



Transitioning to a 100% renewable electricity generation system for New Zealand: technical issues and policy challenges

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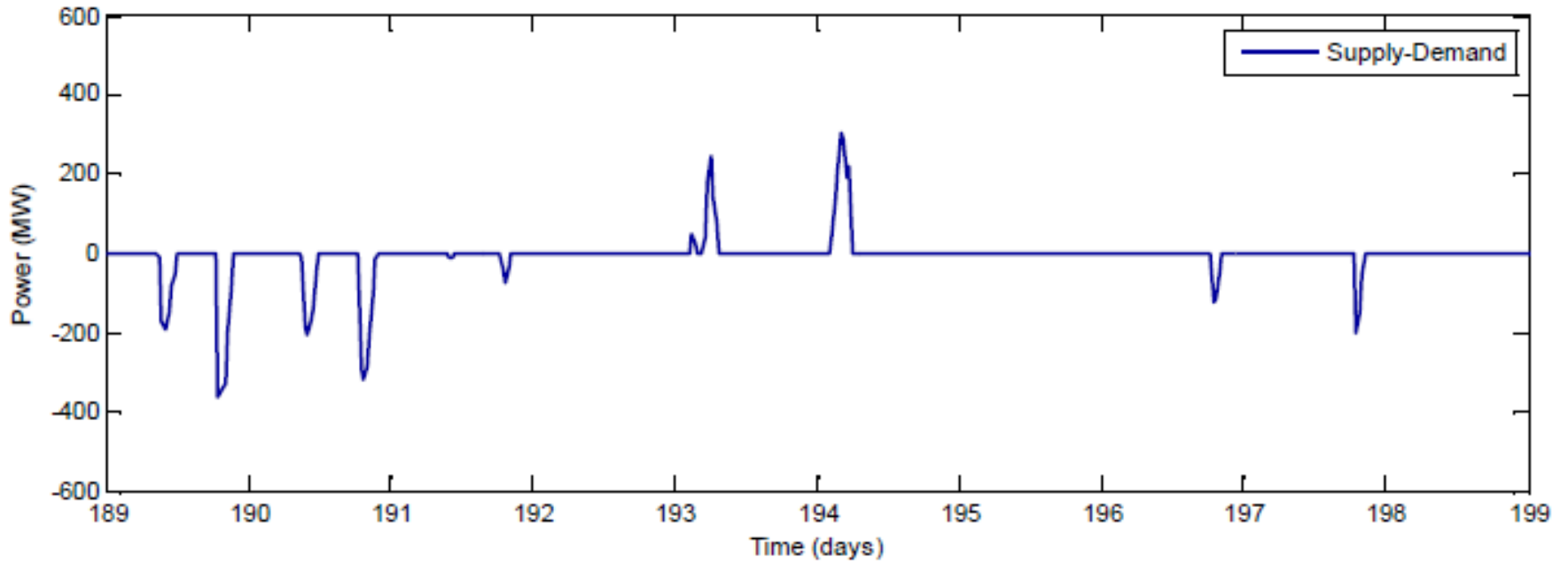
IMAGINE...

- All fossil-fuelled electricity generation in NZ **deleted** between 2005 – 2010;
- **Replaced** with wind and geothermal generation;
- **NB:** 2008 – the driest year since 1931!
- What would happen?

KEY ASSUMPTIONS

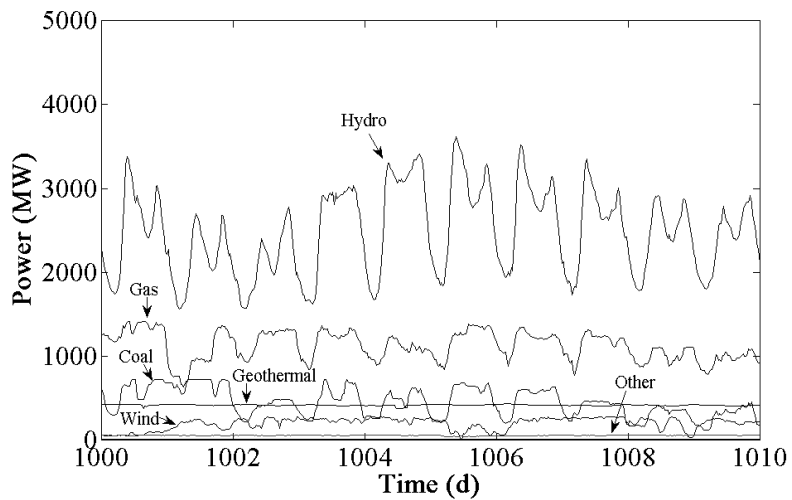
- Centrally planned and operated system
- Goal: optimisation of energy resource use; minimisation of spillage
- Hydro lakes treated as single reservoir
- Hydro operation allowed to vary in response to wind
- Wind treated as “must run”

SUPPLY-DEMAND

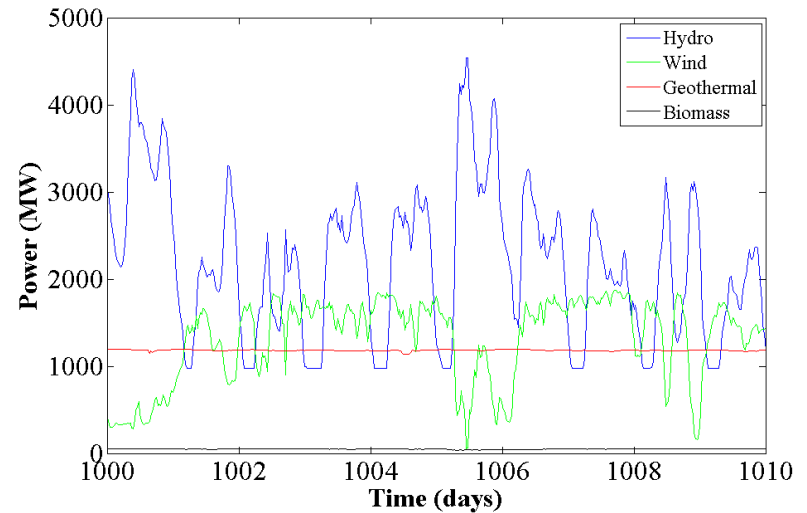


GENERATION PATTERNS

HISTORIC (half-hourly)

