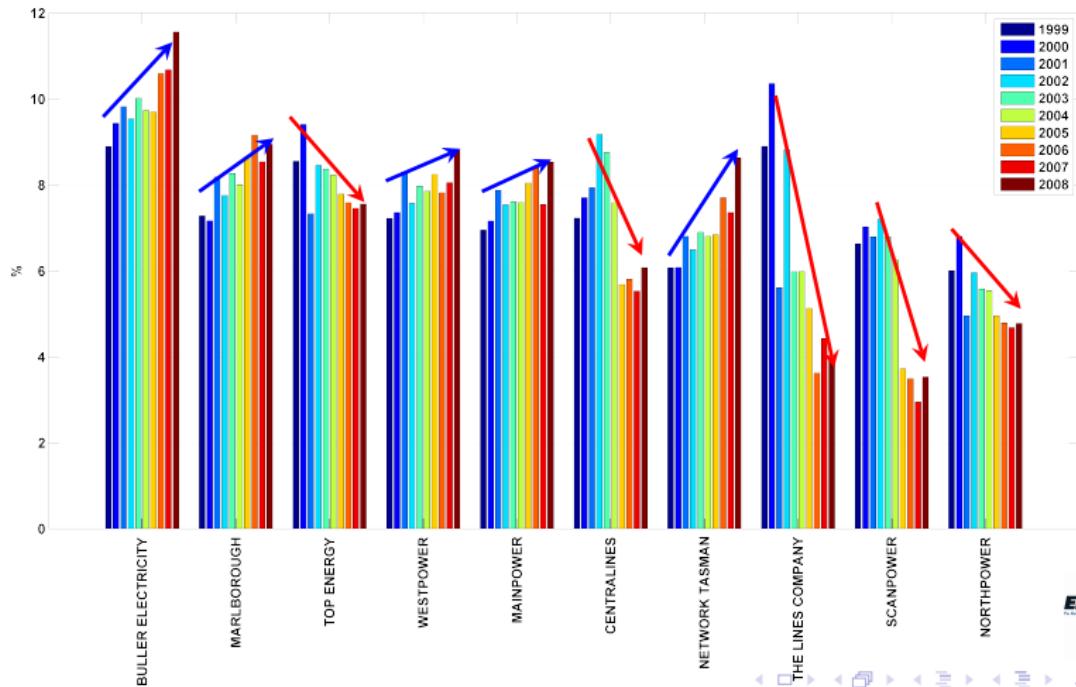
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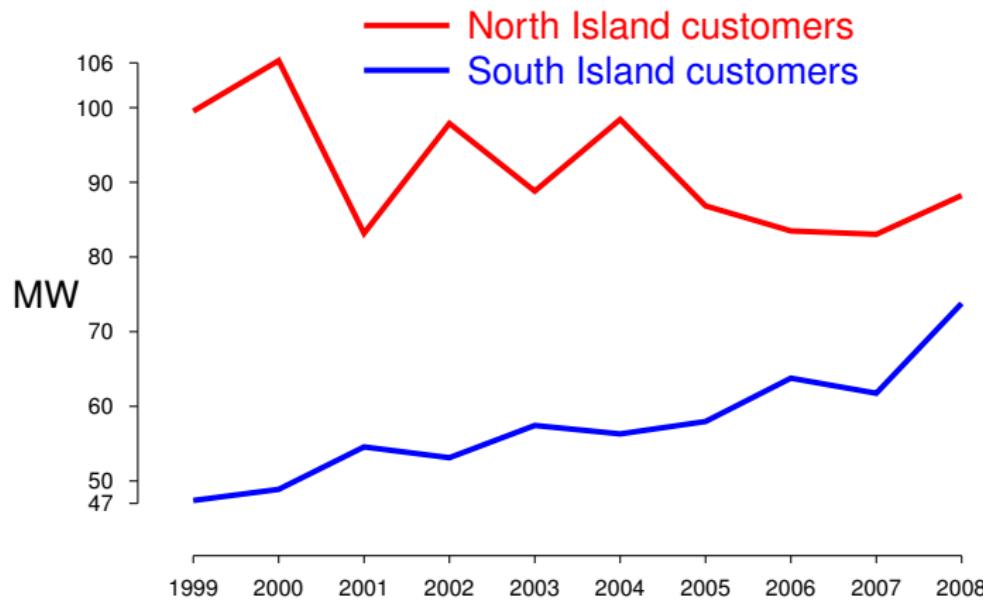
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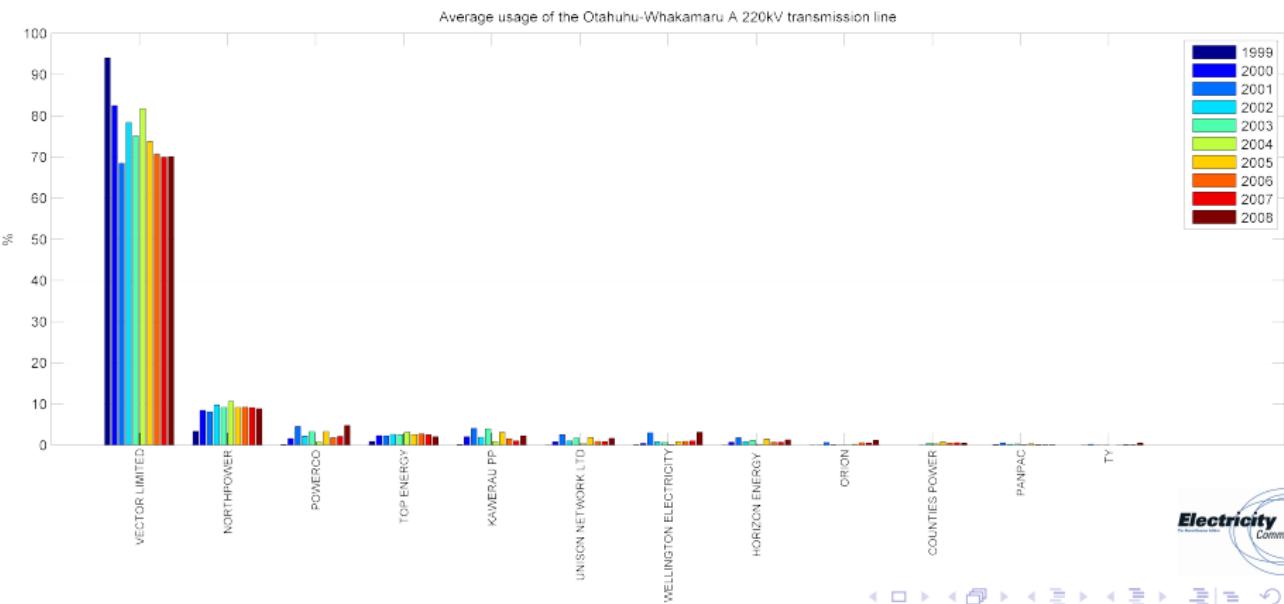
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North and South Island customer grid losses

