

# Higher Renewable Energy Generation Market and Infrastructure

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# Contents

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- The Opportunity – how to decarbonise our economy
- Challenges
- Potential Solutions to technical challenges

# How to De-carbonise our Economy: Electrification

Current annual electricity generation: 42,000 GWh (34,000 renewable)

Current annual replaceable non-renewable fuel use in transport and stationary energy: 130,000 GWh

Exclude air-transport, trucking, & non-renewable electricity: 85,000 GWh

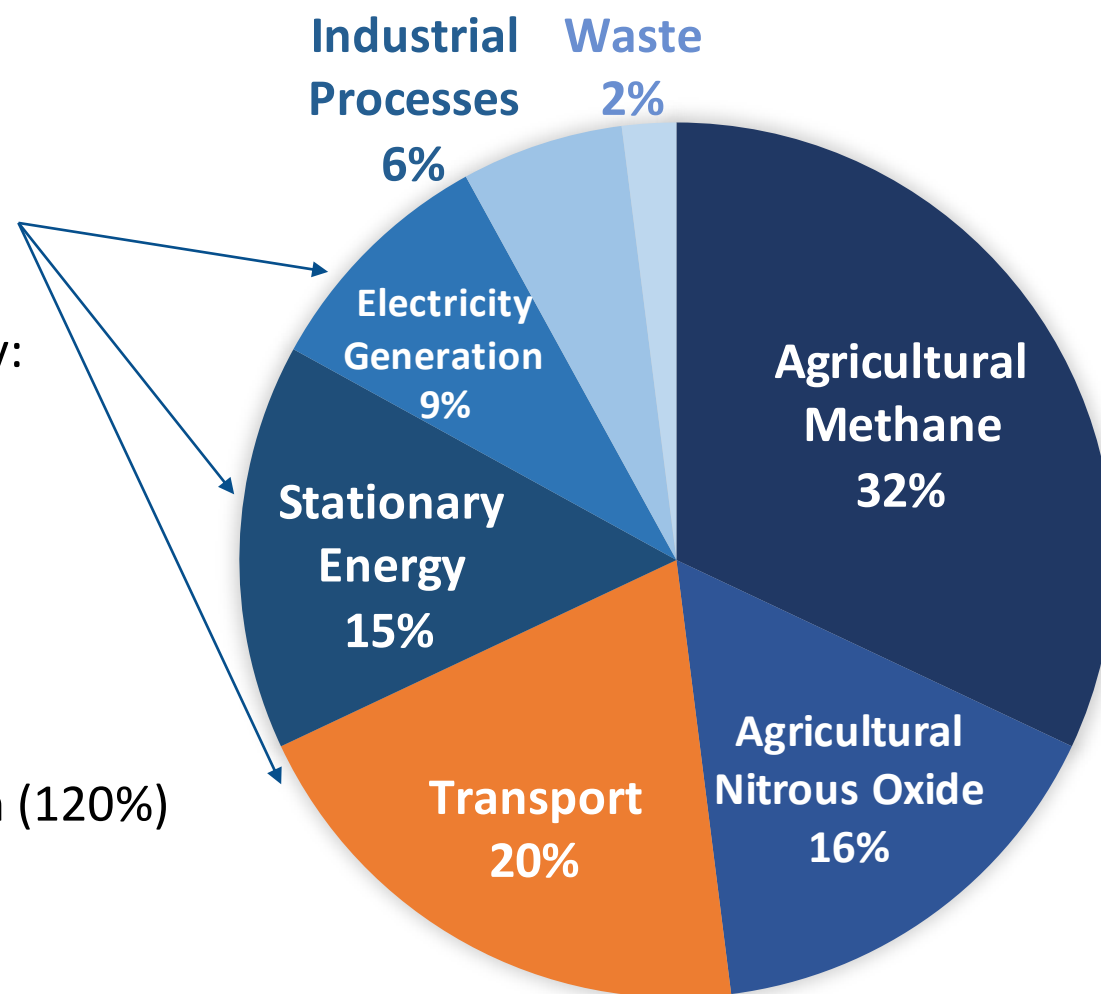
Annual energy requirement to replace these by electricity: 42,000 GWh