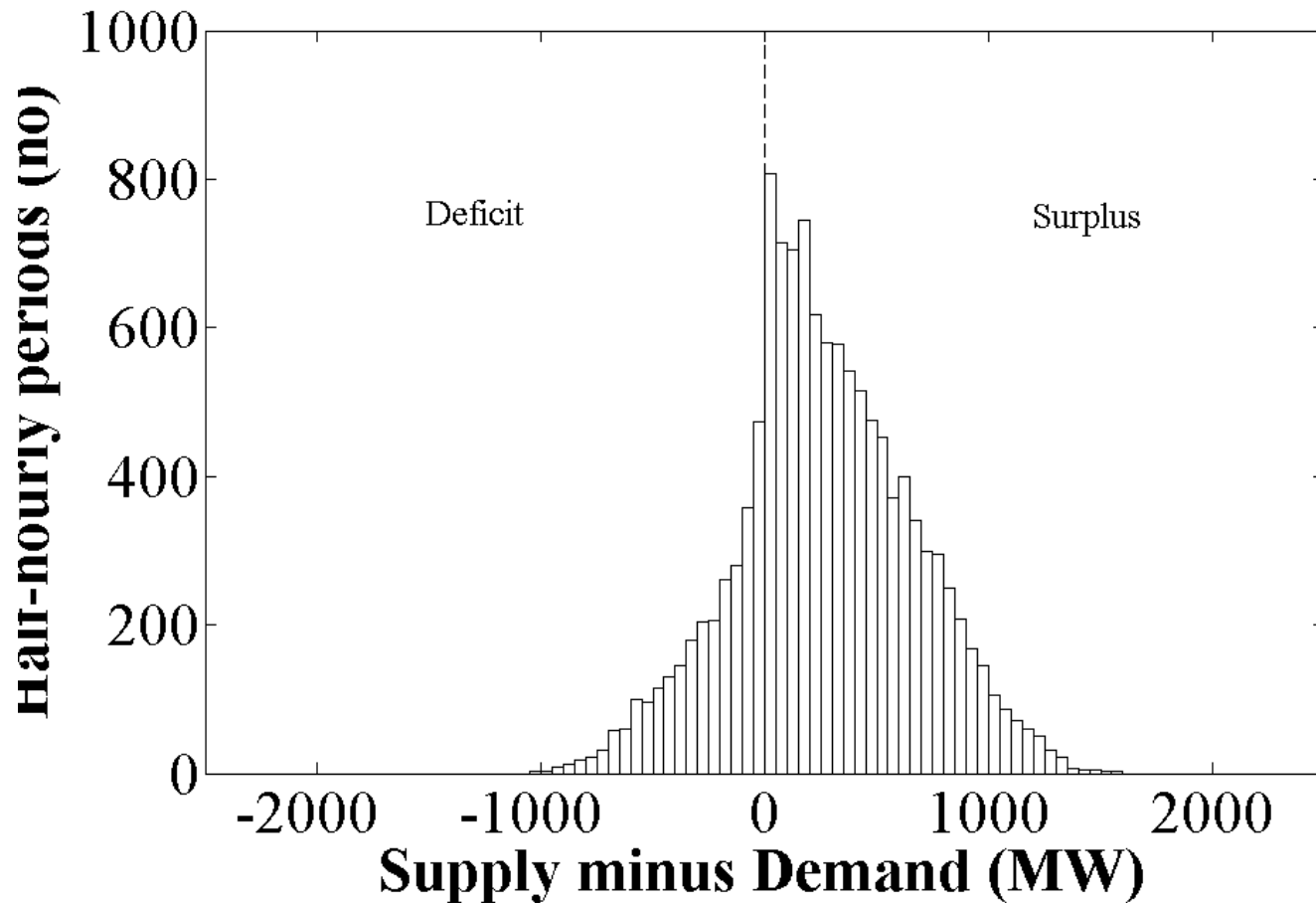


STEP 4 (half-hourly)



