

Harmonics and Keeping the Grid in Tune: Reducing a Dissonant Crescendo within the Renewable Future

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Nick Davies, Power Systems Engineer

November 2024

Presentation Overview



Understanding Harmonics



Why Do We Care About Harmonics?



Solutions and Limitations



Looking Ahead

Understanding Harmonics

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Renewable Energy - Why Do We Need Growth?

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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More wind and solar generation needed to meet future demand

Published: 03 July 2024

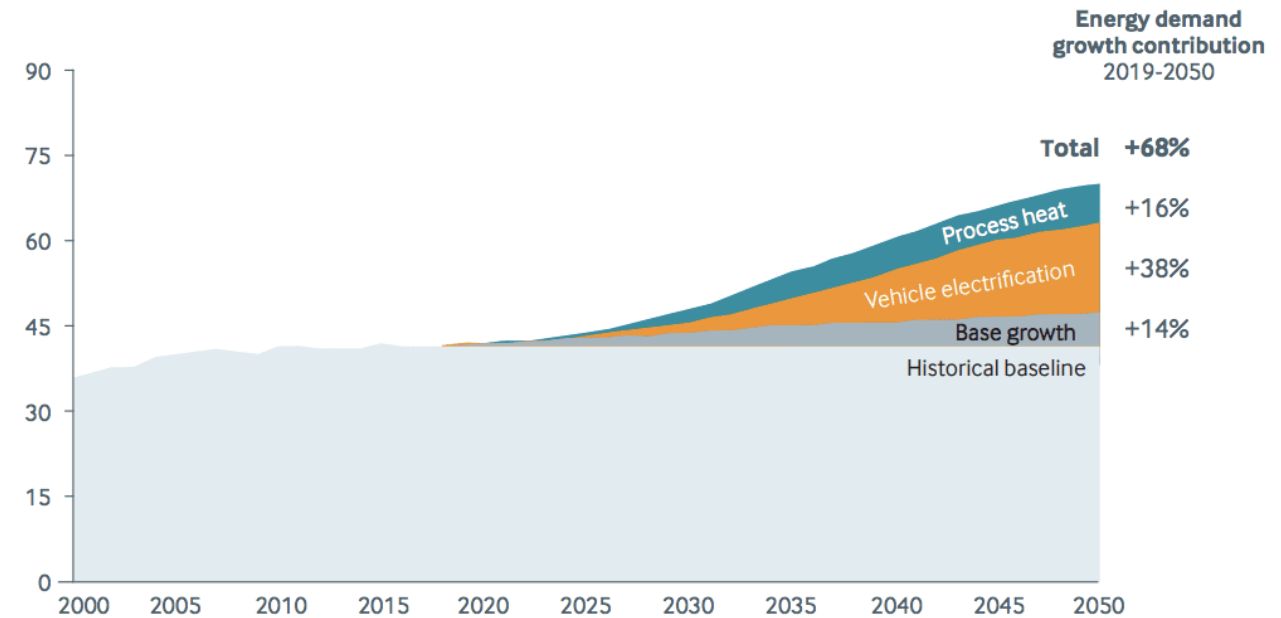
Aotearoa New Zealand will require new generation to meet future electricity demand, according to the latest Electricity Demand and Generation Scenarios (EDGS) report released by the Ministry of Business, Innovation and Employment (MBIE) today.

Demand for electricity is expected to grow as existing fossil fuel use switches to electricity, higher uptake of electric vehicles, and new demand – such as large-scale data centres coming online. By 2050, it is expected around half of all energy demand will be met by electricity," says Markets Manager Mike Hayward.