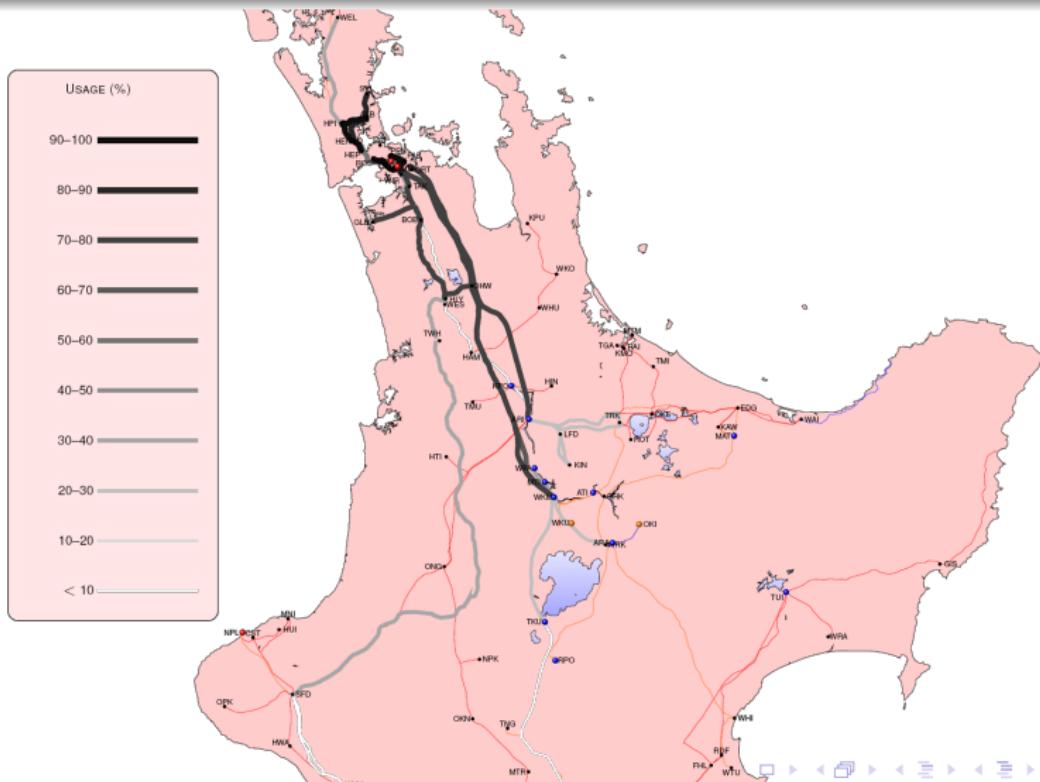


Transpower asset usage

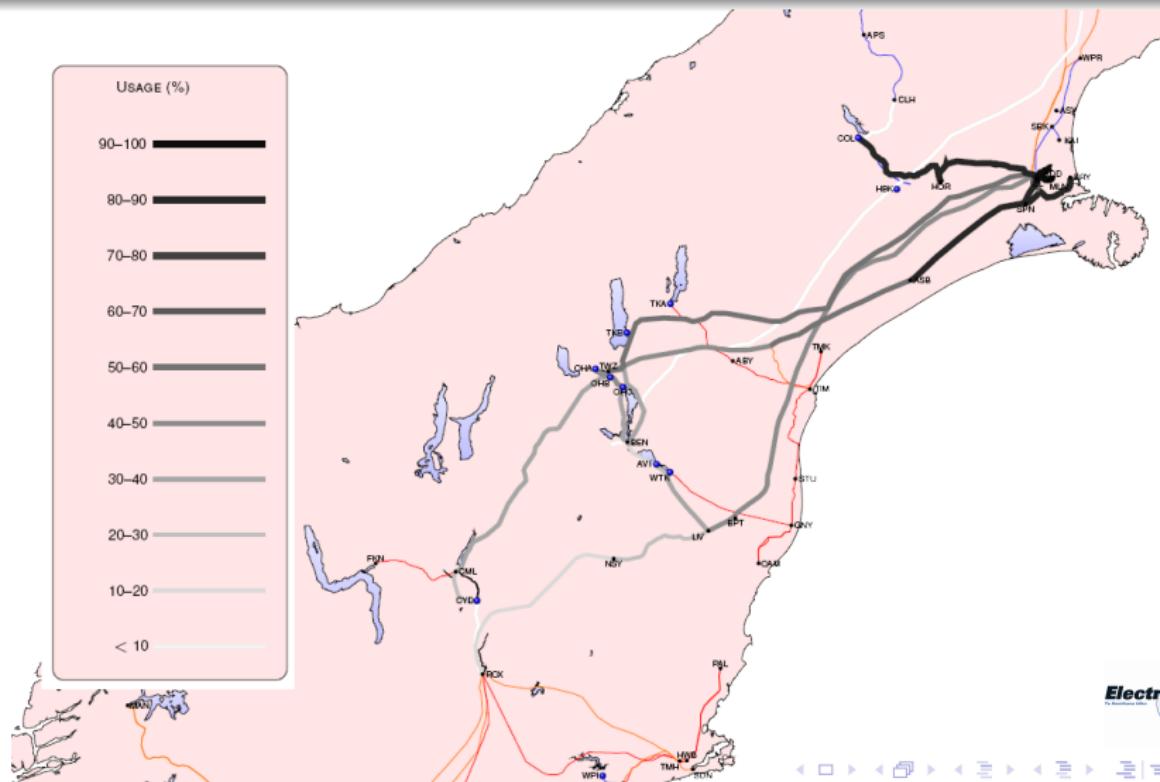
Average usage of the Otahuhu–Whakamaru A 220kV transmission line



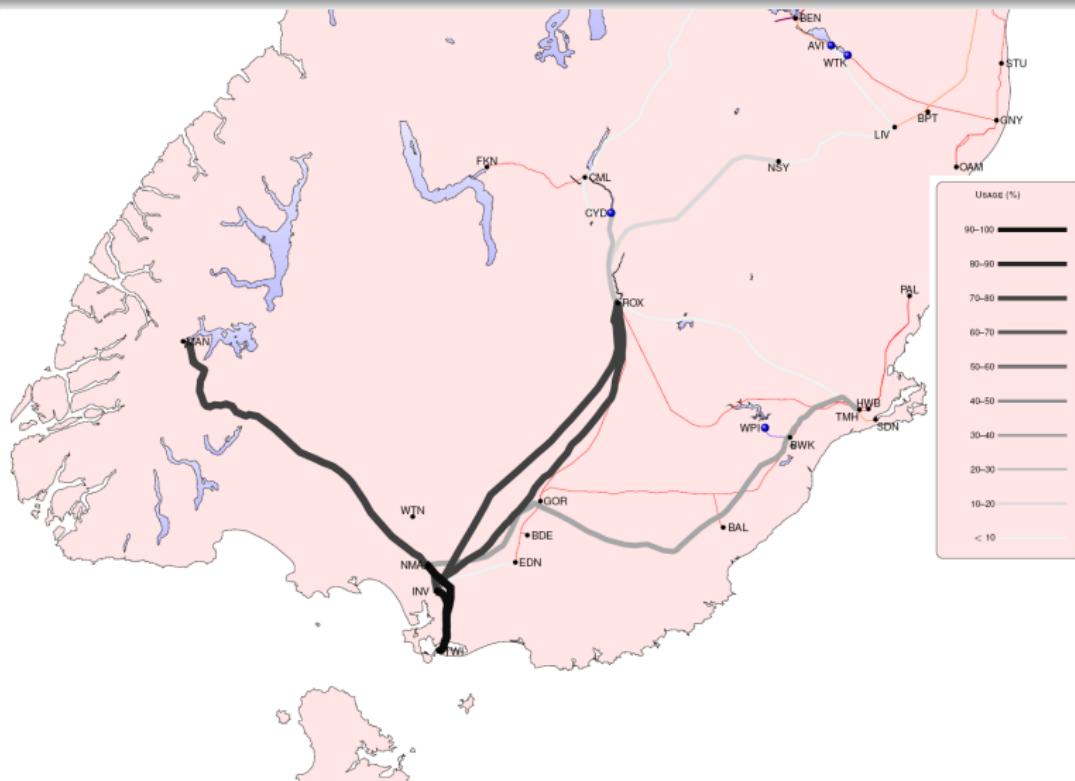
Vector transmission usage – 2007



Orion transmission usage – 2007



Tiwai asset usage – 2007



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Tracing to assist Market Development?

Useful for:

- Transmission Pricing
 - How Transpower allocates transmission charges to customers
- Location Price Risk Management
 - Transmission rental allocation, LRA/FTRs



Transmission Pricing

Current allocation methodology (TPM)

- Connection assets
 - Assets easily identifiable for an individual grid user
 - Costs allocated on a user pays basis
- Interconnection assets
 - All other assets
 - Costs postage stamped to off-take
- HVDC link
 - Costs postage stamped to South Island generators