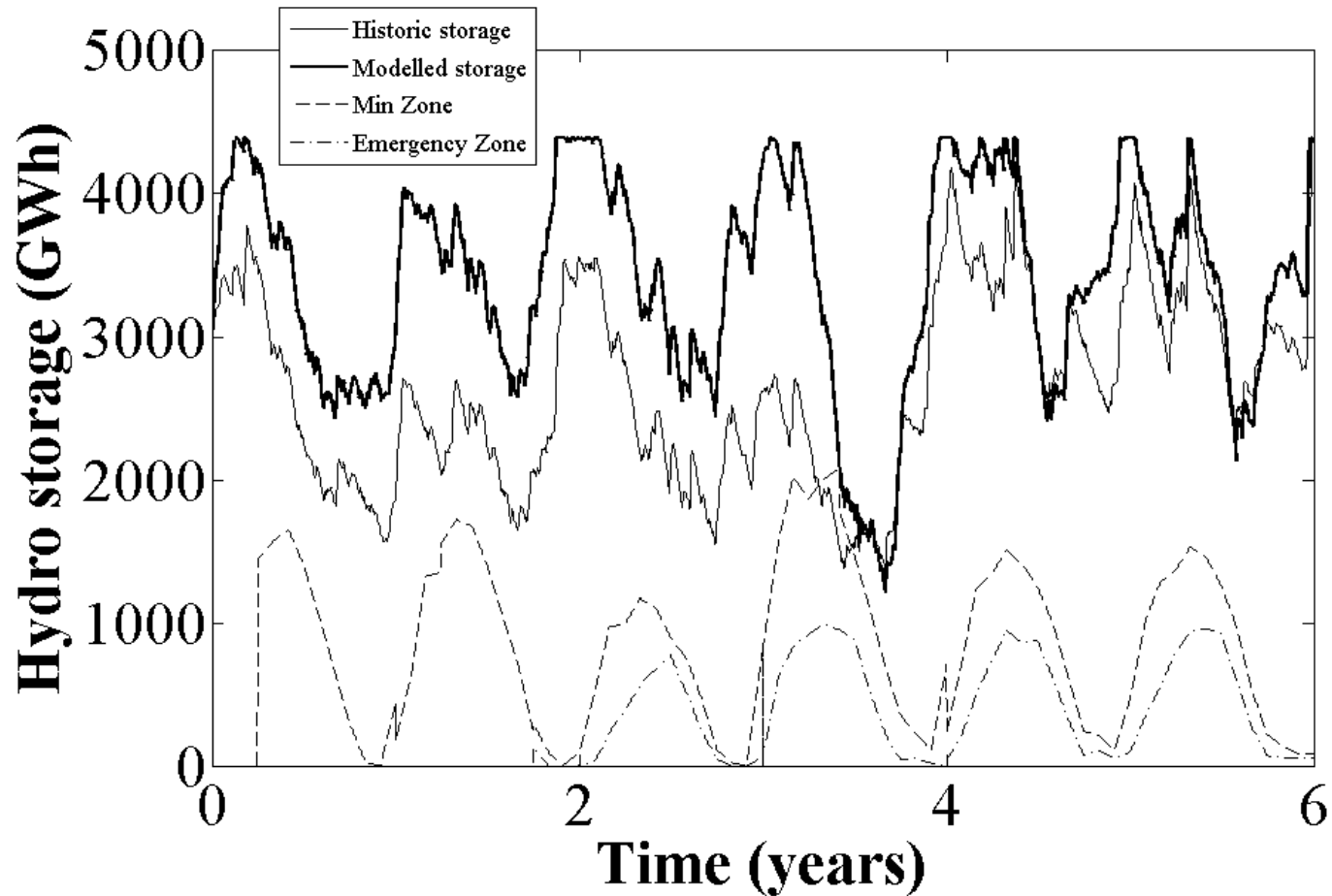
DEFICITS & SURPLUSES

(2495 MW wind; 1364 MW geothermal)



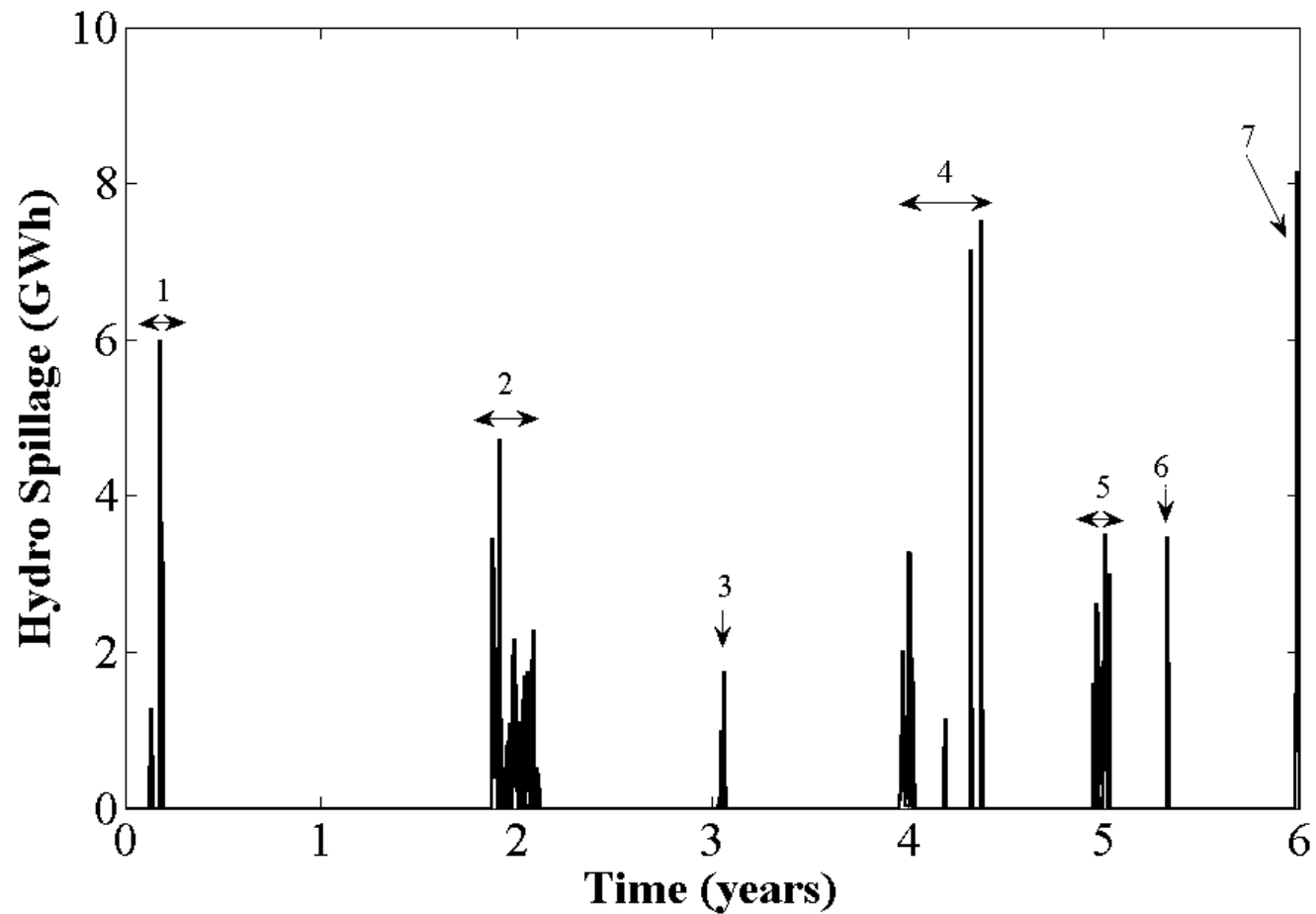
HYDRO STORAGE

(2495 MW wind; 1364 MW geothermal)



