Understanding New Zealand's GHG Emissions Profile as a Basis for Strategic Planning

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Overview

- Waikato Energy Research Centre
- NZ’s Emissions Targets
- Emissions Contribution and Analysis by Sector
  - Agriculture
  - Transport
  - Process Heat
  - Electricity
- Conclusions

ENERGY RESEARCH CENTRE

Waikato Energy Research Group

- 2 Associated Faculty
- 4 Full-time Researchers
- 2 x PhD students
- Focused on engineering research that leads to <u>Industrial Implementation</u>
  - 4 Major MBIE Contracts
- <u>Industry Courses</u>
  - EECA Webinars

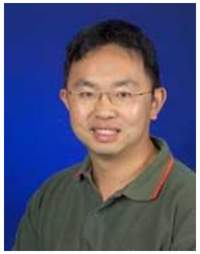
Professor Peter Kamp (Director)

Associate Professor Michael Walmsley

Dr James Neale (2005)

Dr Martin Atkins (2007)

Dr Tim Walmsley (2014)



Mr Lance Wong (2009)

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End User Focused

Fonterra™

SCION
forests · products · innovation

OJI
Beyond the Boundaries
Oji Fibre Solutions

EECA BUSINESS™
PUTTING ENERGY TO WORK

Norske Skog
Tasman

PROTECTS WHAT'S GOOD
Tetra Pak

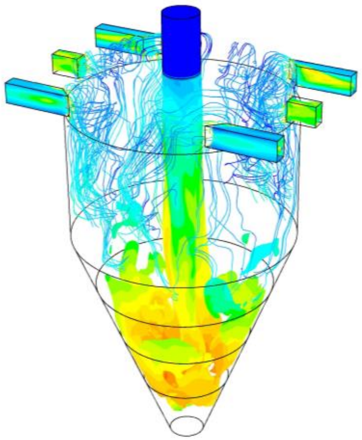
GEA

ue
SYSTEMS INC
The ultrasound approach

Windsor

Our Engineering Capability

- Energy Systems Analysis / Planning
    - EROI, Net Energy Analysis
- Industrial energy auditing
- Process and site integration
- Computational fluid dynamics
- Experimental lab research
- Process modelling
- Industry training - ECCA



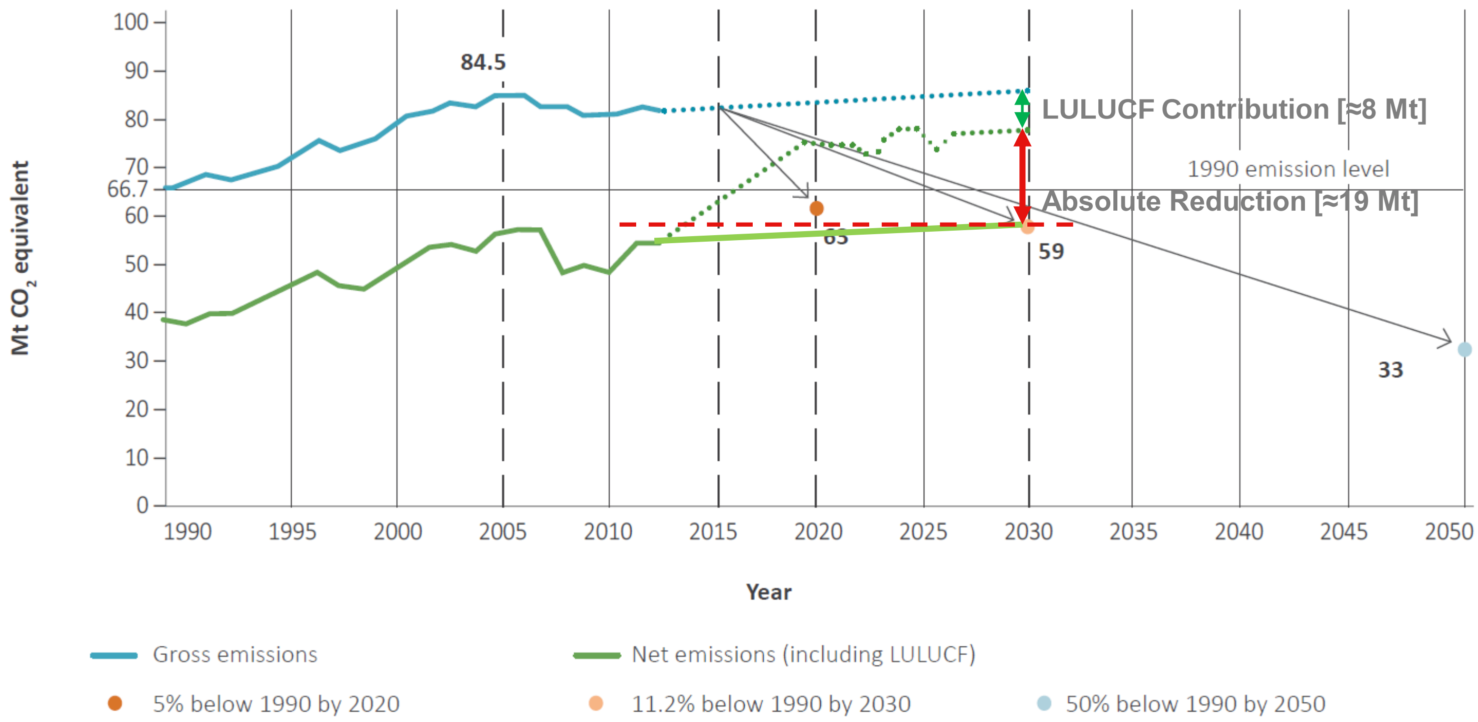
NZ’S EMISSIONS & TARGETS

NZ Emissions Reduction Target

- By 2020
  - 5% below 1990 levels (unconditional)
  - 10 – 20% below 1990 levels (conditional)
- By 2030
  - 30% below 2005 levels [11.2% below 1990] (provisional)
- By 2050
  - 50% below 1990 levels (aspirational)

NZ Emissions Reduction Target

Figure 3.5 New Zealand's gross and net emissions from 1990 to 2013, future projections and national emission reduction targets for 2020, 2030 and 2050.



Note: The 2020 conditional target range of 10–20% below 1990 is not shown.

Source: Based on MfE (2015e).