Connection/interconnection asset distinction

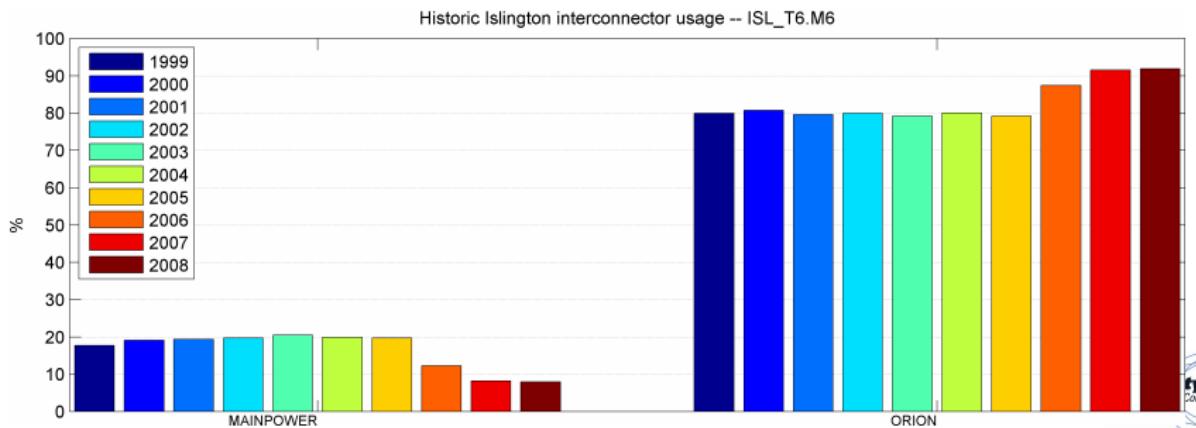
- Creates incentive for grid users to push for new investment in interconnection assets
- Several issues identified by Transpower
 - 220kV/66kV capacity into Christchurch
 - Improving security of supply to Te Awamutu
 - Network configuration in the lower Waitaki Valley
- Possible solutions include:
 - Shallower definition of connected assets
 - Deeper definition of connected assets, or, allocated interconnection



Connection/interconnection asset distinction

Example: 220kV/66kV capacity into Christchurch

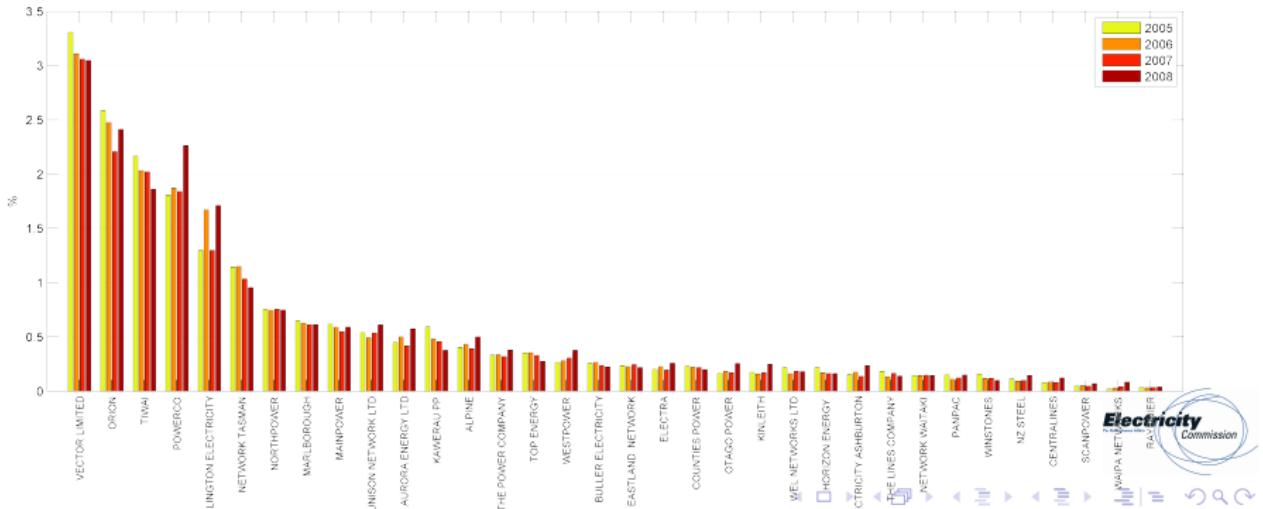
- Orion pays 100% for Bromley investment
≈ 10% for Islington investment
- Tracing usage can help investigate these issues