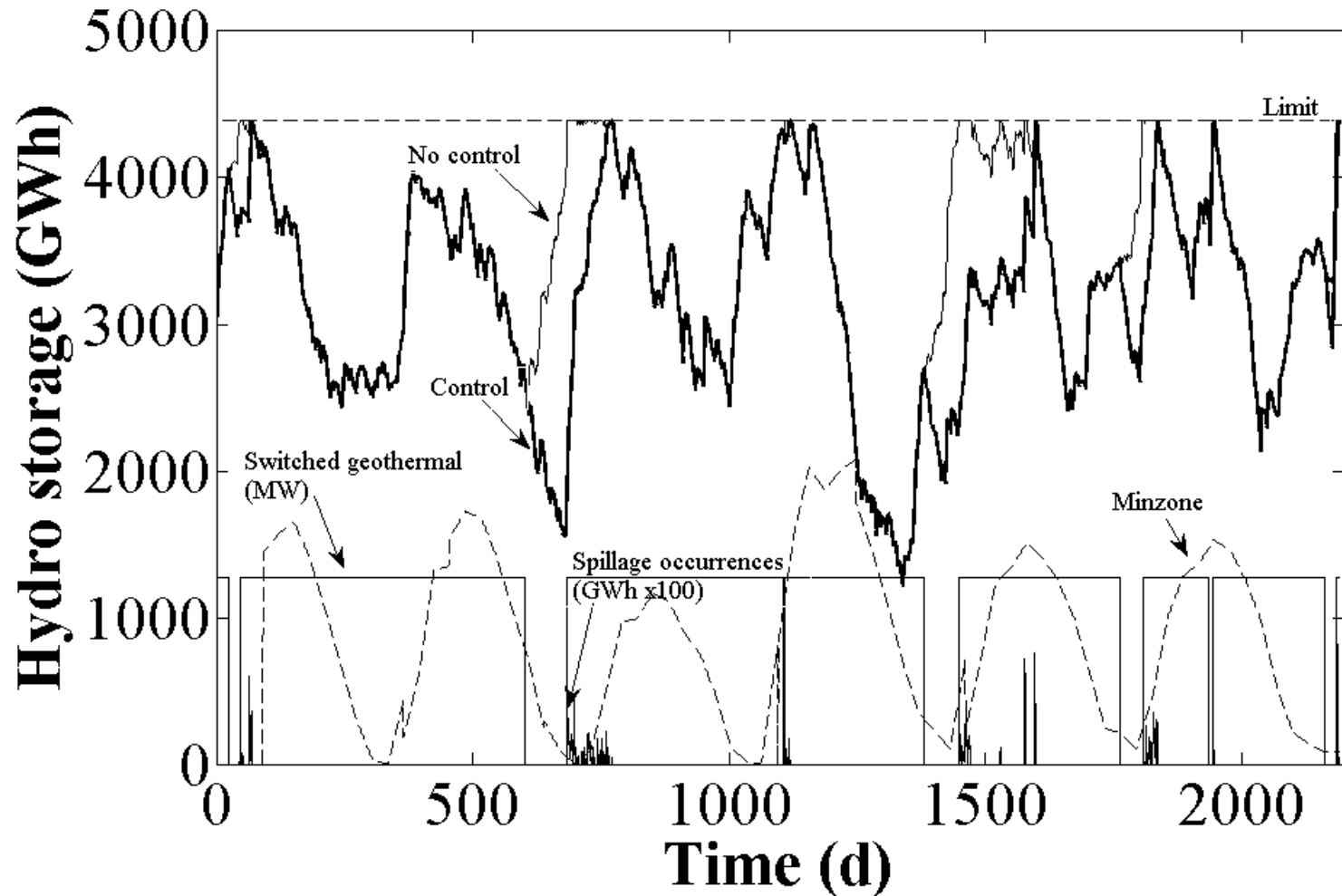
HYDRO SPILLAGE

(3.2% of total energy; 7801 GWh)



GEO THERMAL SWITCHING

(1277 MW; unconstrained hydro)