Royal Society, 2016

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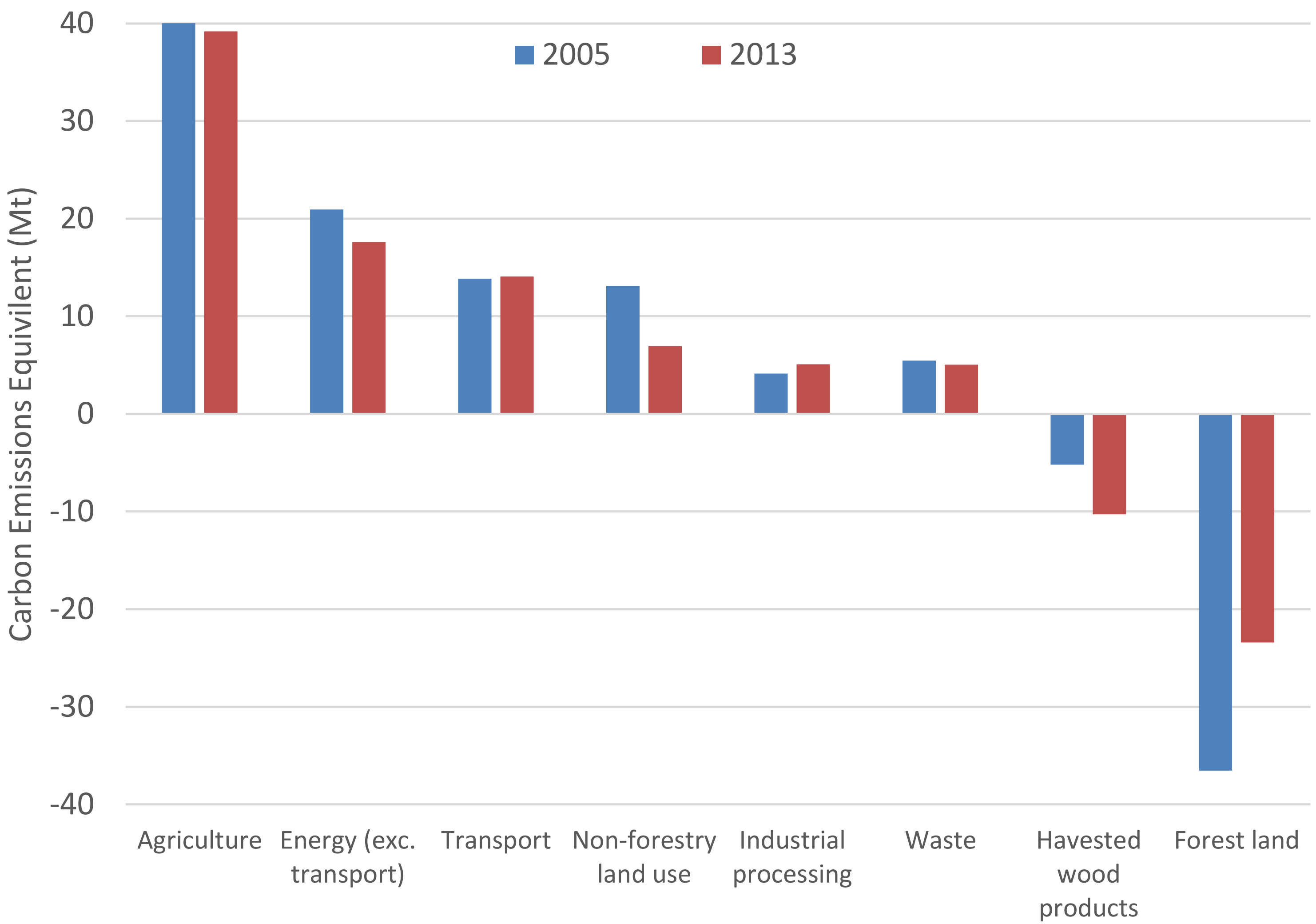
NZ Carbon Balance



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AGRICULTURE

NZ Agricultural Emissions Breakdown

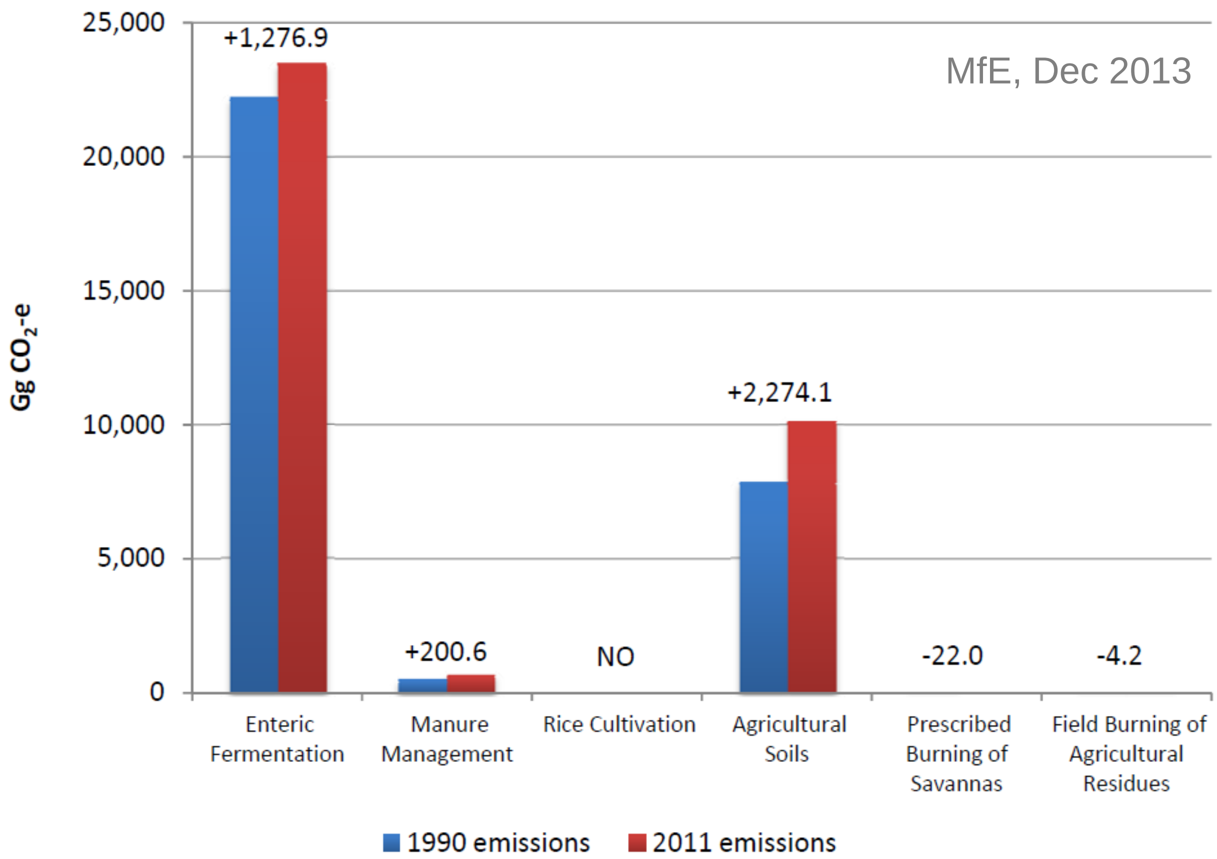
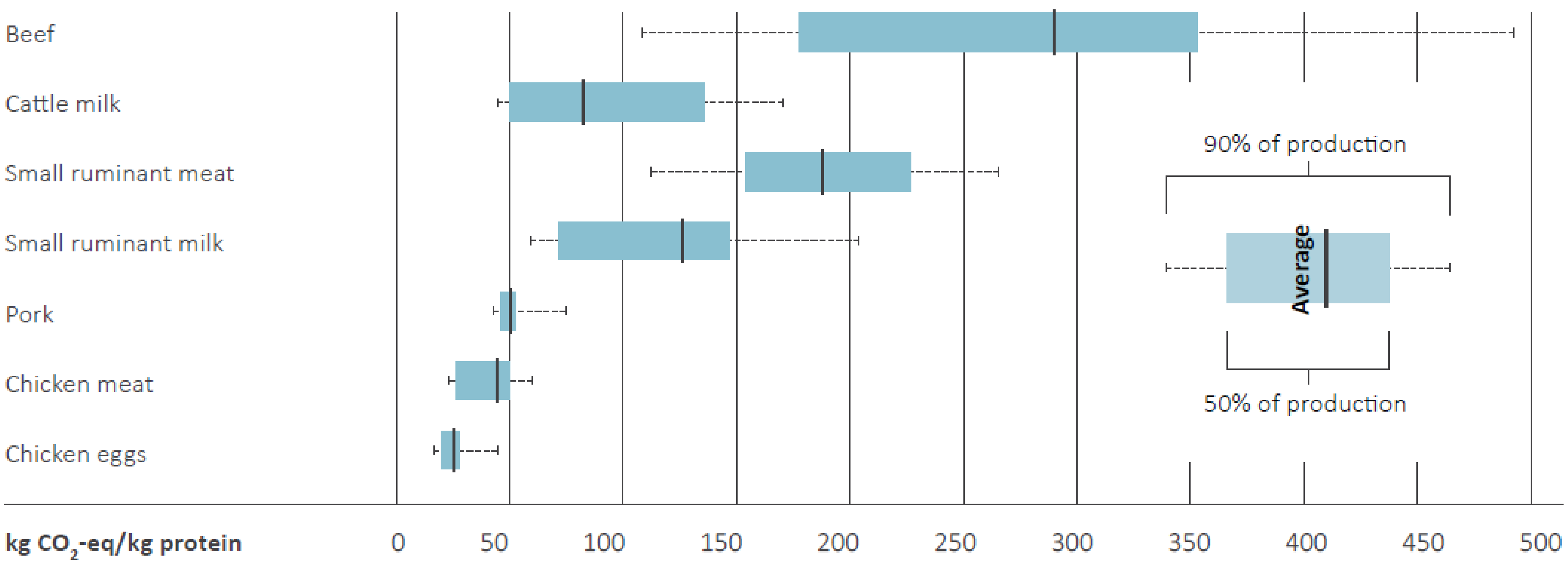