source: MBIE

Figure 3: **Gross energy demand**

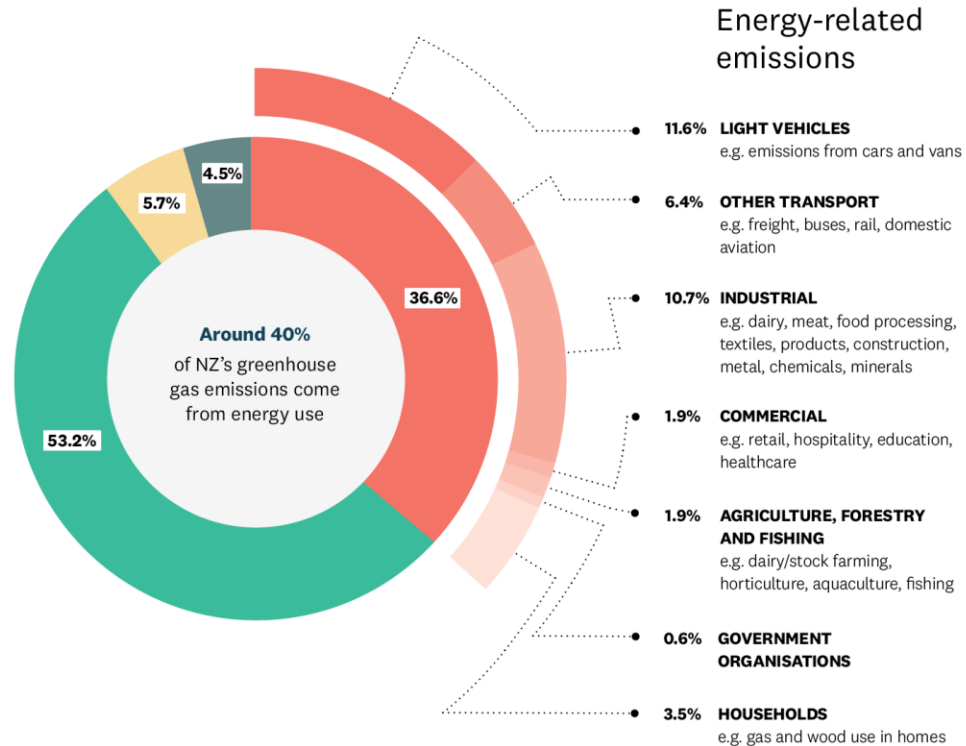
(TWh, Accelerated Electrification)



source: Newsroom

New Zealand's greenhouse gas emissions

Total emissions



source: Ministry for the Environment

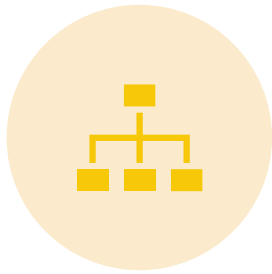


source: NZ Steel

Why Do We Need Power Quality?