'Used' grid capacity demonstration

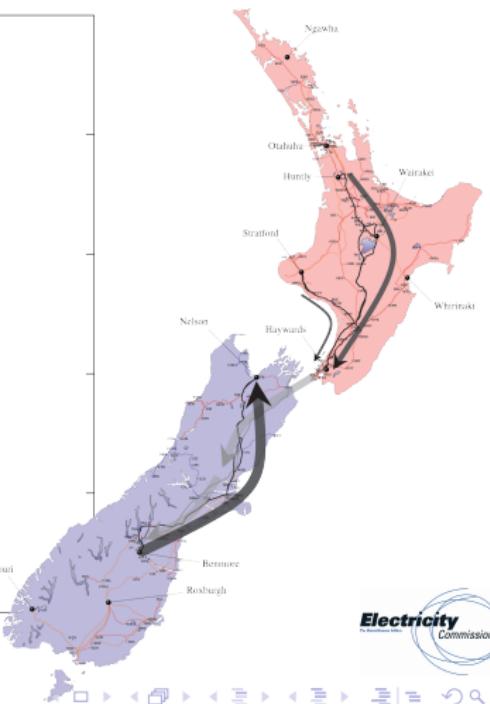
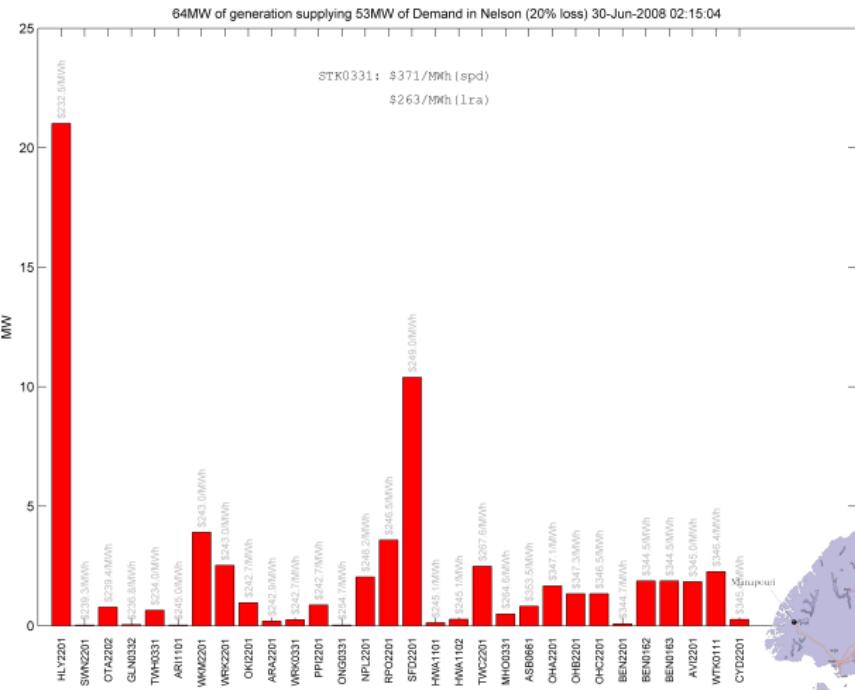
Average usage of Transpower transmission assets, based on asset capacity and replacement cost

- No connection or interconnection asset distinction
- Just 'used' and 'unused' assets
- Used charged to users, unused postage stamped?



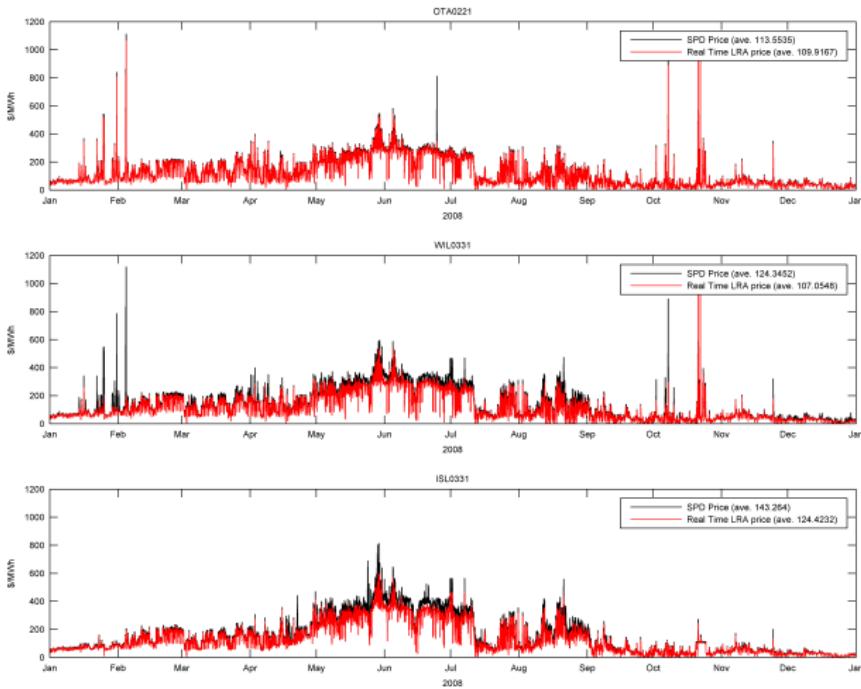
Locational price risk – rental elimination

Generation supplying Nelson GXP (2am–30/06/2008)



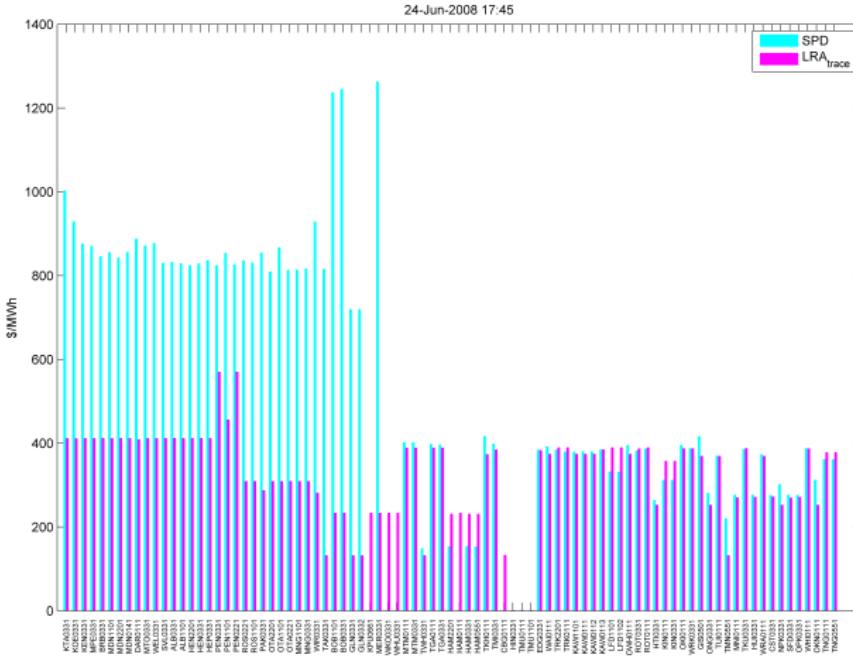
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Nodal and LRA prices at Auckland/Wellington/Christchurch