Figure 3.5: Change in New Zealand's emissions from the agriculture sector, 1990 – 2011

GHG Intensities

Figure 5.28 Range of emissions intensities per kg protein for different livestock products.



Source: Gerber et al. 2013.

Royal Society, 2016

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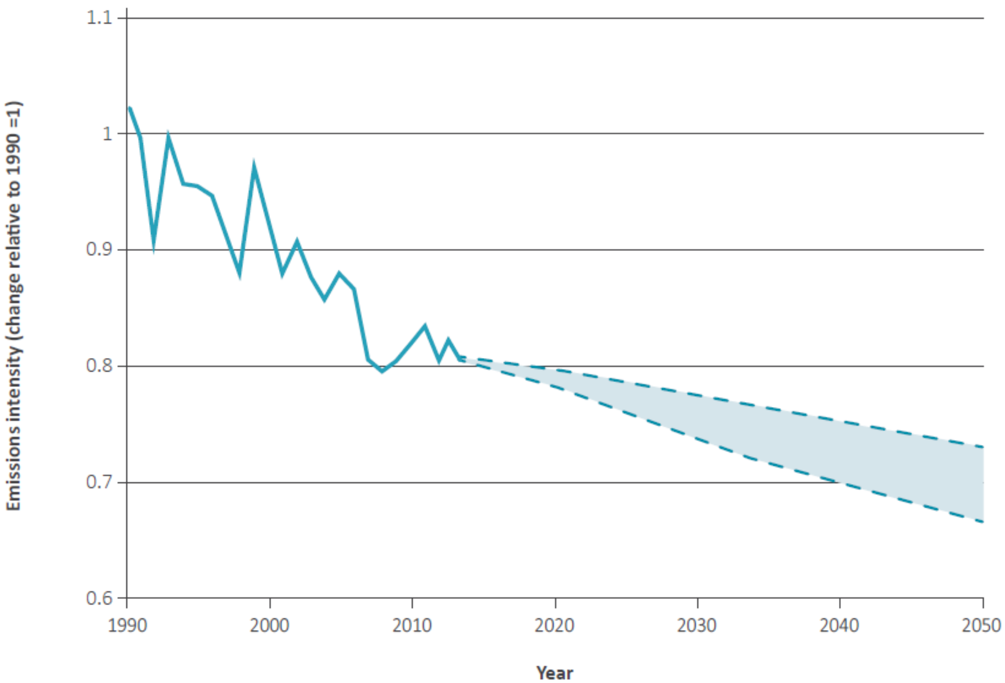
Agriculture Emissions Intensity

Figure 5.30 Historical and projected future changes in aggregate on-farm emissions intensity for dairy, beef and sheep meat production in New Zealand.



Note: Shaded projections are for two alternative baseline scenarios reflecting different productivity improvements.

Royal Society, 2016

Source: Reisinger and Clark (2015).

