Renewable Energy Grid Integration in New Zealand

Workshop on Grid Interconnection Issues for Renewable Energy

12 October, 2010

Tokyo, Japan

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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,

29 Distributors,

610 km HVDC link between North and South Islands,

Installed Capacity 8,911 MW,

System Generation Peak about 7,000 MW,

Electricity Generated 42,000 GWh,

Electricity Consumed, 2009, 38,875 GWh,

Losses, 2009, 346 GWh, 8.9%

Annual Demand growth of 2.4% since 1974

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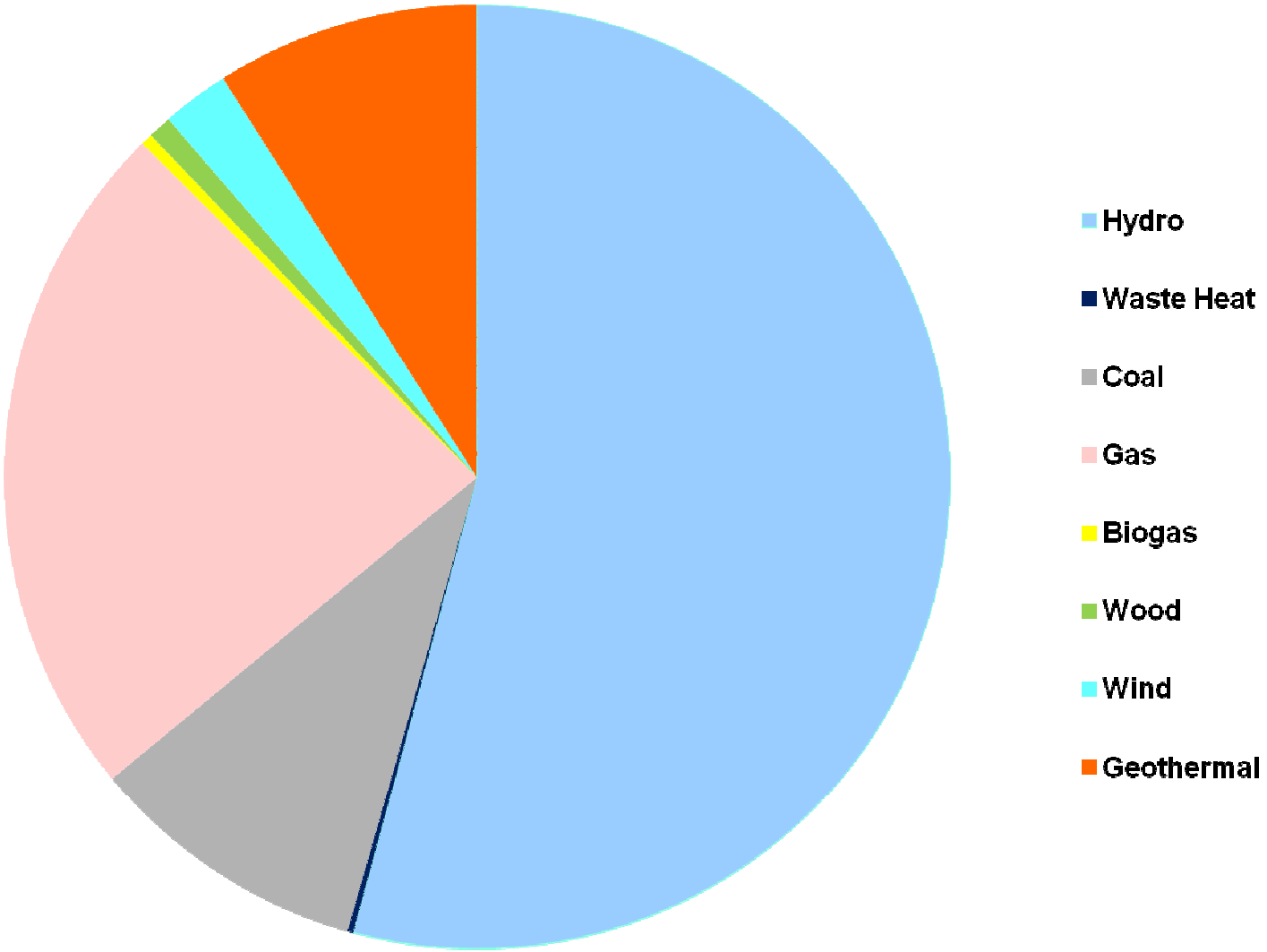
Installed Electricity Capacity, 2009 (MW)

Renewable	Hydro	5,378	60.4%
Generation	Geothermal	627	7.0%
	Wind	496	5.6%
	Wood	18	0.2%
	Biogas	9	0.1%
	Total	6,528	73.3%
Non-Renewable	Gas	1,228	13.8%
Generation	Coal	1,000	11.2%
	Diesel	155	1.7%
	Total	2,383	26.7%
Total Generation		8,911	100.0%

Electricity Generation 2009



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Electricity Generation, 2009 (GWh)

Renewable	Hydro	23,962	57.0%
Generation	Geothermal	4,542	10.8%
	Wind	1,456	3.5%
	Wood	323	0.8%
	Biogas	195	0.5%
	Total	30,478	72.6%
Non-Renewable	Gas	8,385	20.0%
Generation	Coal	3,079	7.3%
	Oil	8	0.0%
	Waste Heat	58	0.1%
	Total	11,530	27.4%
Total Generation		42,008	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 57% (decreasing but seasonal),**
- **Geothermal 11% (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 4,000 hrs/year at full capacity,

- **Germany 2,000 hrs/yr,**
- **Scotland, Wales & W. Ireland 3,000 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

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Electricity from Renewable Energy