LONGEVITY OF
EQUIPMENT



OPERATIONAL
DISRUPTION,
STABILITY

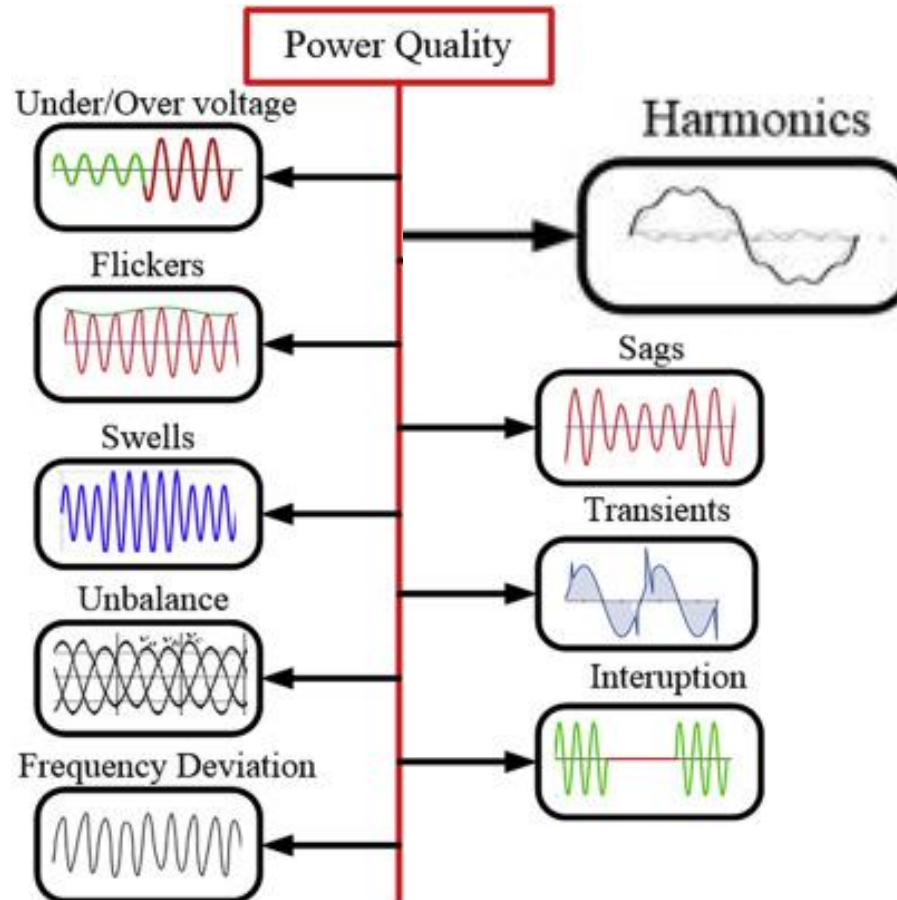


EFFICIENCY



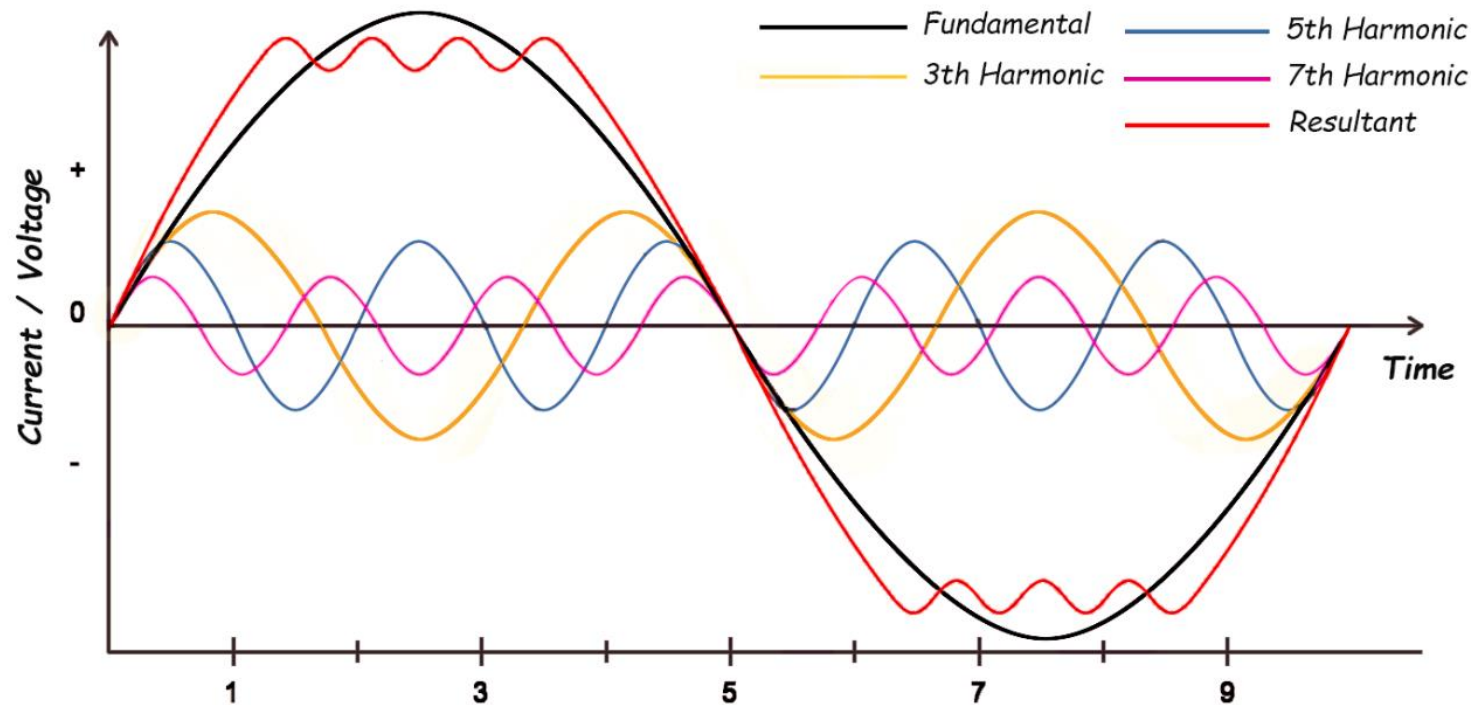
LAW

What Threatens Power Quality?



source: ScienceDirect

What are Harmonics?



source: LinkedIn

How Are They Generated?

- INVERTER BASED RENEWABLE SOURCES
- LOADS
- POWER ELECTRONICS / MODERN TECHNOLOGY



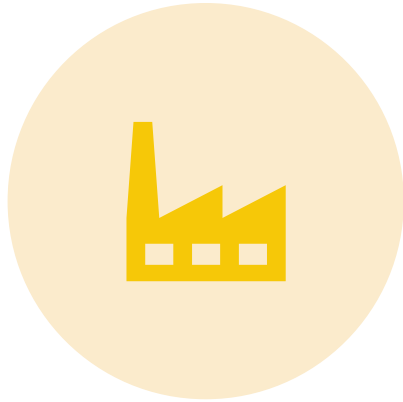
Why Do We Care About Harmonics?