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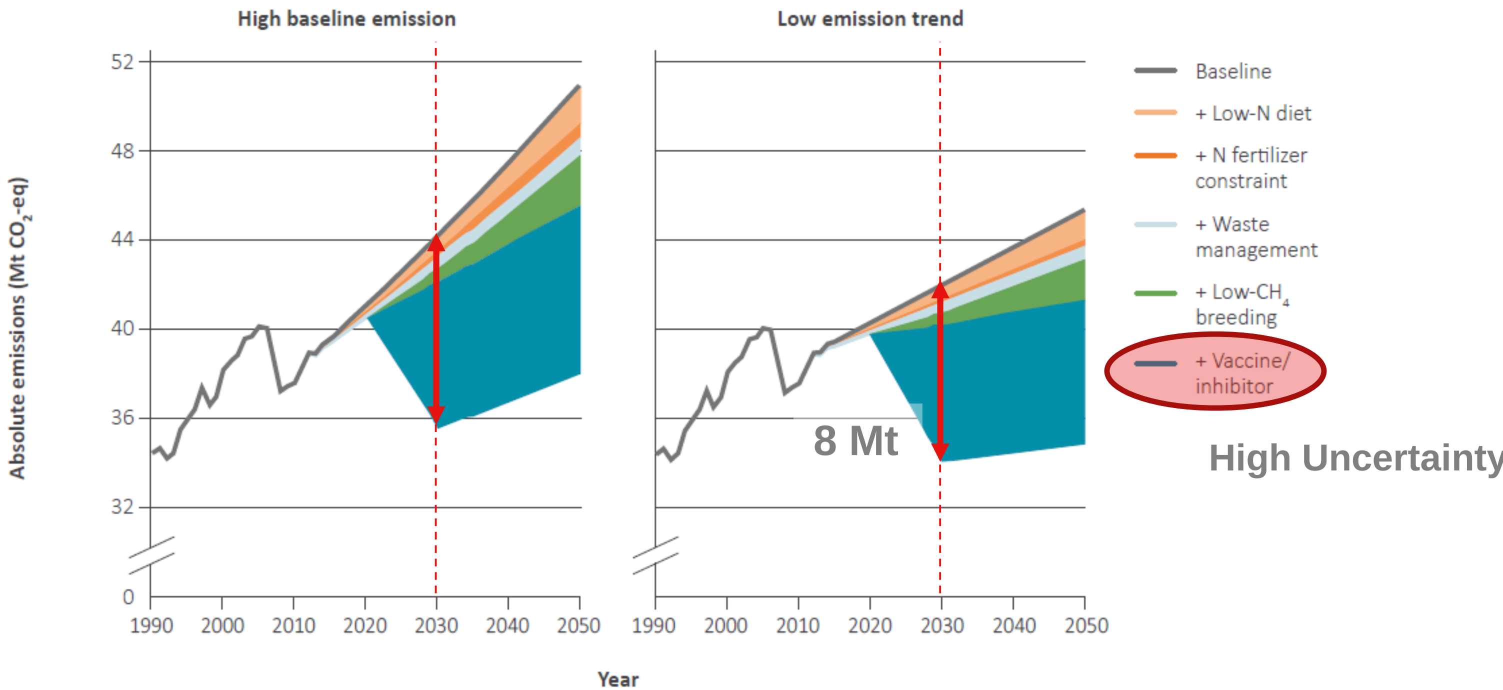
Mitigation Options

	Discovery & proof of concept	Pilot studies	Good practice
Feed & nutrition	Incorporating low GHG traits into forage plants Identification and synthesis of compounds from plants that can reduce methane and nitrous oxide	Low-methane feeds Low-nitrogen feeds	Forage crops with improved energy values and lower nitrogen content Improved forage quality
Animal genetics & breeding		Identification and selective breeding of low greenhouse gas animals	Good reproductive performance High growth rate High milk yield Breeding high-value animals
Rumen modification	Anti-methane vaccines	Testing and improving methane inhibitors	

Royal Society, 2016 (from Fig. 5.32)

Emissions Reduction Potential

Figure 5.33 Mitigation potential for all New Zealand agriculture, against high (left) and low (right) business-as-usual emission trends.



Mitigation is shown for high adoption rates and highly optimistic assumption that new technologies are available as early as 2020.

Source: Reisinger and Clark (2015).

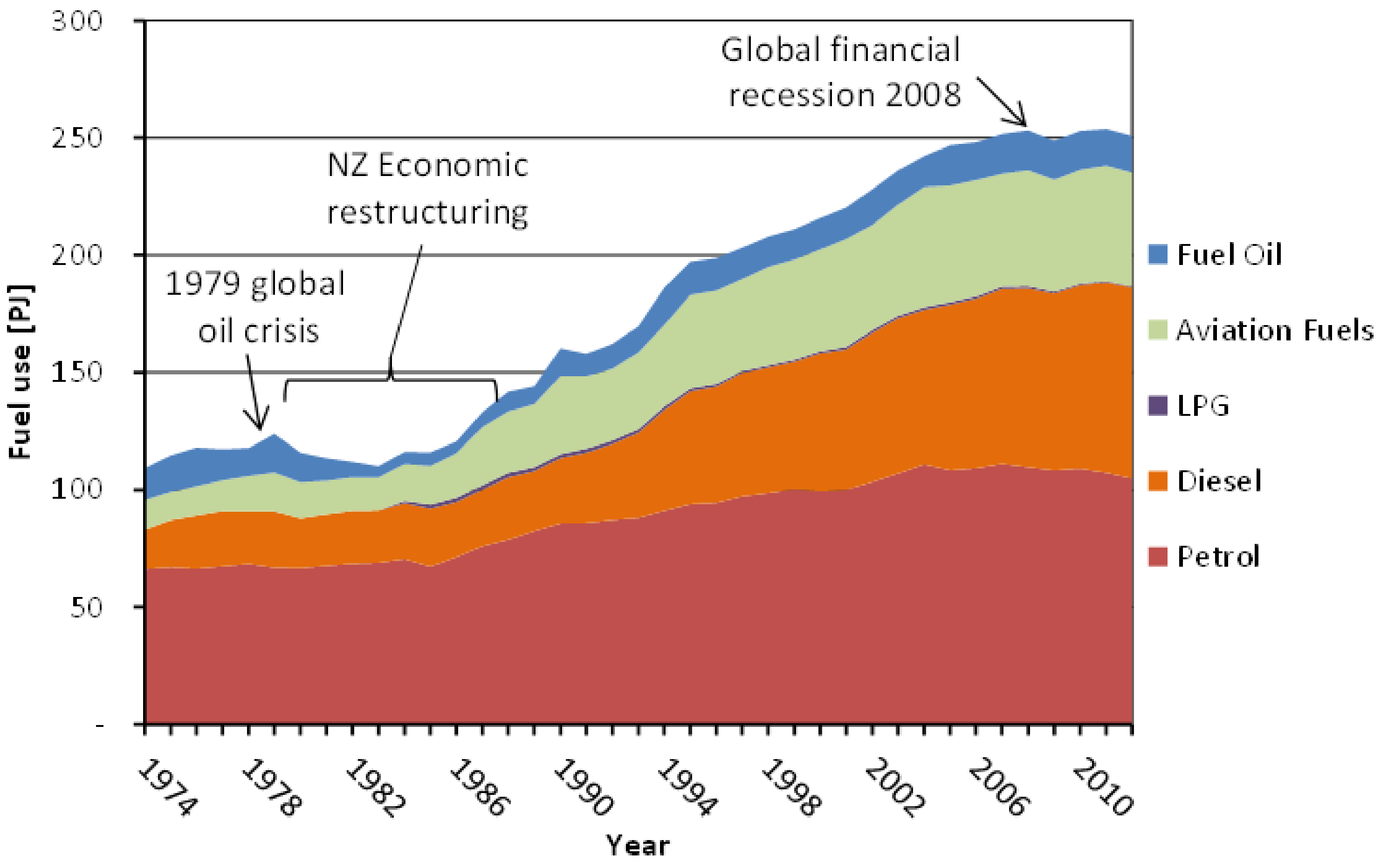
Reduction Potentials

Sector	Low Estimate [Mt CO_2-eq]	High Estimate [Mt CO_2-eq]
Agriculture	2.0 (5.1%)	8.0 (20.4%)