Locational price risk – rental elimination

Undesirable Trading Situation – 24/06/2008



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Future work

- A lot of data!
- Requires time to investigate
- Much work required on options for transmission pricing
 - Many different options/variants
 - Must have low year-on-year price fluctuation
 - Don't want step changes in customer charges
 - Quantify net positions inclusive of future LRA/FTR



Summary

- Tracing can:
 - ‘Characterise’ grid usage
 - Inform market participants
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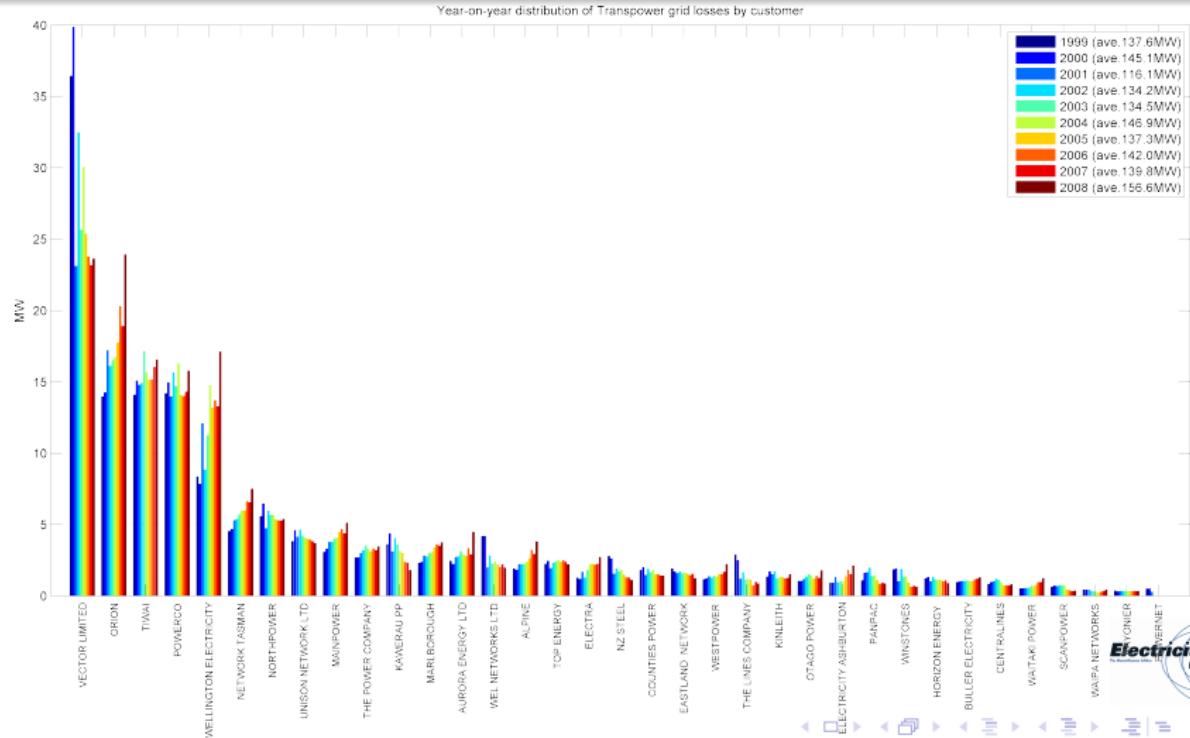
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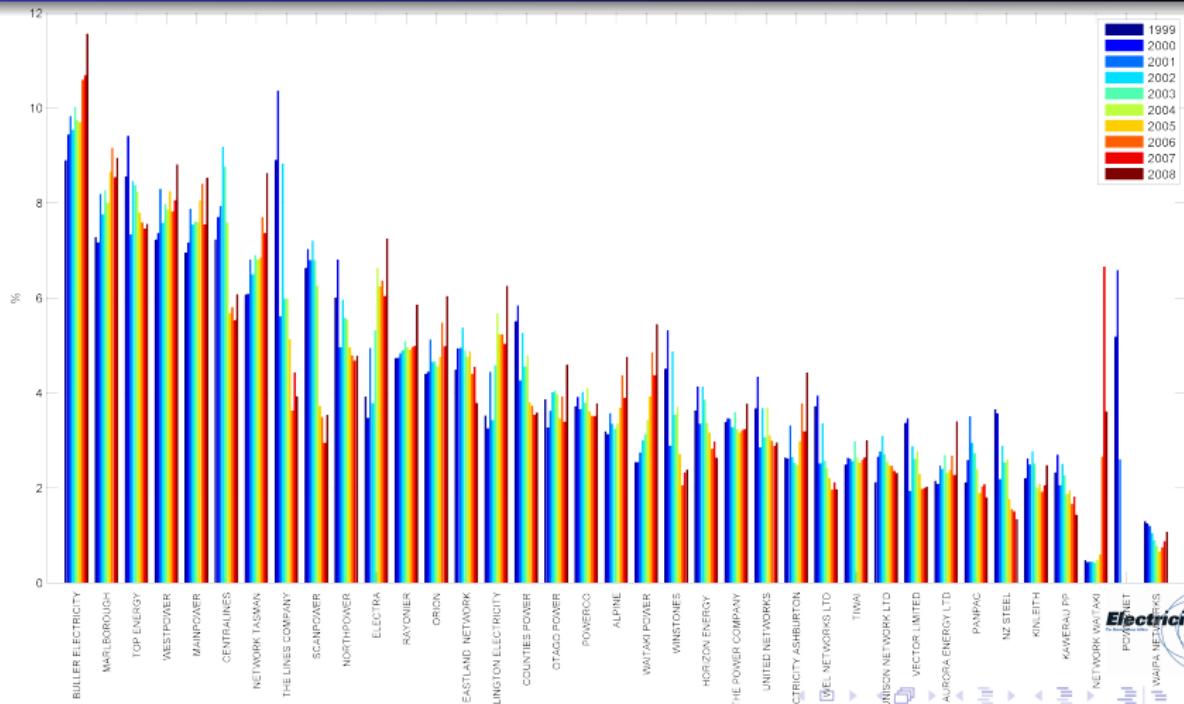
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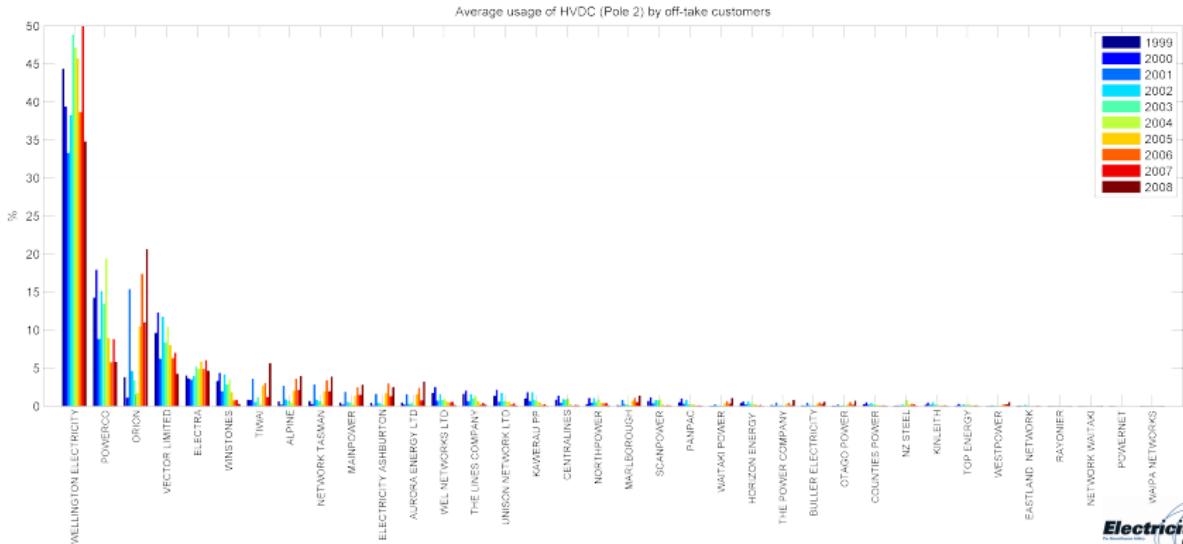
Transpower grid losses

