



Wind Power Grid Integration in New Zealand

REGIS Workshop on Grid Integration of
Renewable Energy

13-15 January, 2009

Lānaʻi, Hawaii

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Coverage

Electricity Generation in New Zealand

The Electricity Market,

Grid Connection Issues,

Technical Solutions,

Market Solutions,

Problems Encountered

Key Points.



Electricity in New Zealand

7 Major Generators

1 Transmission Grid owner – the System Operator

28 Distributors

610 km HVDC link between North and South Islands:

Installed Capacity **9,133 MW**

System Generation Peak about **7,000 MW**

Electricity Generated **42,700 GWh**

Electricity Consumed in 2008, **37,000 GWh**

Losses in 2008, **8 GWh, 13.3%**

Annual Demand growth of 2.4% since 1974

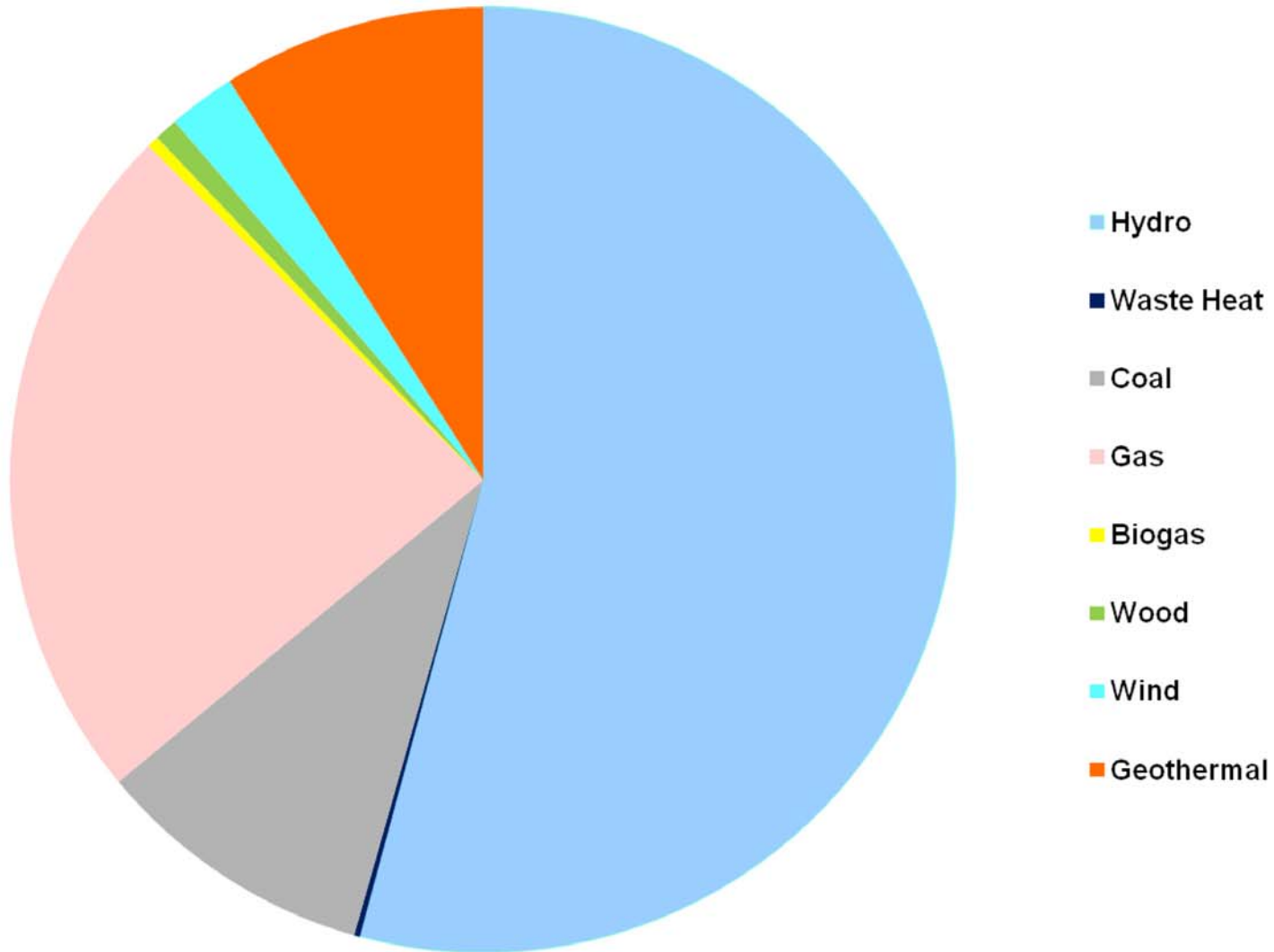


Installed Electricity Capacity, 2008 (MW)