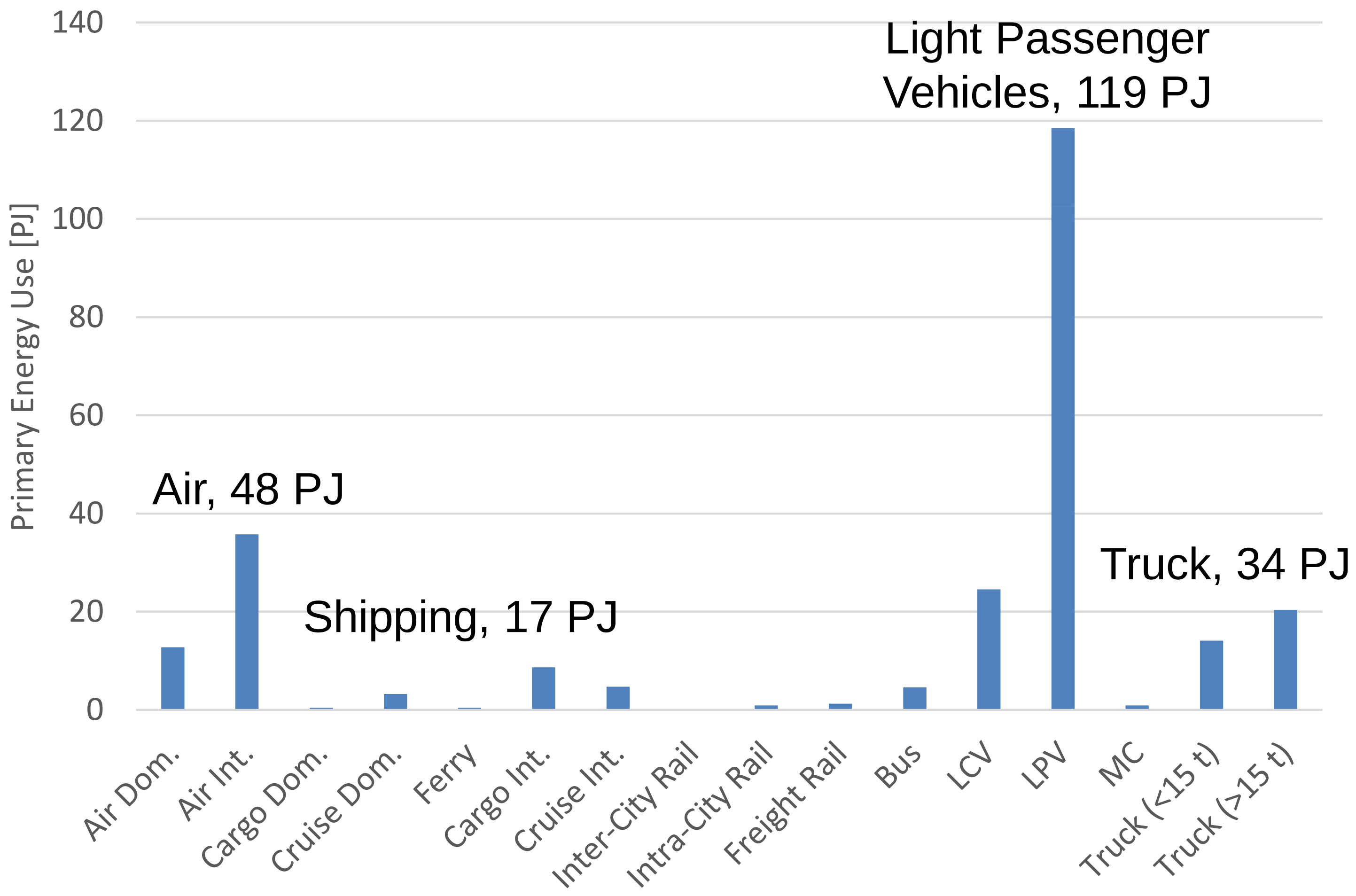
TRANSPORT SECTOR

Transport Fuel Growth since 1974

99.8% Transport Fuels from Fossil Fuels



Energy Use by Transport Method in 2012



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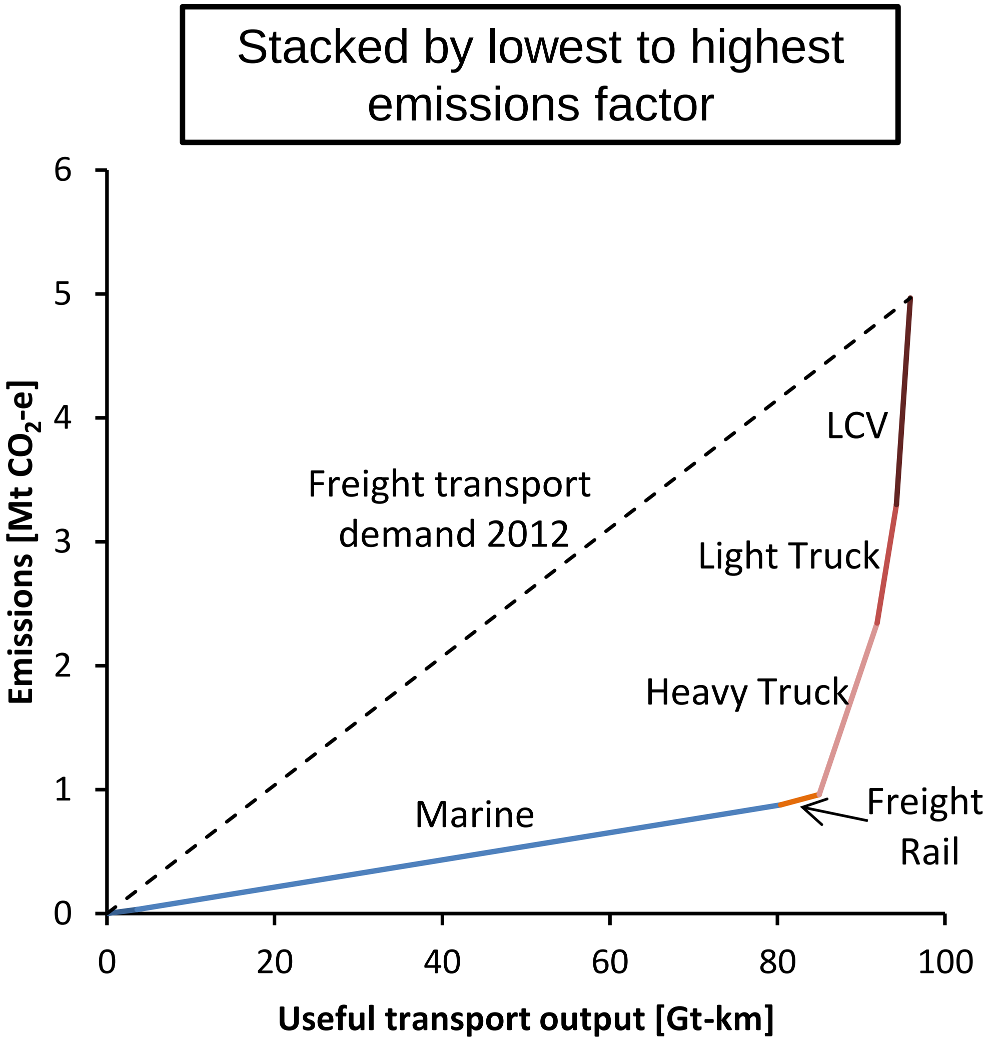
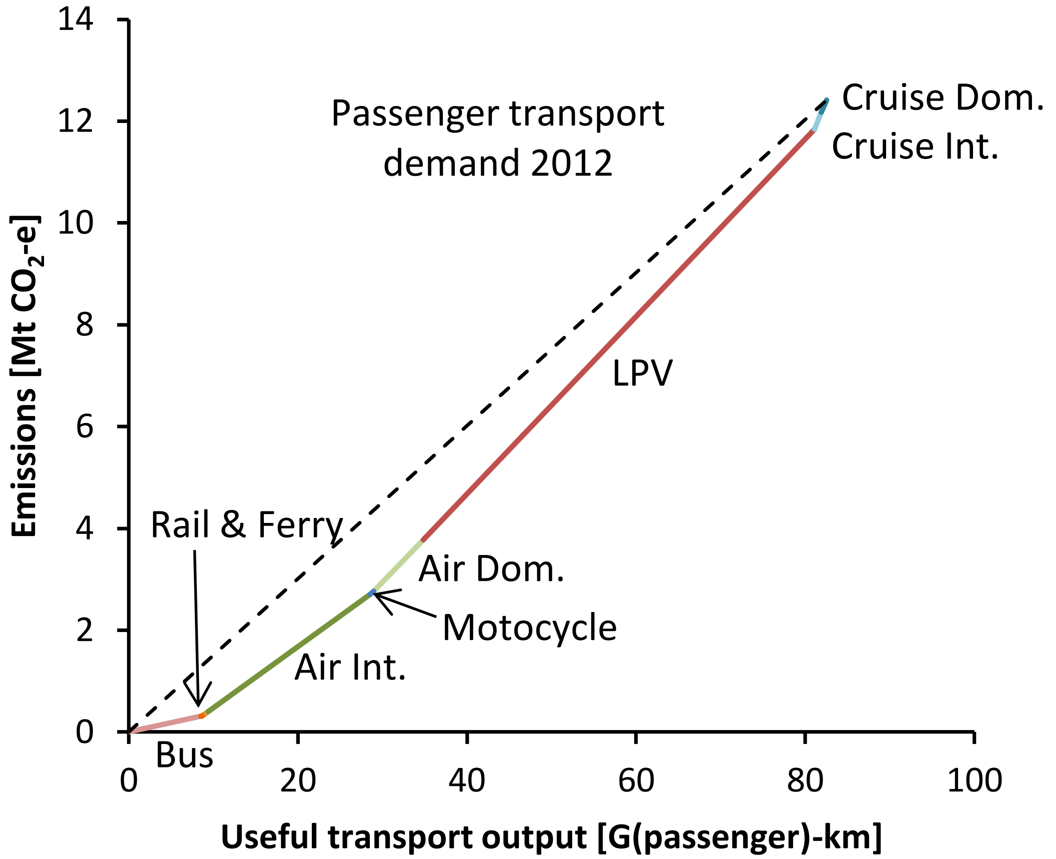
Emissions and Freight Demand