Year-on-year percentage loss of demand incurred on Transpower's network by customer



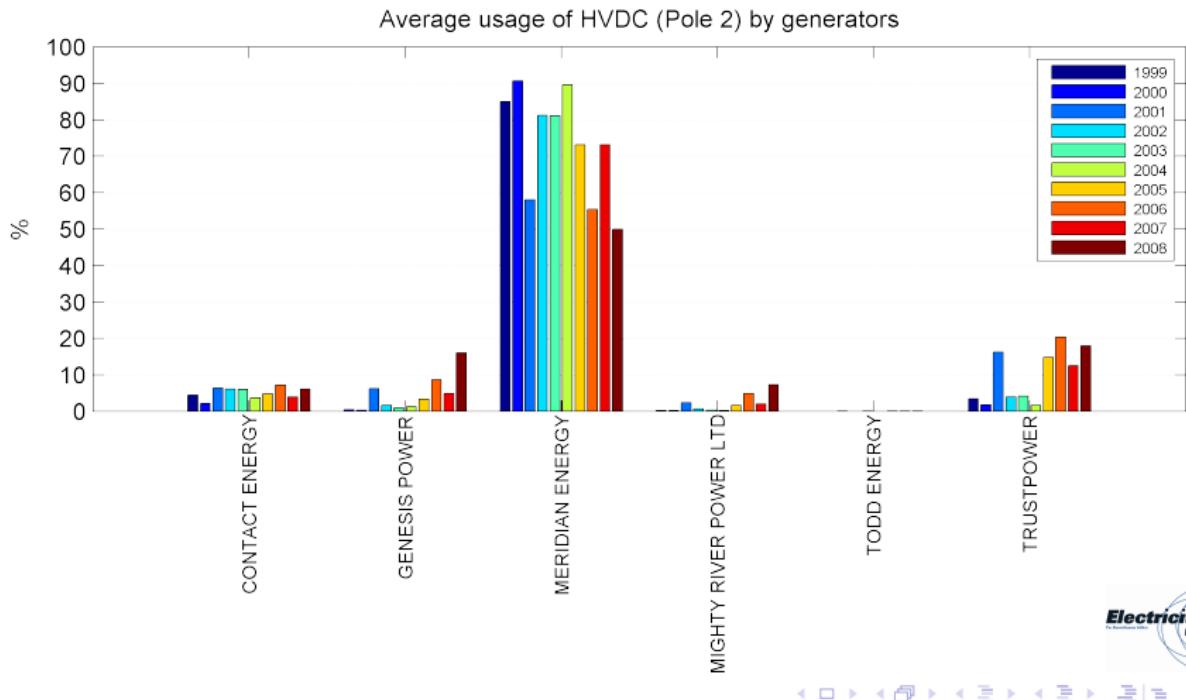
Transpower asset usage

HVDC by demand (not presented in paper)