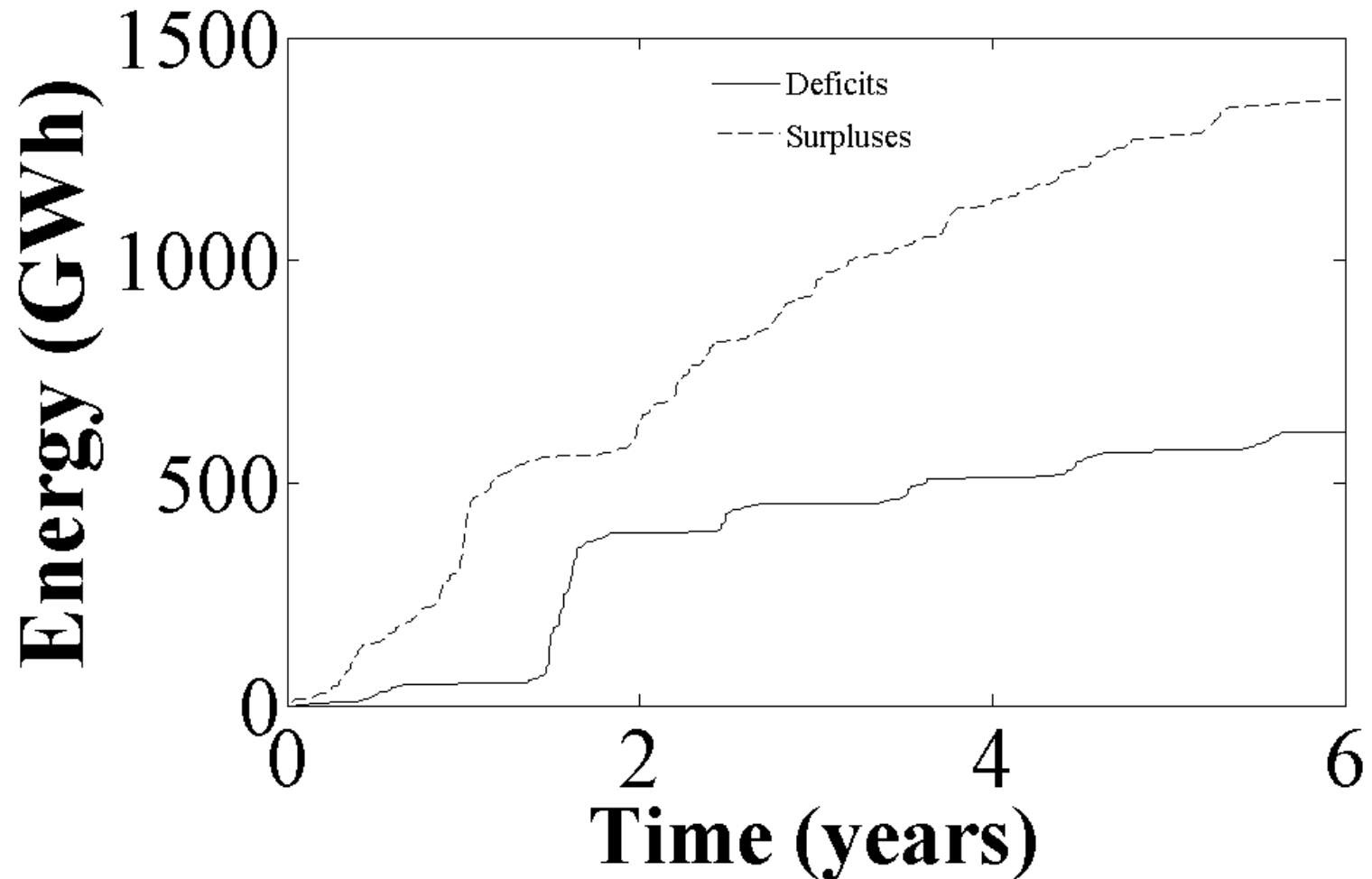
CONSTRAINED HYDRO

- Switch 1277 MW => 87% reduction (955 GWh spill)
- Subsequent hydro storage unaltered
- Alternatively allow post-event levels to fall in places; => 100% reduction

HALF-HOURLY DEFICITS

- Load shifting...
- Hydro...
- Gas turbine...(biomass)
- Pumped hydro storage...(wind surplus)