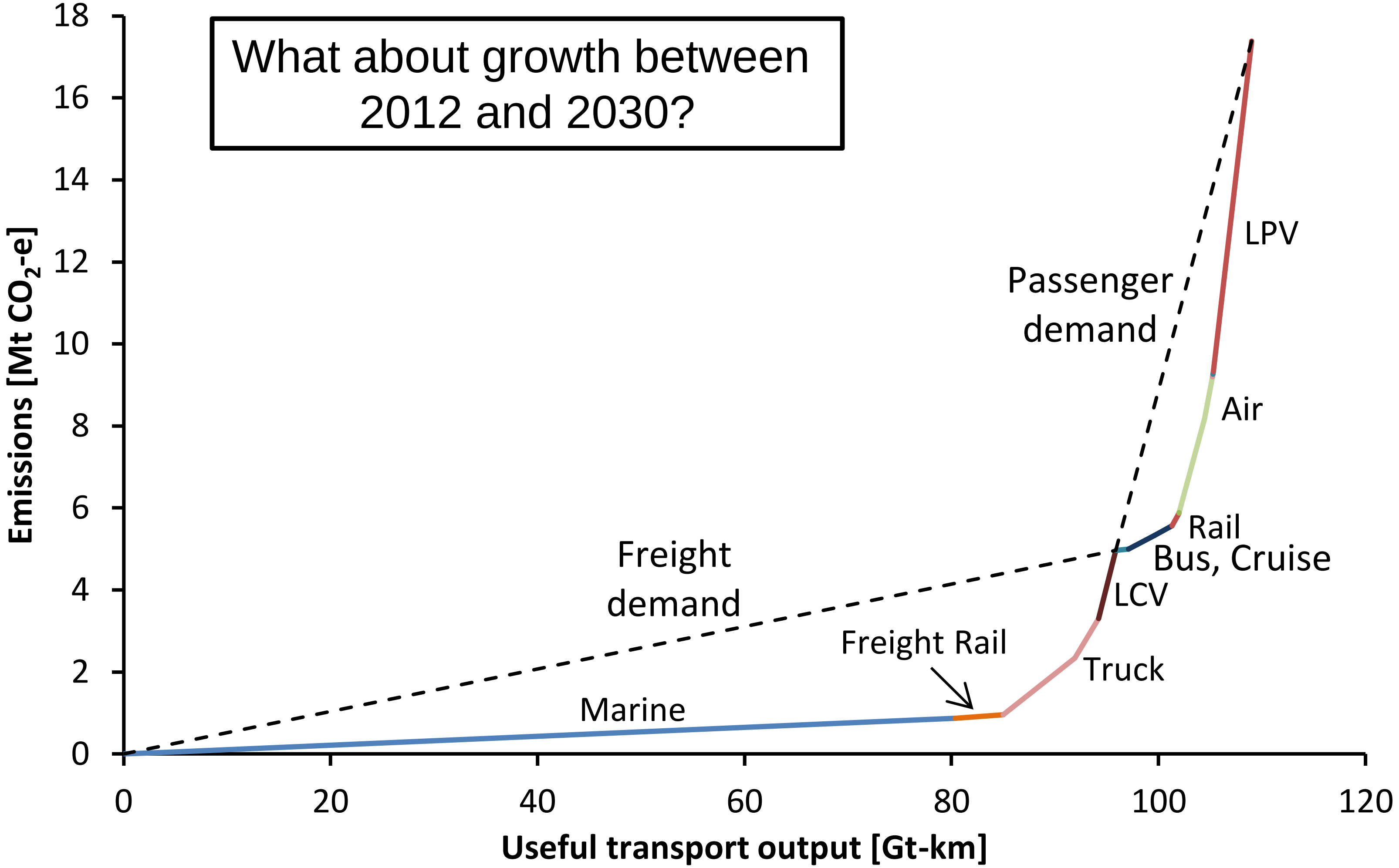


Emissions and Passenger Transport

Stacked by lowest to highest emissions factor



Emissions and Transport Demand in 2012