## 53% reduction in NZ's energy use

Increase in renewable electricity requirement: 50,000 GWh (120%)

**Reduction in GHG emissions: 25 MT per year**

From: *Transitioning New Zealand to Renewable Energy*, Ian Mason, Harry Gates, Henna Chua, and Allan Miller, 2017 & *Electric vehicles in New Zealand*, from passenger to driver, Scott Lemon and Allan Miller, 2013.



# Challenges

- Infrastructure development



6GW



2GW



5GWp



- Conversion of end use to electricity / signals to invest in generation
- Technical integration of more renewables

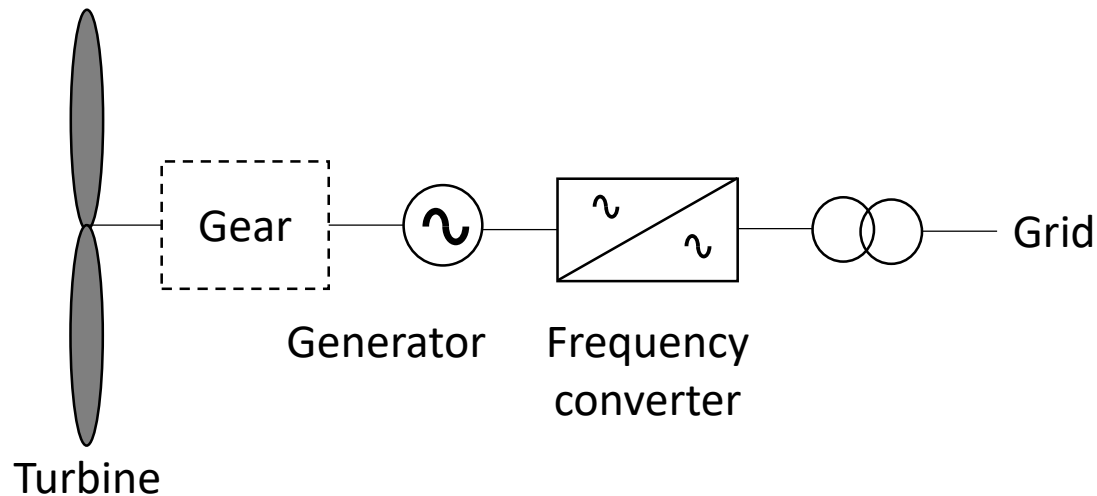
# Technical Challenges

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- Reduced inertia
- Increased variability
- Increased wind spill / curtailment
- Solar congestion in distribution networks