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The Impact of Harmonics

- INEFFICIENCIES
- EQUIPMENT LIFESPAN
- INVESTOR CONFIDENCE

The Cost of Harmonics



INDUSTRY



CONSUMER



FUTURE

Solutions and Limitations

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Regulatory Landscape

- CURRENT REGULATIONS
- INTERNATIONAL REGULATIONS
- DIFFICULTIES AND LIMITATIONS



THE ELECTRICITY ACT 1992

APPROVAL OF ELECTRICAL CODE OF PRACTICE

FOR

HARMONIC LEVELS

Pursuant to Section 36 of the Electricity Act 1992 ("the Act")

On the 1st day of February 1993, the Secretary of Commerce issued the Electrical Code of Practice for Harmonic Levels ("the Code")

On the 4th day of February 1993, pursuant to Section 38 of the Act the Secretary published in the Gazette a notice of intention to apply to me for approval of the code, and there has been consultations with such persons (or their representatives) as will be affected by the Code and they have had the opportunity to consider possible effects and comment on those effects.

I have considered the comments concerning those effects and where necessary amendments were made to the Code.

Therefore Pursuant to Section 38 of the Act, I, John Luxton, Minister of Energy, have this day approved the Code as attached to this approval, which Code shall come into force on the 1st day of April 1993.

Dated this 18th day of March 1993.