Renewable Capacity	Hydro	5,023	55.0%
	Geothermal	731	8.0%
	Wind	321	3.5%
	Biomass	46	0.5%
	Total	6,120	67.0%
Non-Renewable Capacity	Gas	2,375	26.0%
	Coal	594	6.5%
	Other	46	0.5%
	Total	3,014	33.0%
Total Capacity		9,133	100.0%



Electricity Generation Q3 2008





Electricity Generation, 2008 (GWh)

Renewable Generation	Hydro	21,944	51.4%
	Geothermal	3,603	8.4%
	Wind	1,037	2.4%
	Wood	467	1.1%
	Biogas	197	0.5%
	Total	27,251	63.8%
Non-Renewable Generation	Gas	10,961	25.7%
	Coal	4,314	10.1%
	Oil	122.3	0.3%
	Waste Heat	57	0.1%
	Total	15,454	36.2%
Total Generation		42,705	100.0%



Electricity from Renewable Energy

New Zealand has a high usage of Renewable Energy

- Penetration **67%**
- Market Share **64%**

Renewable Energy Penetration Profile is Changing

- Hydroelectricity **55%** (decreasing)
- Geothermal **8%** (increasing)
- **3.5%** Wind Power (increasing)

Target is 90% penetration by 2020

Renewable Energy is doing well in New Zealand

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Wind Power in New Zealand

New Zealand has a very robust wind resource

- Long coastline in the “Roaring 40s”
- Both prevailing Westerly wind and shore breezes