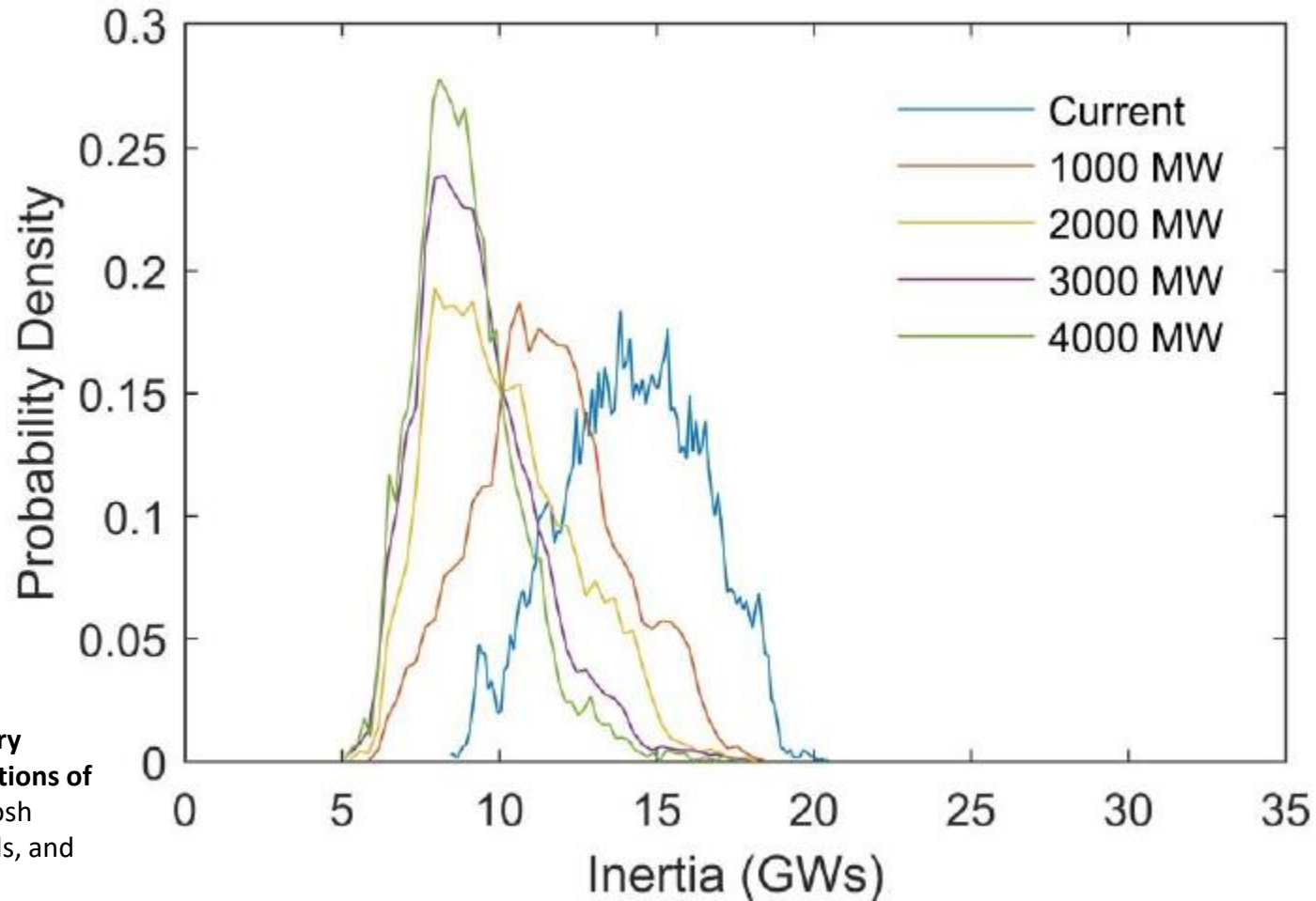
# Inertia reduces

- Rotational speed and system frequency normally tightly coupled
  - Shares inertia of the many rotating machines synchronised to the grid



