<u>The New Zealand</u> <u>Power System</u> <u>in Balance</u>

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<u>Overview</u>

- New Zealand and its Power System
- Balancing in:
 - Real Time
 - Day ahead
 - Seasonal Operations
- Wind Generation in New Zealand
- Speculation about the Future



New Zealand's Place in the World



No opportunity for interconnection

Have to meet all our own electricity needs







Transpower New Zealand Limited



- The owner of the **National Transmission Grid**.
- The System Operator.



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New Zealand power system



- Two AC island power systems connected by an
 700 MW HVDC link
- Peak Demand, 7001 MW
- Installed Generation, 9040 MW

Total Energy, 42,000 GWhr

Currently 65% renewable: 54% hydro, 8% geothermal, 3% wind



Figure 18: International comparison – electricity prices



Source: Ministry of Economic Development, Energy Data File

The System Operator's Balancing Act







New Zealand Electricity Market

- Security constrained economic dispatch
 - Gross energy pool, no capacity payments
 - Compulsory market, but no compulsion to offer
 - Locational nodal prices, no price caps
 - Energy and reserves co-optimised
 - No rights to transmission capacity
 - No liquid financial hedge markets

In Real Time this means:

- We issue at least every 5 minutes a:
 - Minimum cost, optimised despatch of generation, reserves and transmission capacity
 - While ensuring the N-1 security criteria
- We solve Kirchhoff's Law between 20 to 40 million times per second.
- We observe the conservation of momentum and energy on a continuous basis



Real Time Continued,

- Our load flow models contain over 400 buses and 800 branches.
- Our security constrained economic despatch model has over 20,000 variables and 12,000 constraints, and must solve in under 20 seconds.
- We commissioned our new Market Systems model, that does all this for us (!), 13 days ago, cost \$70 million.





N – 1

Security and Reliability























THE ENERGY and MOMENTUM BALANCE





North Island Load





BALANCING GENERATION AND DEMAND











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0







BRINGING TOGETHER

ECONOMICS AND ENGINEERING









Transmission Line Overloaded





Using High Priced Generation....



\$800/MWh



CHALLENGES

Where is Technology leading?

- Recently commissioned a new Market Systems Program, cost \$70 million, with about \$10 million of secure on line storage.
- Installing "Power System Monitors", (PMUs)

 Provide 100 to 1000 times more data than
 present systems.
- SO's current investigations all focus on data



The System Operator's Dilemma

- Too much DATA
- Limited INFORMATION
- Very little KNOWLEDGE

• How do you improve decision making?





Active Visualisation





Where to !!

- Situational Awareness
 - Providing the SO with the "nous" to manage
 - Italian Birth Rate
- Smart Grids
 - Overlaying the Electrical Network with a "Command & Control" digital network
 - Giving hackers the tools to do real damage





Monthly Forecasts - Accuracy

<u>Monthly Inflows and Temperatures</u>
 <u>(April 99 to April 03)</u>



TRANSMISSION



NORTH ISLAND BALANCE 2008



NZ's LONG TERM BALANCE





Source: Power station data from Annual Reports and various other sources, otherwise Electricity Commission data and assumptions

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Wind (Dec 03)- Gusts 230 km/h









Lightning Strikes over New Zealand on 14th October 2007 Total of 20,882 strikes, 3344 of them over land.







WIND

Wind resource

Te Uku (84 MW) Taharoa (100 MW)

Waverley (135 MW) Mill Creek (71 MW)

White Hill (57 MW) Project Hayes (630 MW)

Kaiwera Downs (240 MW) Mahinerangi (200 MW) Hawkes Bay Wind Farm (225 MW) Titiokura (48 MW) Te Waka (102 MW)

> Te Apiti (91 MW) Tararua (161 MW) Te Rere Hau (48 MW) Motorimu (110 MW)

_ West Wind (143 MW)
from 2009

Mount Cass (69 MW)

Wind speed (m/s)



Existing357MWImminent143MWProposed2014MW



Wind farm output variability over 4 hours Changes in output from an initial 40 MW

Wind generation



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Correlation of wind generation













Low output in first half of 2008

Daily NZ wind generation production



Day

MWh ----- 30 per. Mov. Avg. (MWh)

Is there a solution!







JMINION, WEDNESDAY, NOVEMBER 28, 1973

New Zealand Electricity



Maui gas field delays move to nuclear age

Nuclear development put off till 1980'

The discovery of the Maul s field delayed New aland's move into the era the nuclear power staa. lefore 1980 a decision ether or not to proceed maximum-usage level of gas resources will be reached soon.

Nuclear-powered thermal stations operating overseas have been as economic to run as conventional thermal Radiation levels from nuclear power stations posed no problems overseas. A person suffers more radiation exposure from one medical X-ray than he would from living a lifetime

installed for use in the extremely unlikely event of this failure.

Controversy over the effectiveness of these emergency systems erupted in the U.S.A. Performance processing plant extracts many valuable elements, such as plutonium and unused uranium. The small quantities of unusable elements are stored. * 'No country in the world









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Control Room in the 1950s







Control Room in the early 1990s



CO-ORDINATION CENTRE of the 2000s



Visualization is presented across multiple screens







Next Day Overview