Turbines operate **4000** hrs/year at full capacity

- Germany 2000 hrs/yr
- Scotland, Wales & W. Ireland 3000 hrs/yr

Wind Load Factor **51-54%**

- Average over all energy forms is **45%** in NZ

Theoretical penetration is **35%**,

Theoretical Market Share is **20%**

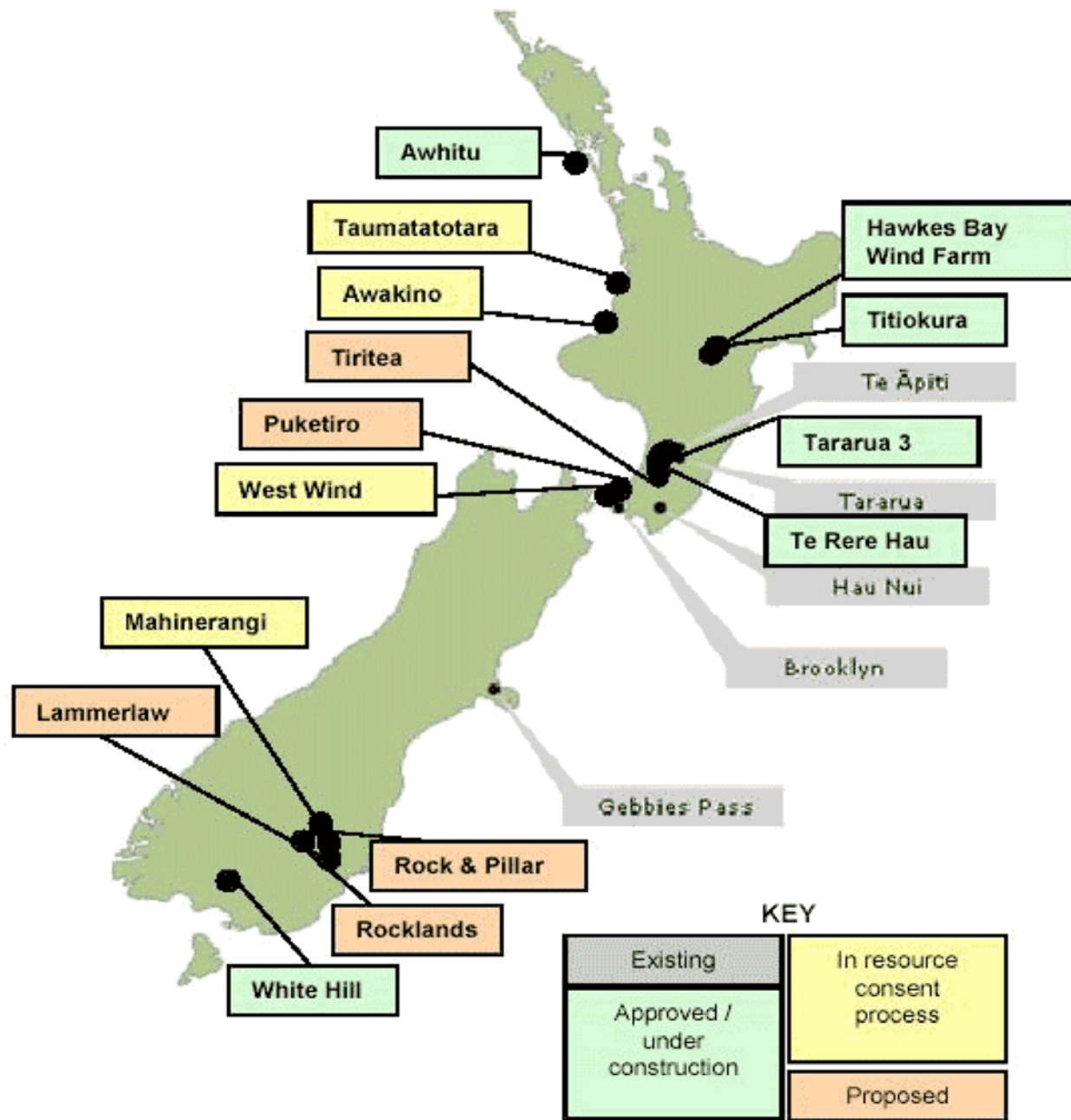
An attractive Renewable Energy Prospect



Electricity from Renewable Energy

Name	First Commissioned	Operator	Installed capacity (MW)	Projected capacity (MW)
Awhitu	Proposed	Genesis Energy	0	2.5
Chatham Island	Proposed	CBD Energy	0	0.4
Hau Nui	1997	Genesis Energy	8.8	8.8
Hauauru ma raki	Proposed	Contact Energy	0	54.0
Hawke's Bay	Proposed	Hawkes Bay Wind Farm Ltd	0	22.5
Horsehoe Bend	Under Construction	Pioneer Generation	0	2.5
Kaiwera Downs	Proposed	TrustPower	0	24.0
Long Gully	Proposed	Mighty River Power	0	1.0
Mahinerangi	Proposed	TrustPower	0	20.0
Mill Creek	Proposed	Meridian Energy	0	7.1
Mount Cass	Proposed	MainPower	0	6.9
Project Hayes	Proposed	Meridian Energy	0	63.0
Project Central Wind		Meridian Energy	0	13.0
Project West Wind	Under Construction	Meridian Energy	0	142.6
Puketiro	Proposed	RES NZ	0	15.0
Rototuna ⁽⁷⁾	Proposed	Meridian Energy	0	50.0
Tararua	1999	TrustPower	16.0	16.0
Te Apiti	2004	Meridian Energy	90.8	90.8
Te Rere Hau	2006	NZ Windfarms	2.5	48.5
Te Uku	Proposed	WEL networks and Meridian Energy	0	8.4
Te Waka	Proposed	Unison Networks and Roaring 40s	0	10.2
Turitea	Proposed	Mighty River Power	0	36.0
Waitahora	Proposed	Contact Energy	0	17.7
White Hill	2007	Meridian Energy	5.8	5.8
			320.1	4024.6

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The Electricity Market

There are three official markets

- The Wholesale Electricity Market
- The Reserve Market, 50 MW
- The Frequency Keeping Market, also 50 MW
 - One in each island due to HVDC link between

Bids for 30 min supply 24 hrs ahead at 244 nodes

- Revision up to 2 hours before dispatch

Penalties for default

About 15% of electricity traded, rest on direct contract

Provides access to a large electricity pool



Grid Integration Issues

Relatively small load cf. Grid Size,

- No external links
- Load is split into two by HVDC link

Issues to be addressed:

- Frequency Management
- Short term Variations
- Generation Scheduling
- Wind Farm Clustering
- Formulation of Standards and Regulations

Challenges rather than Barriers



Technical Solutions employed

Improved Generator Technology for:

- Voltage control at the output terminals
- Maintaining consistent output during grid faults
- Maintaining output over a range of grid frequencies

Intra-Generator load balancing:

- Primarily with Hydro and Geothermal
 - Virtual Hydro storage
 - Turbine interconnection
- Dynamic Reactive Power reserve
 - Sale of VARs to large variable loads



Technical Solutions (continued)

Wind Forecasting

Energy Storage

- Battery Storage – **Electric Cars/Hybrids**
- Pump water to storage (35% energy loss)
- Super Capacitors, new technology

System Strengthening

- Up-rating hydro/stations
- Grid Strengthening
- Strengthening Fault ride-through requirements

There are a number of options

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Market Solutions

Inter-Generator load balancing through the market

- The Wholesale Electricity Market
- The Reserve Market, 50 MW
 - Non essential load disconnected instantaneously
- The Frequency Keeping Market, also 50 MW
- Virtual Hydro storage

Updating Electricity Market Governance Rules (EMGs)

The Market is the key!

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Ongoing Issues

Generally integration works well with few problems,
but:

Wind flow forecasting is not perfect,

Electricity replacement may be at different nodes,

- Contract default issues may arise;

Wind Farm Clustering must be addressed,

- Need for Grid strengthening; and

Good Industry Standards and Market Rules are essential.

Wind Power Integration is not a major Issue in NZ!



Key Points

New Zealand has a high usage of Renewable Energy

Wind Power installations increasing very rapidly in NZ

Grid Integration issues are addressed primarily by:

- Individual Generator actions and generation balancing &
- Balancing using the Electricity Market Pool

Two innovative Wind Power Storage options:

- Electric/Hybrid vehicle batteries
- “Virtual” storage in Hydro Lakes

Market solutions are the key instruments!

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Thank You!

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