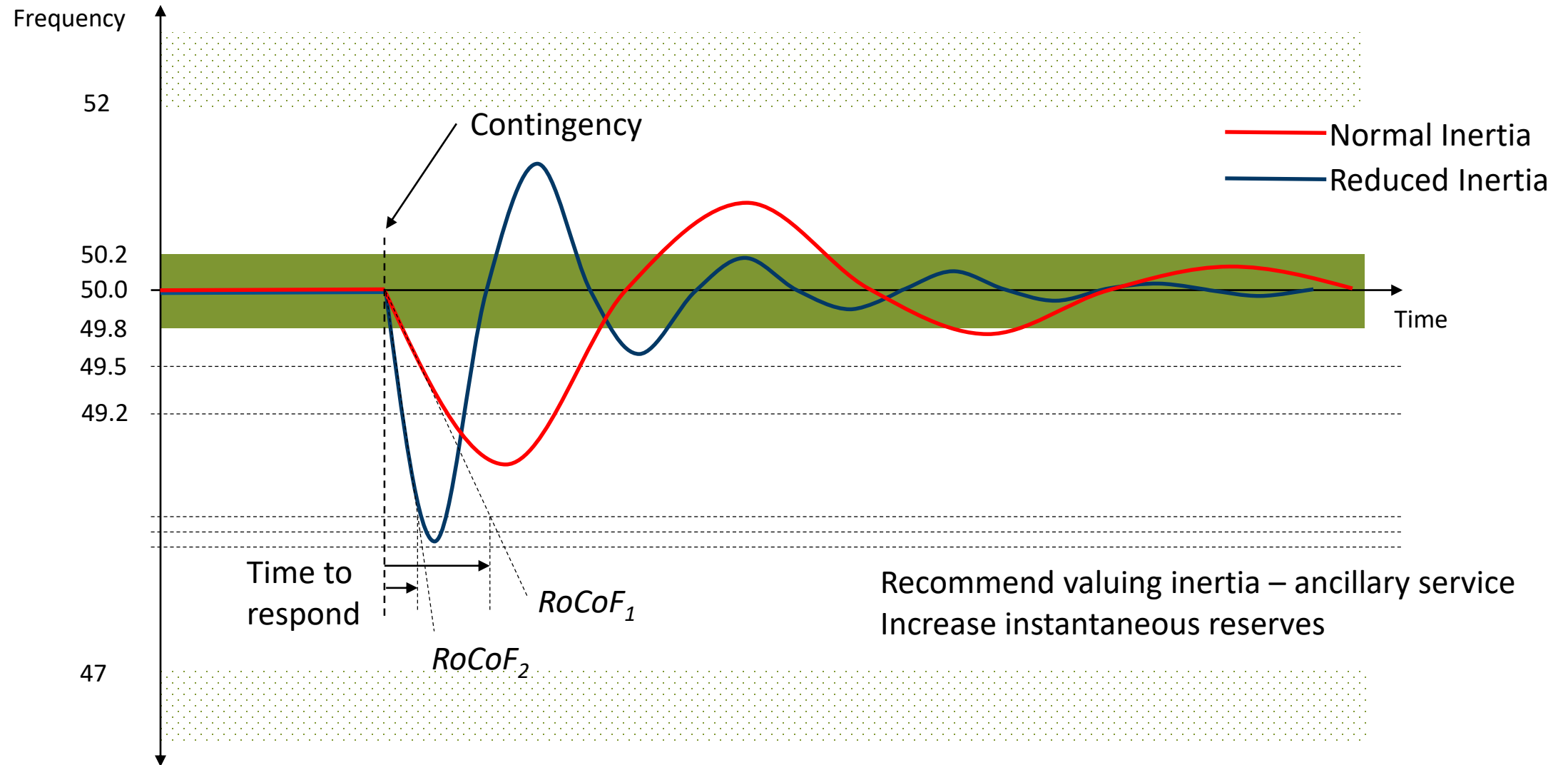
- Rotational inertia of turbine and generator decoupled from electrical power system