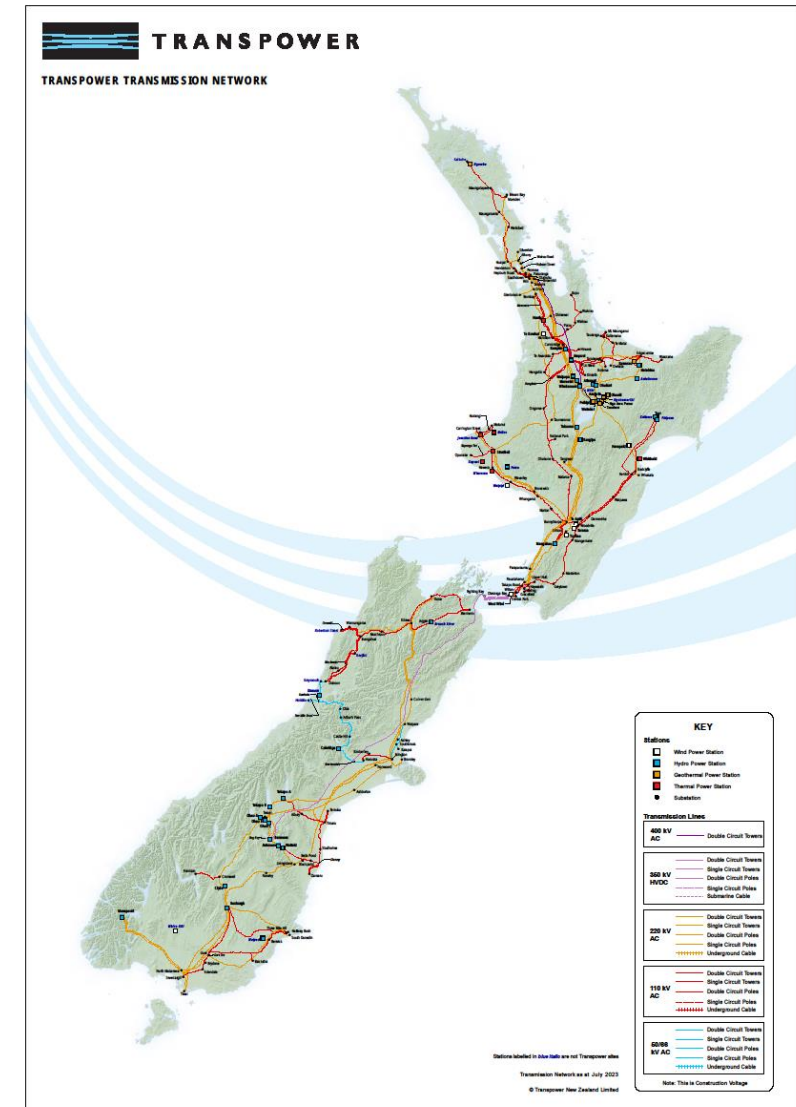
source: NZ EA

Monitoring Harmonic Output

- TECHNIQUES AND TECHNOLOGIES
- INTRINSIC DIFFICULTIES WITH MONITORING & ACCOUNTABILITY



source: Transpower



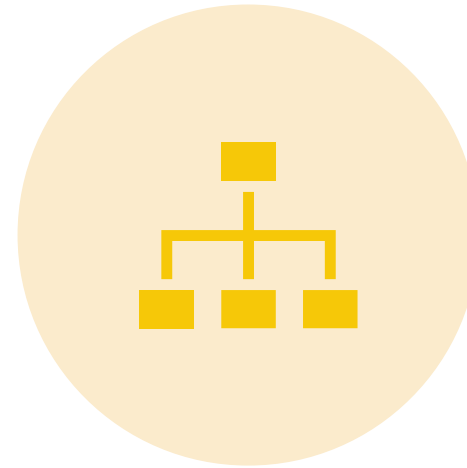
Mitigation



Liability



WHO BEARS THE COST



NEW FRAMEWORKS?

Retroactive Changes to Generator Substations



A low-angle, close-up shot of a white wind turbine against a clear blue sky. The image shows the hub, the base of the blades, and one blade extending towards the top left. The perspective creates a sense of height and scale.

Looking Ahead

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Going Forward



How to future-proof designs

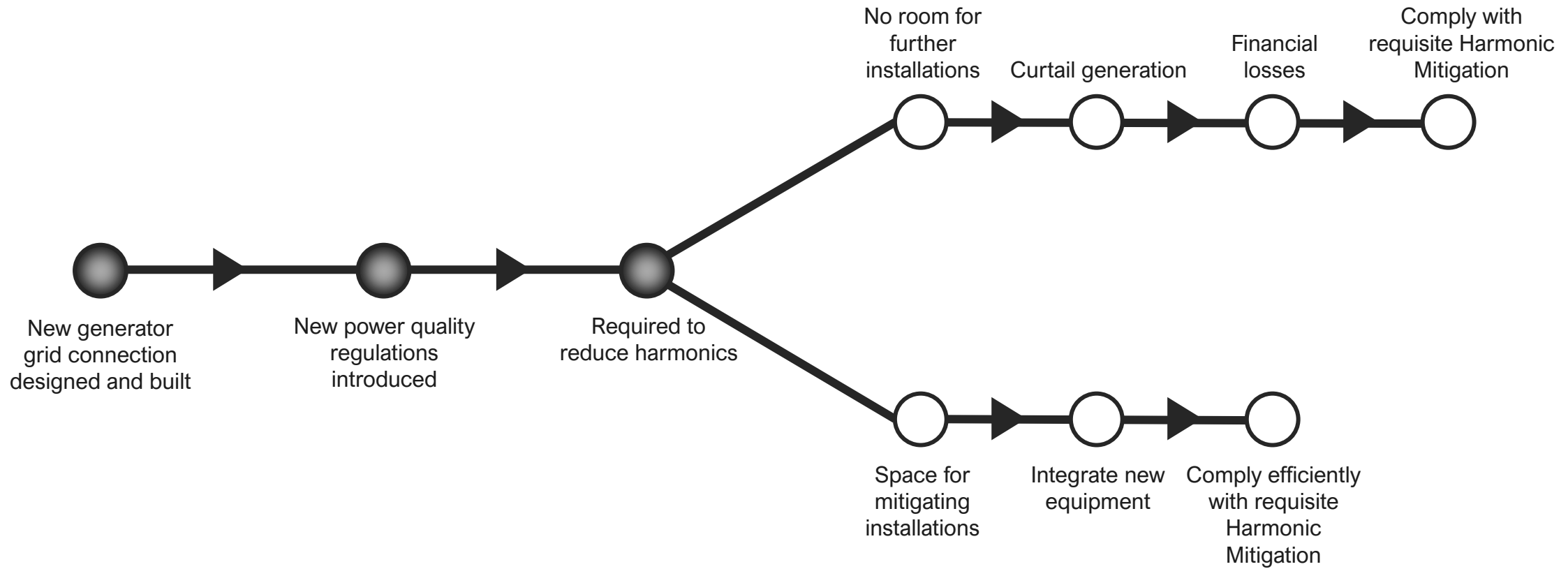


Expansion space



Industry Coordination

Generator Design Outcomes



Summing Up

- Renewable Generators = More Harmonics
- Harmonics = Harmful, Costly
- Regulations are Increasing
- Limitations in Accountability = Shared Costs
- Mitigation via Space/Future Equipment
- Proactive Measures = Generator Longevity
- Must Ensure Investment in Renewables Persists for NZ Future

Q&A

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Acknowledgements

Rob Sawrey

Kevin Friesen

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Thank you

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