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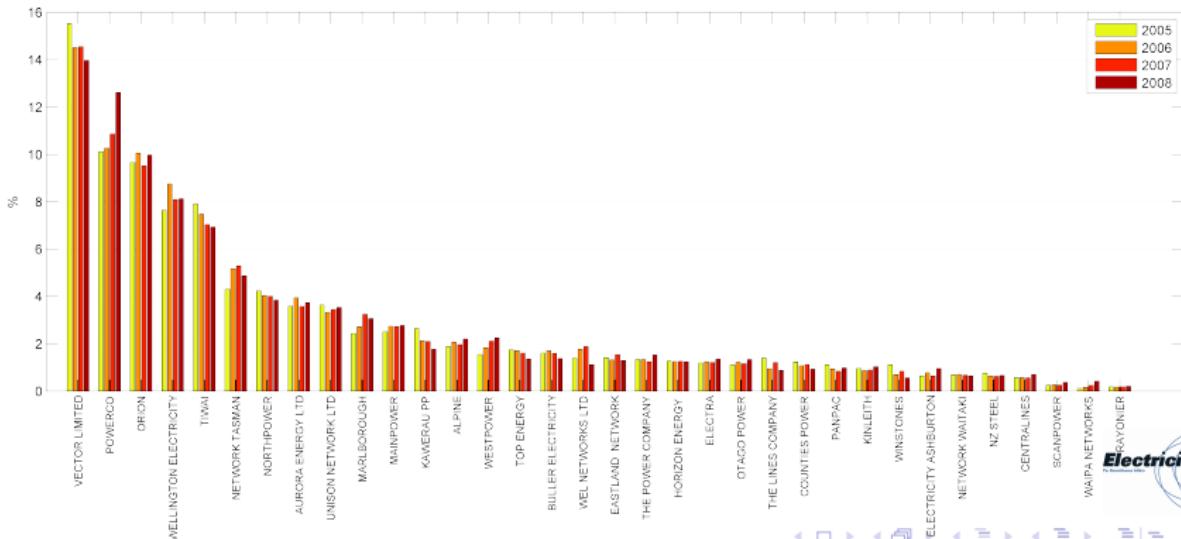
HVDC by generation (not presented in paper)



Transmission Pricing

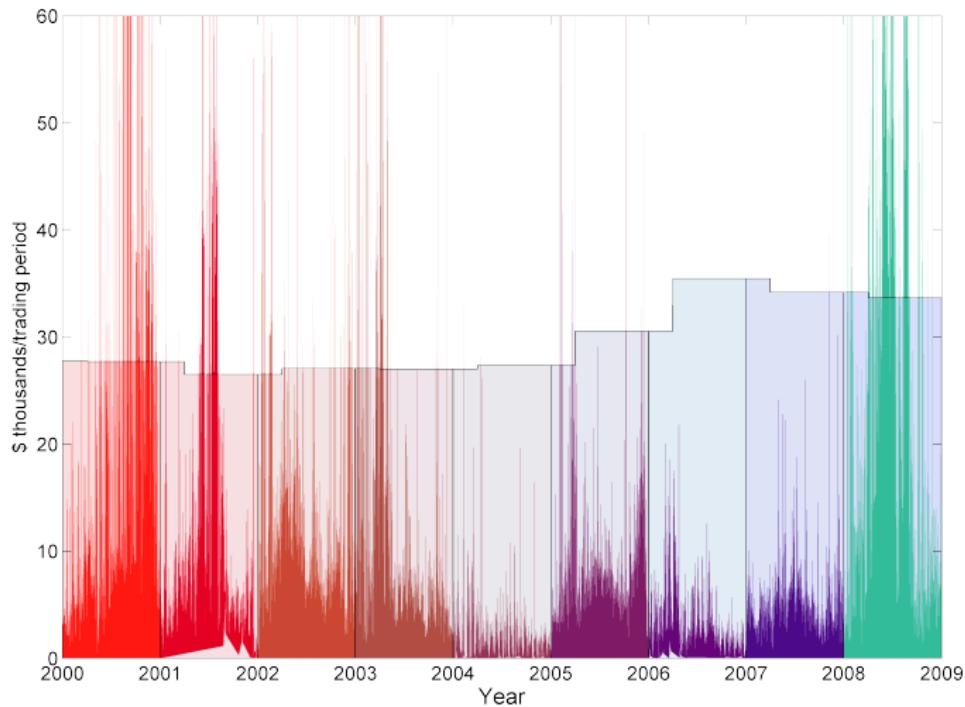
Average usage of Transpower transmission assets, based on asset MW flow

- 100% allocation based on % of MW flow
- perhaps an *extreme* example
- would substantially increase charges to remote locations



Rentals vs TP revenue in perspective

The Wagging Tail – half-hourly



Rentals vs TP revenue in perspective

The Wagging Tail – yearly