# Inertia reduces...



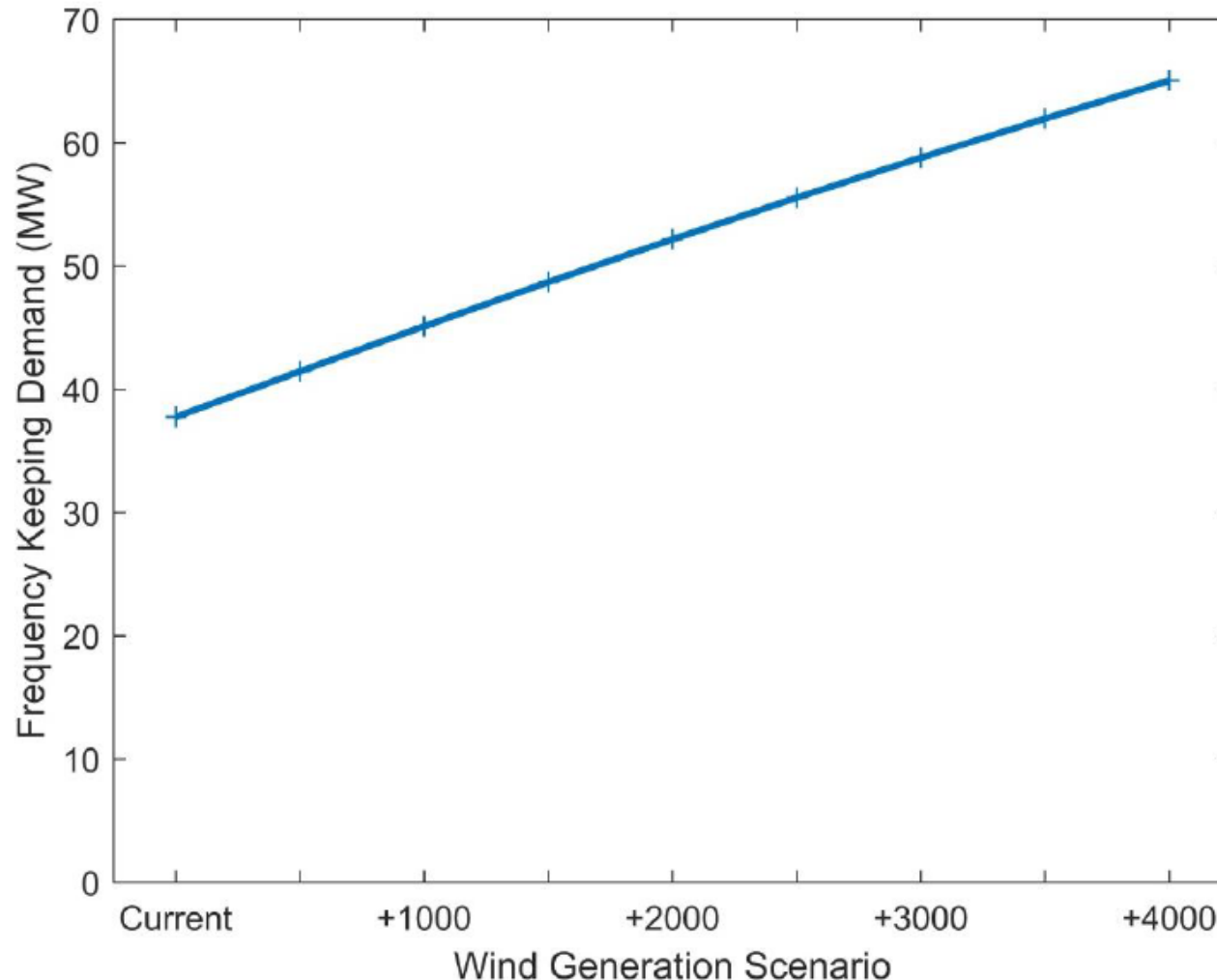
From: **Recommendations for Ancillary Service Markets under High Penetrations of Wind Generation in New Zealand**, Josh Schipper, Alan Wood, Conrad Edwards, and Allan Miller, pre-release draft, 2018.