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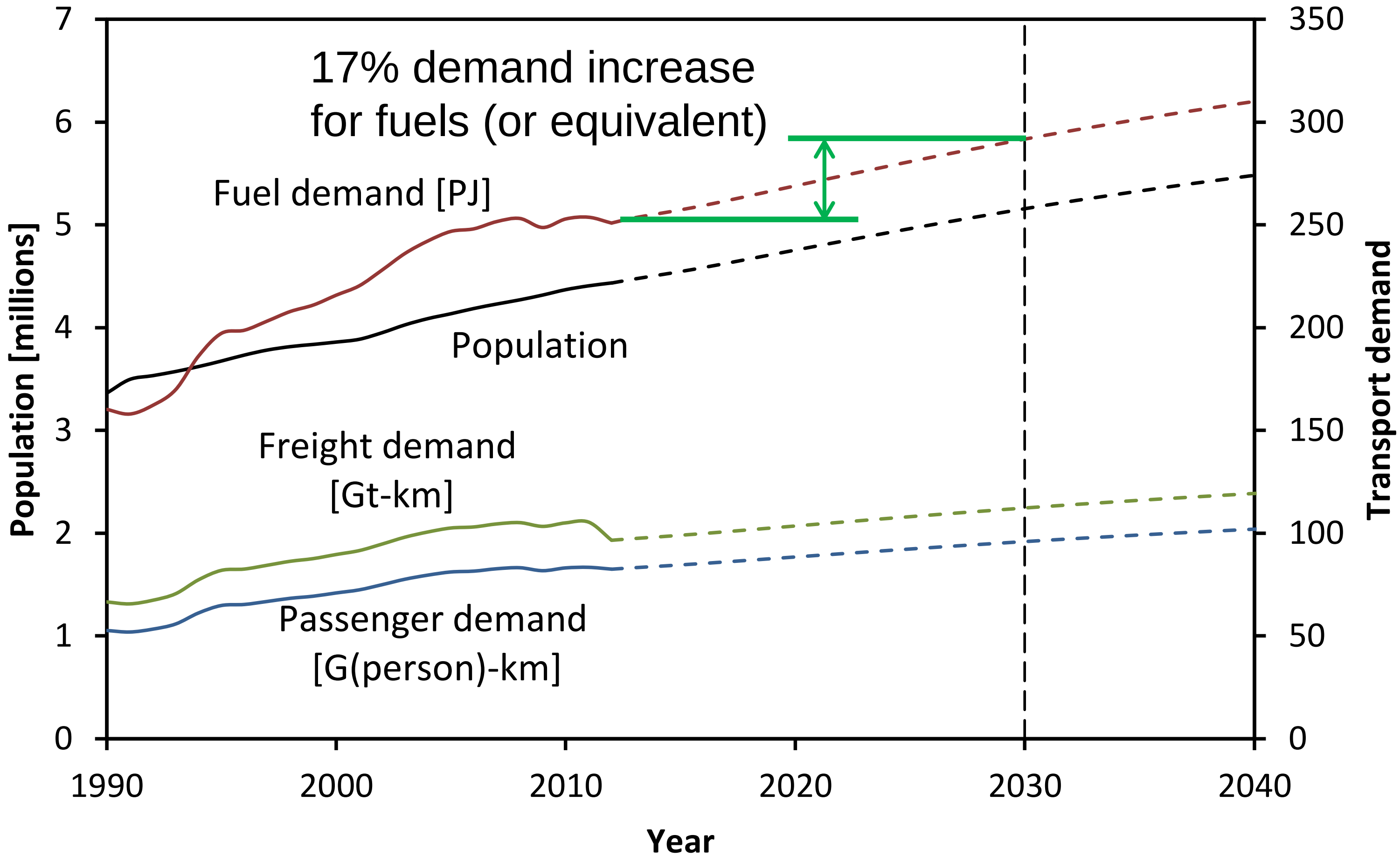
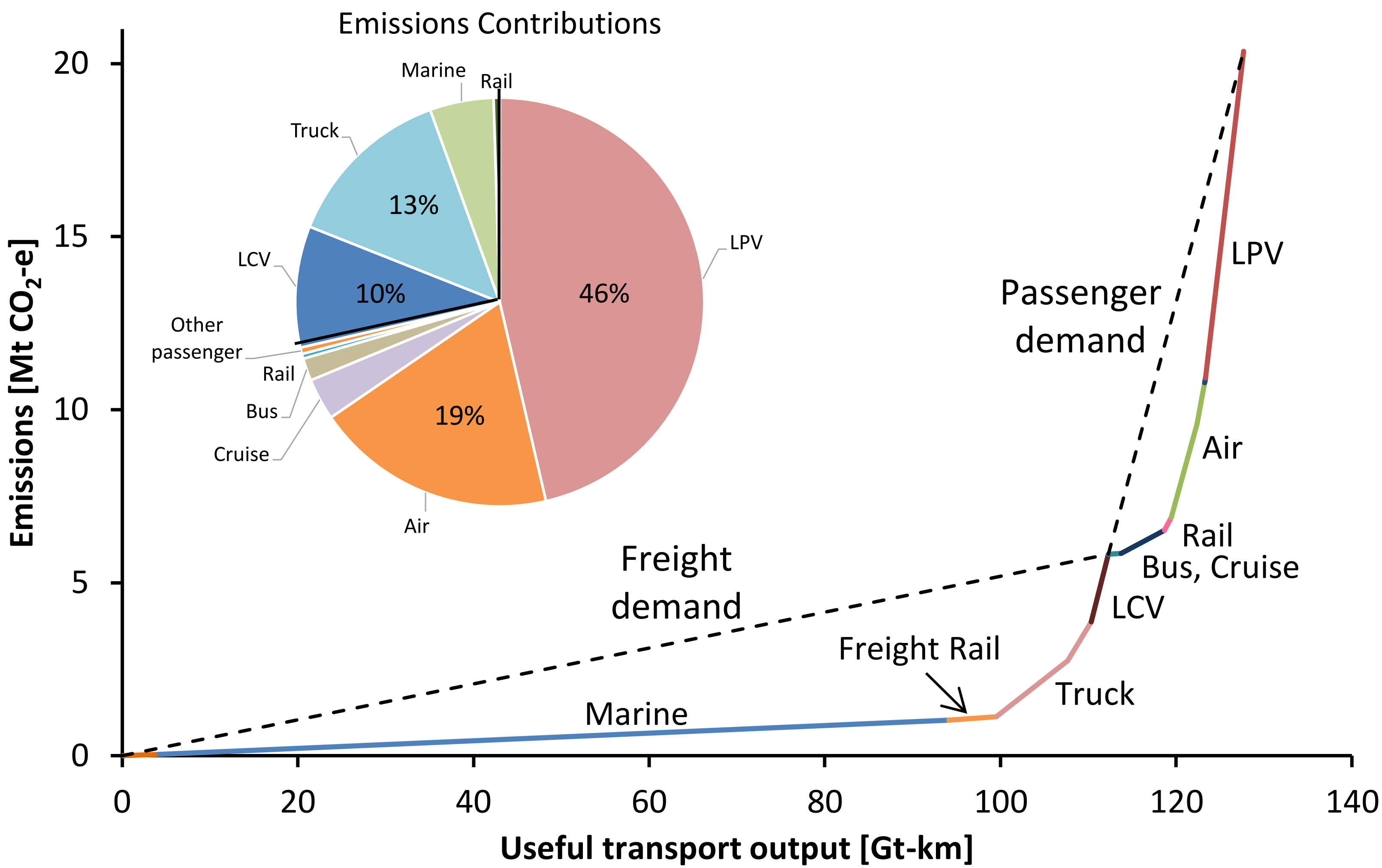
Projected Transport Demand in 2030