Wind spillage: 1362 GWh
Deficits: 616 GWh (0.25%); 1549 MW



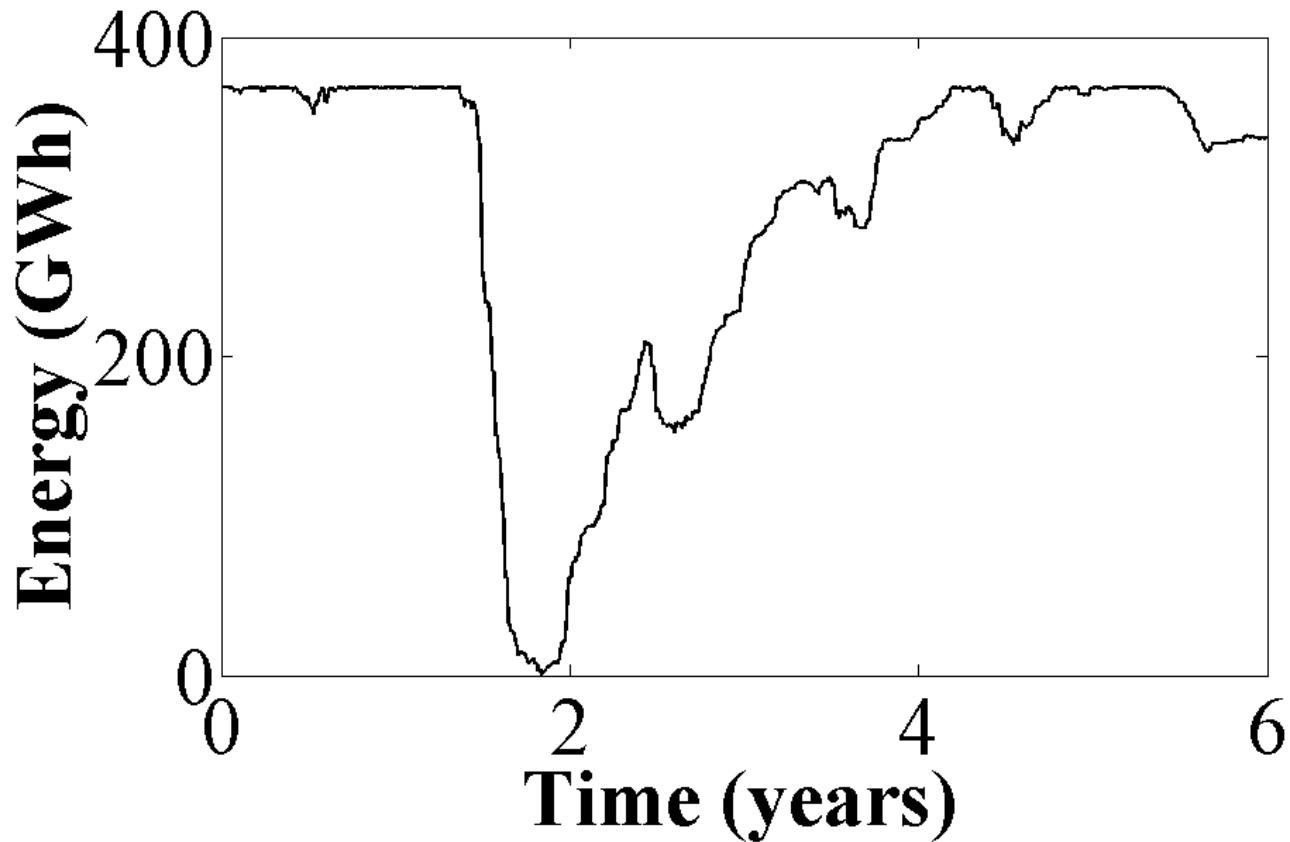


Pumped hydro storage using seawater in Okinawa

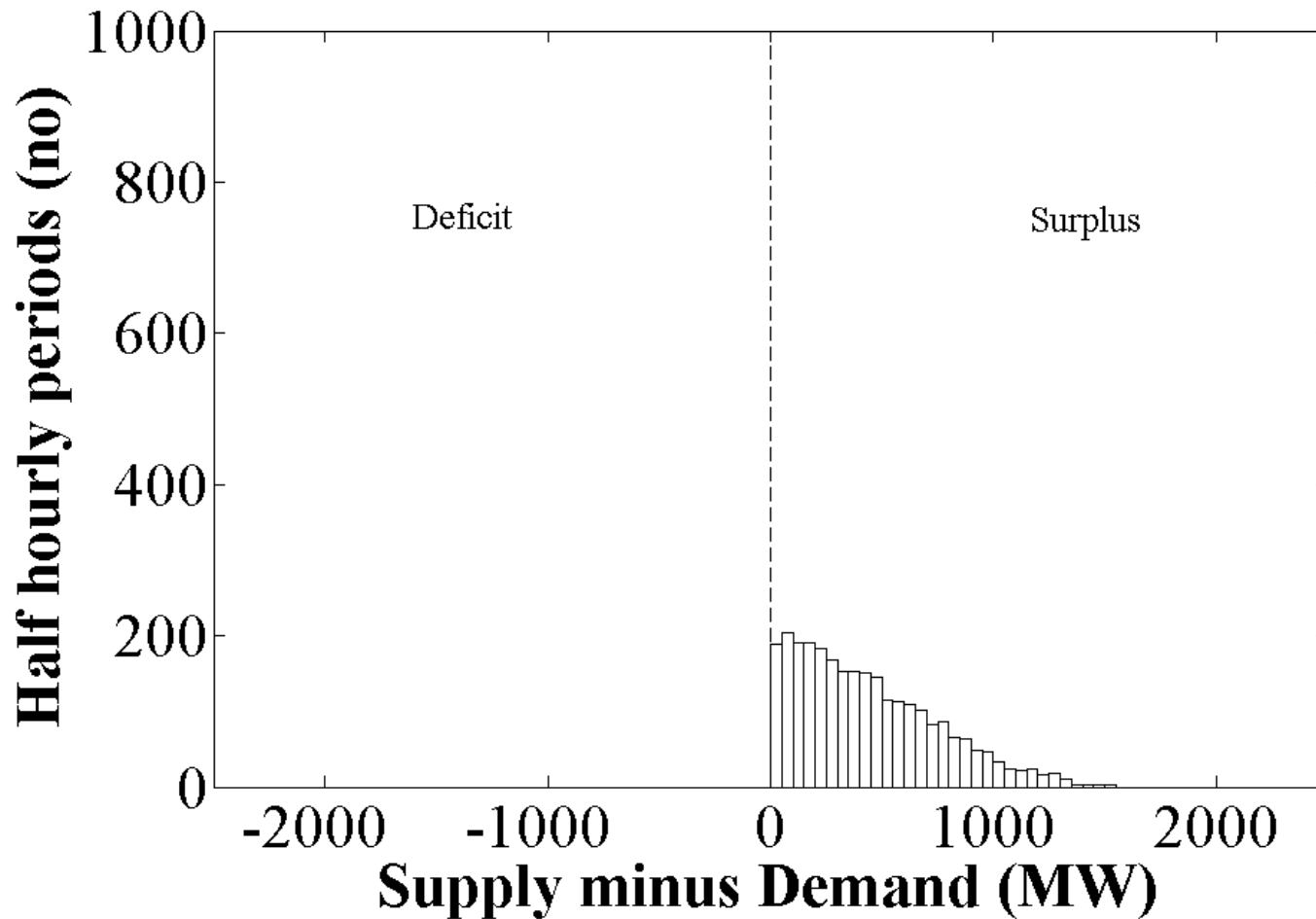
SOURCE: GOOGLE EARTH

PHES STORAGE

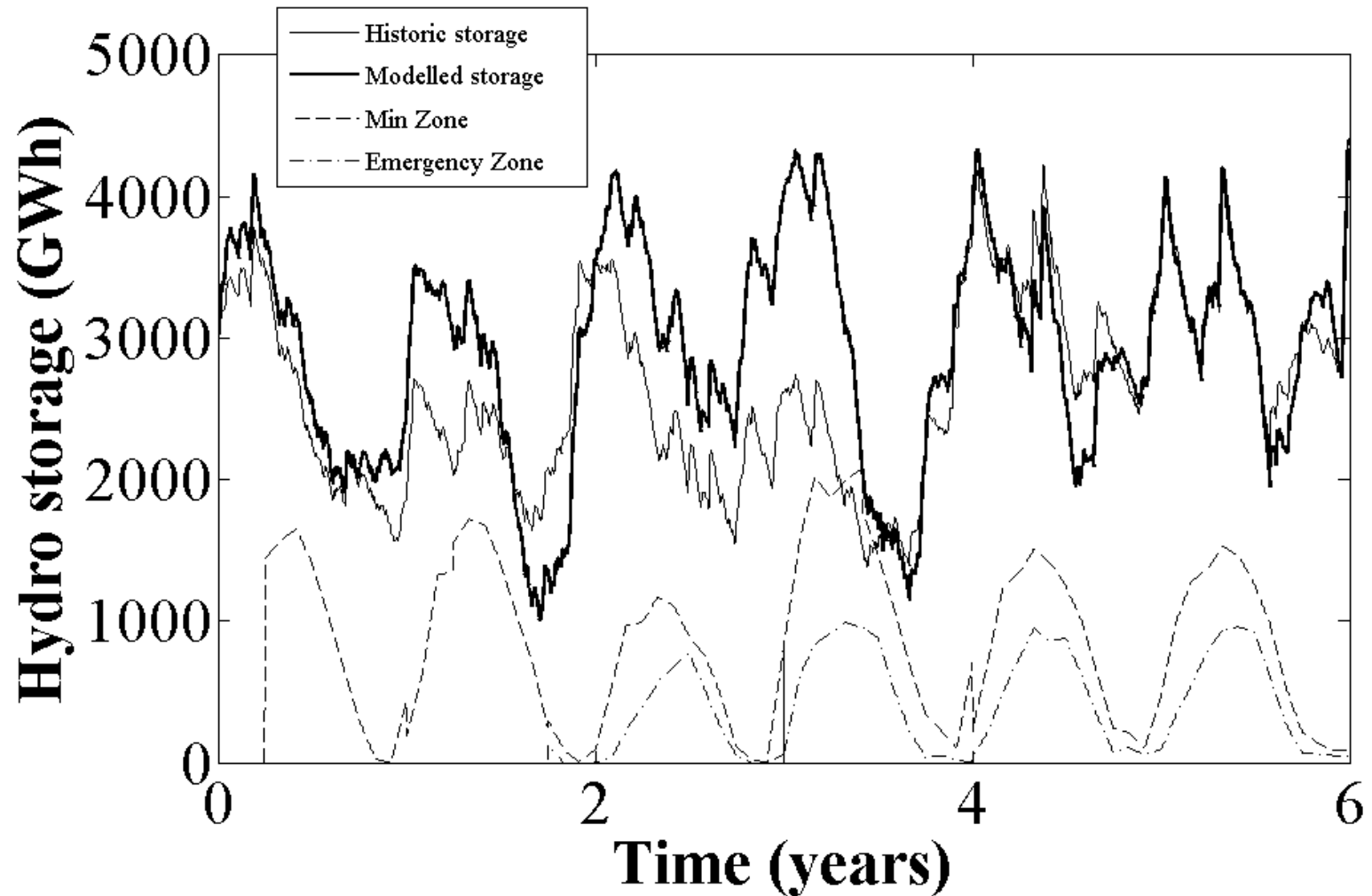
(76% efficiency; 368 GWh)



FINAL SYSTEM - surplus

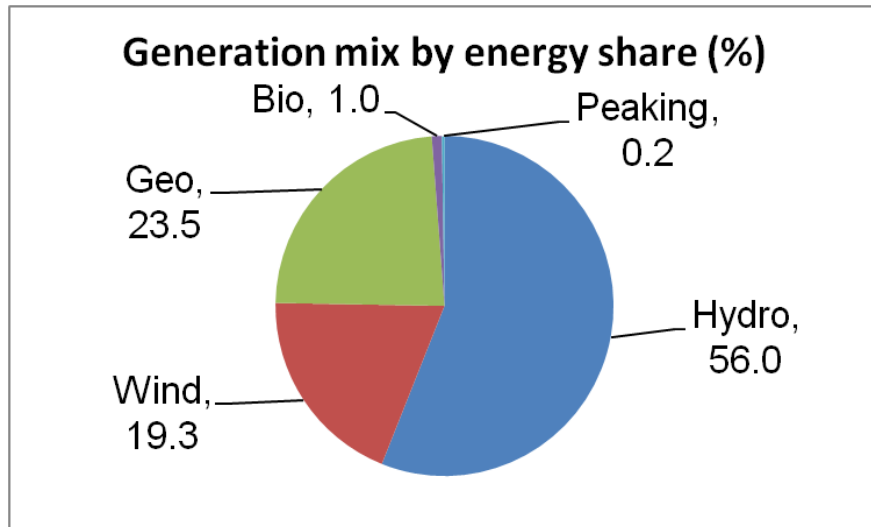


FINAL SYSTEM - storage



KEY TECHNICAL POINTS

100% renewable system



Characteristics

- Security of supply – **YES** ;
- Hydro spillage control by switching 46-100% of flexible base-load;
- Wind utilisation 99.8%;
- PHES reservoir 8% of existing storage

WHERE TO FROM HERE?

- Spatial modelling/ transmission issues
- Sub-30 min issues
- Solar generation
- Transitional issues
- Forecasting model - hydro spill control
- **Can the market deliver?**

MARKET ISSUES

- IPENZ-convened report (2010): 90% by 2025 impractical (this system); relying solely on market “considerably risky”;
- IEA review (2010): NZ needs roadmap to 90%; MED **83%** by 2025;
- MED later projections: **77-80%** by 2025

INTERNATIONAL DEBATE

(Hood, 2011)

- a) do present market structures create a lower risk for fossil-fuel generators?
- b) do low, zero or negative prices pose an increased risk for investors in renewable generation?
- Rationale (b): infra-marginal rents decrease; (higher) capital costs more difficult to recover; increased volatility

SOLUTIONS?

- a) capacity payments for renewable-energy generators to recover capital costs, and
- b) retain the market mechanism for short-term fuel and running costs, or
- c) abandon the market

FOR NEW ZEALAND...