# Inertia reduces...





# Variability increases

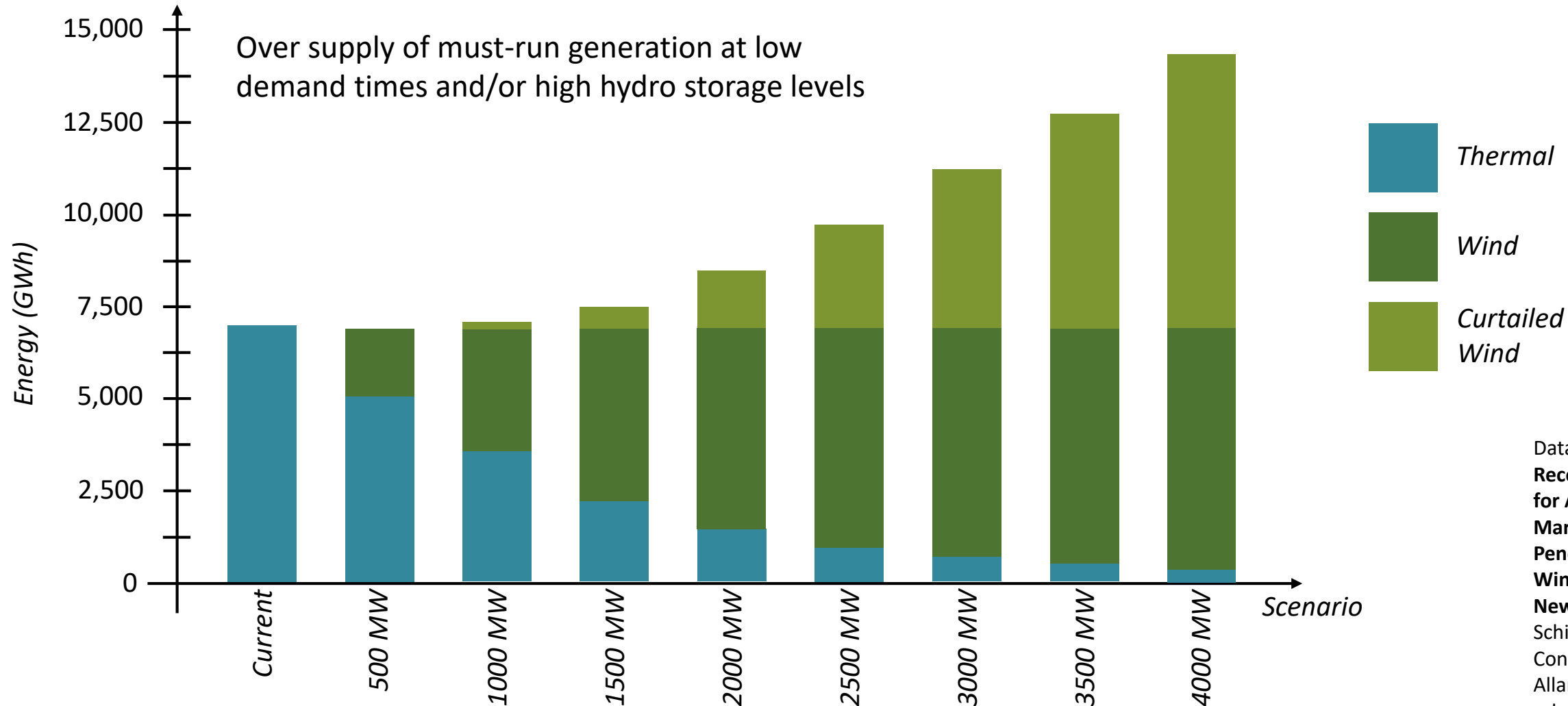


Need for droop response and frequency keeping will increase

Recommend making droop response an ancillary service, able to be provided by consumers as well as generation