Name	First Commissioned	Operator	Installed capacity (MW)	Projected capacity (MW)
Awhitu	Proposed	Genesis Energy	0	25
Chatham Island[5]	Proposed	CBD Energy	0	0.4
Hau Nui	1997	Genesis Energy	8.8	8.8
Hauauru ma raki	Proposed	Contact Energy	0	540
Hawke's Bay	Proposed	Hawkes Bay Wind Farm Ltd	0	225
Horsehoe Bend[6]	Under Construction	Pioneer Generation	0	2.5
Kaiwera Downs	Proposed	TrustPower	0	240
Long Gully	Proposed	Mighty River Power	0	10
Mahinerangi	Proposed	TrustPower	0	200
Mill Creek	Proposed	Meridian Energy	0	71
Mount Cass	Proposed	MainPower	0	69
Project Hayes	Proposed	Meridian Energy	0	630
Project Central Wind		Meridian Energy	0	130
Project West Wind	Under Construction	Meridian Energy	0	142.6
Puketiro	Proposed	RES NZ	0	150
Rototuna[7]	Proposed	Meridian Energy	0	500
Tararua	1999	TrustPower	160	160
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	84
Te Waka	Proposed	Unison Networks and Roaring 40s	0	102
Turitea	Proposed	Mighty River Power	0	360
Waitahora	Proposed	Contact Energy	0	177
White Hill	2007	Meridian Energy	58	58
			320.1	**4024.6**

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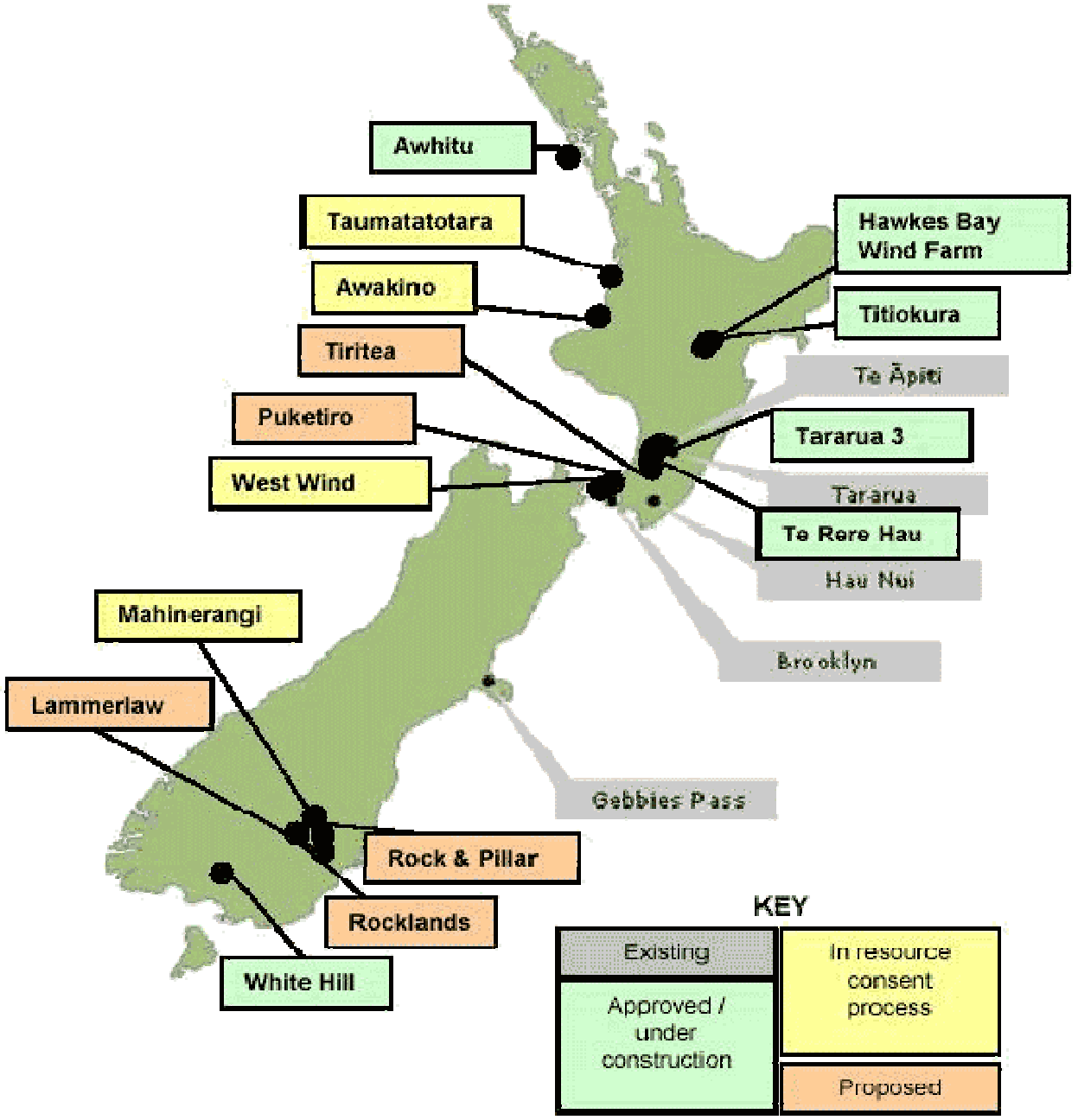
Awhitu
Taumatatotara
Awakino
Tiritea
Puketiro
West Wind
Mahinerangi
Lammerlaw
Rock & Pillar
Rocklands
White Hill
Hawkes Bay Wind Farm
Titiokura
Te Apiti
Tararua 3
Tararua
Te Rere Hau
Hau Nui
Brooklyn
Gebbies Pass
KEY
Existing
Approved / under construction
In resource consent process
Proposed

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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

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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 Condensers, 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,**

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!