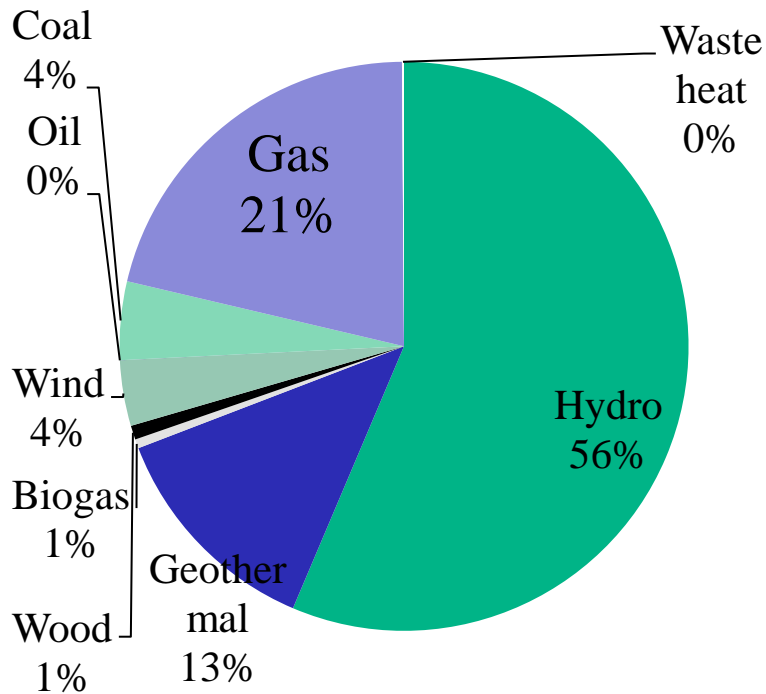
- Looking at approx. 5x present wind and 2x present geothermal
- Transitional strategy: use fossil gas for deficits, only 100 GWh/y; => 99.8%
- High wind penetration predicted to destroy NZ energy-only market (Brown et. al., 2012)

IDEAS FOR NZ...

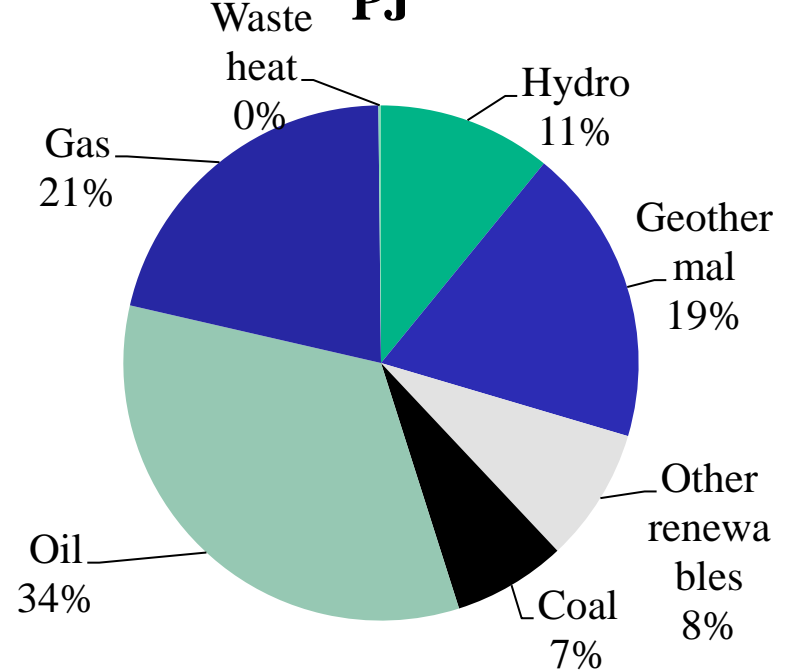
- Capacity payments for/from wind and geothermal; for very low capacity factor fossil gas half-hourly peaking + DSM?
- Price signals for geothermal generators to reduce hydro spill?
- Separate low-carbon market?
- Abandon the market? Political risk...

BROADER IMPLICATIONS

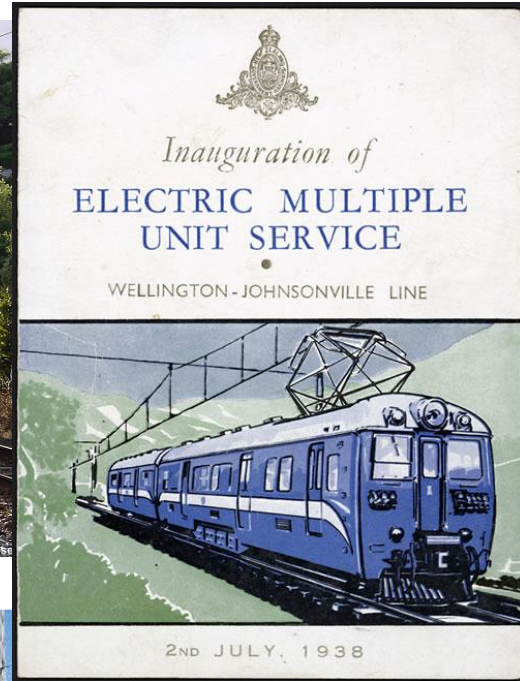
New Zealand's Electricity Generation 2010 : 156 PJ



New Zealand's Primary Energy Supply 2010: 817 PJ



(RE)OPENING THE DOOR



PLUS...



A UK PERSPECTIVE

David Porter, Association of Electricity Suppliers, UK; April, 2012

- “A new electricity supply industry...presents a huge challenge and for many of the participants, a huge opportunity.
- In fact, the destination may be close to where we have to be when finite fossil fuels are in short supply. But, this is about a forced march to that place, rather than an evolutionary stroll.
- It is about pursuing vision, or anticipating events, rather than responding to them.”

OVERALL CONCLUSION

- Could NZ have a 100% renewable electricity generation system?
- Evidence suggests – YES
- Could the present market deliver?
- Evidence/debate suggests - UNLIKELY
- So, modify, or abandon, market?
- Broader policy settings?

ACKNOWLEDGEMENT

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- Brown, O., Poletti, S., Young, D. and Tollestrum, J., 2012 Does wind kill the energy only market? Paper presented to the 12th IAEE European Energy Conference, September 9-12, Venice, Italy. International Association for Energy Economics, Cleveland, USA

THANKS FOR LISTENING

Any questions 

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