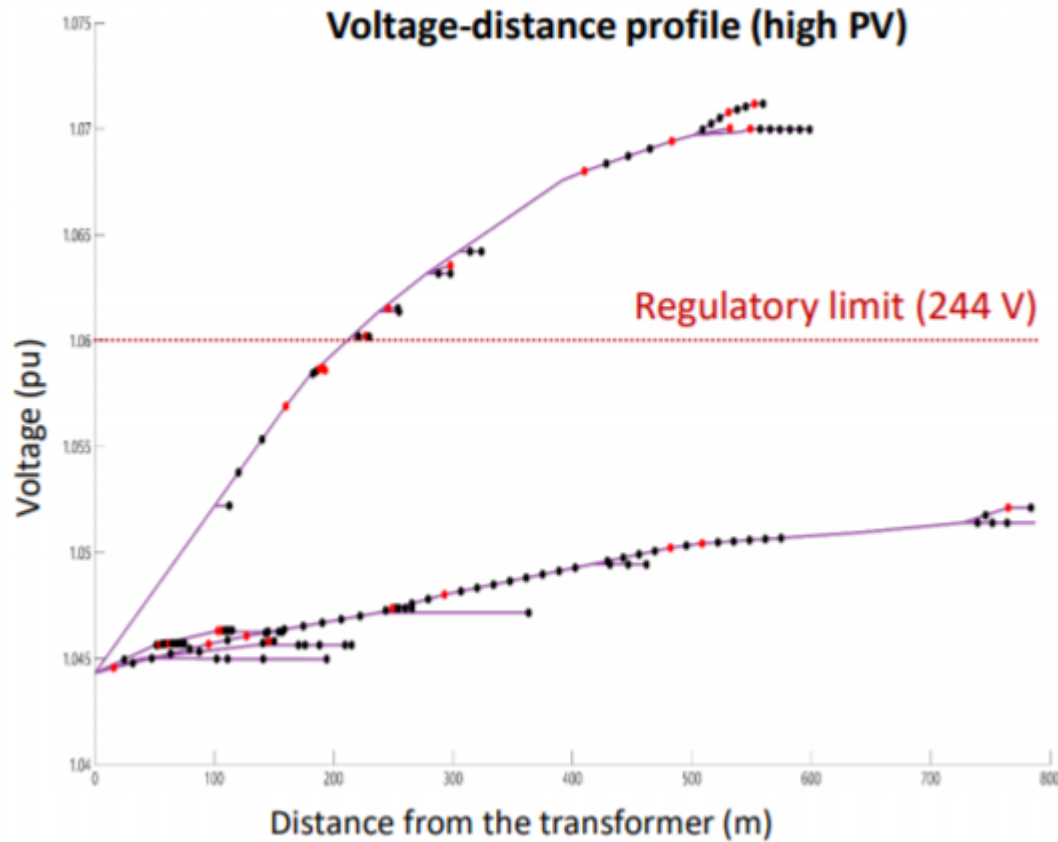
From: **Recommendations for Ancillary Service Markets under High Penetrations of Wind Generation in New Zealand**, Josh Schipper, Alan Wood, Conrad Edwards, and Allan Miller, pre-release draft, 2018.

# Wind curtailment increases



Data from:  
**Recommendations for Ancillary Service Markets under High Penetrations of Wind Generation in New Zealand**, Josh Schipper, Alan Wood, Conrad Edwards, and Allan Miller, pre-release draft, 2018.

# Solar LV distribution network congestion



Distribution network voltage profile is reversed with reversal of power flow from solar

Voltage exceeds allowable limit

From: Scott Lemon, GREEN grid research, 2015.

# Potential Solutions

- Inertia reduction:
  - Recommend valuing inertia – ancillary service?
  - Increase instantaneous (FIR) reserves
- Variability:
  - Value droop response – ancillary service?
  - Enable consumers to provide droop response
  - Longer-term variability: geographical diversity of wind farm locations
- Wind curtailment
  - Storage of energy
  - Enable demand side to store energy
- Solar
  - Implement EEA guide – to be released
  - Require use of AS/NZS 4777 inverters
  - Understand hosting capacity of low voltage networks
  - Storage of solar spill

# Summary

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- Renewable electricity generation is a mature technology for greenhouse gas reduction
- Converting energy end-use to renewable electricity is not as mature – NZ first to face – opportunity
- Many of the challenges are solvable
- Meeting Paris and net-zero emissions will require systematic thinking and direction
- CO<sub>2</sub> emissions are from energy – implies an energy target