Emissions and Transport Demand in 2030



Transport Emissions Reduction Options

- **Fuel switching** away from fossil oil
  - Switch to a fuel with a lower emissions: electricity or biofuels
  - Electric vehicles including plug-in hybrid for LPV
  - 10-20% uptake + low emissions = 0.9 – 1.8 Mt CO_2
  - Extra electricity demand = 1.2 – 2.5 TWh_{ele}
- **Transport mode** switching to low emissions modes
  - IF fill rates are good, public transport modes are lower emissions than private vehicle use
  - Public transport is effective for emissions reduction in dense population centres – most NZ cities lack high density
  - We love our single house and land properties – *Quality of Life*

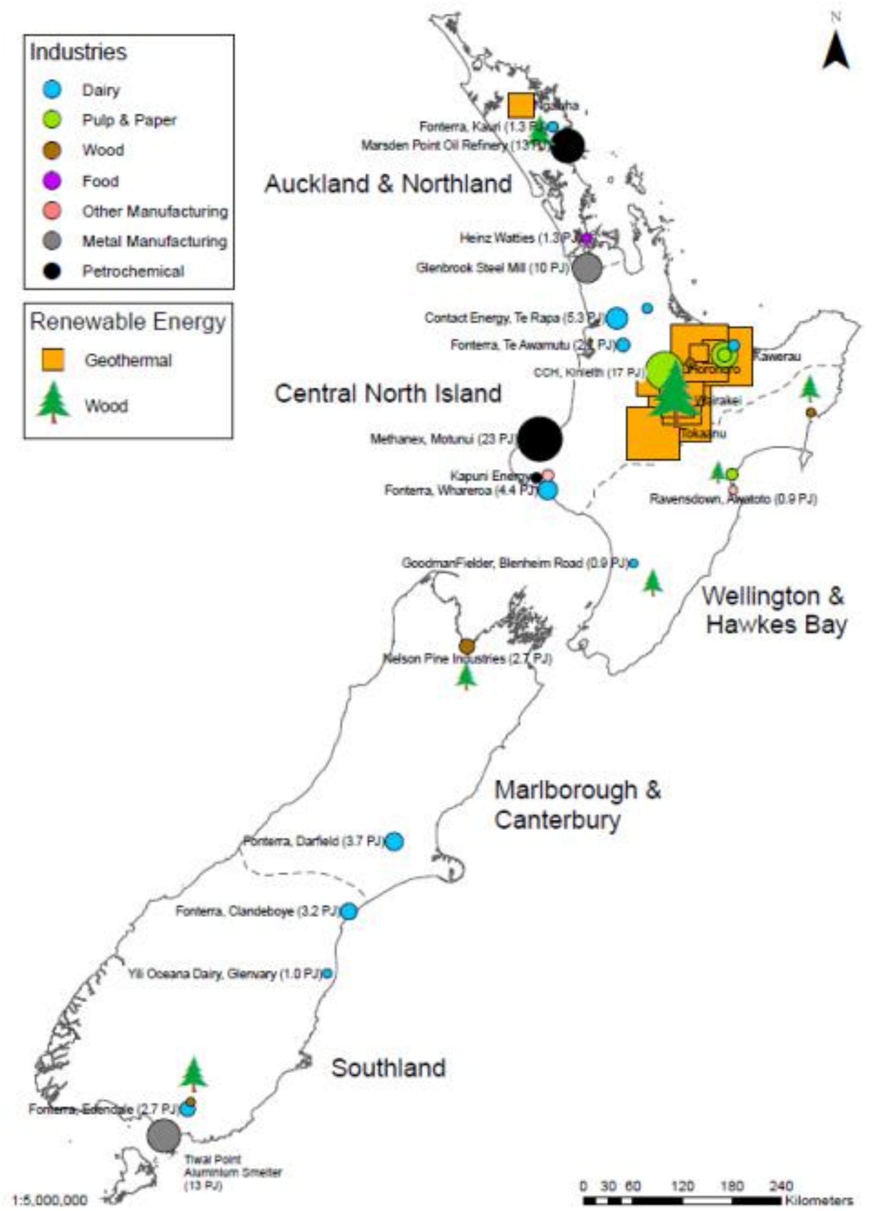
Transport Emissions Reduction Options

- **Efficient engine** technology for LPV, Bus, trucks
  - Hybrid engine, new diesel and gas engines etc.
  - 20-40% uptake + 40% more efficient = 1.7 – 3.5 Mt CO_2
- **Renewable biofuels** for air, ships and large trucks
  - Feedstocks are typically wet, low energy; conversion is energy intensive and therefore expensive
  - What is the minimum biofuels that is needed for the NZ emissions target?

Reduction Potentials

Sector	Low Estimate [Mt CO_2-eq]	High Estimate [Mt CO_2-eq]
Agriculture	2.0 (5.1%)	8.0 (20.4%)
Transport	2.8 (20.0%)	5.3 (37.6%)

PROCESS HEAT SECTOR



Industrial Process Heat Demand

Dairy
P&P
Wood
Meat
Food

Petrochemical
Metals
Manufacturing

Process Heat Supply Options

Biomass
Geothermal
Biogas
Electricity
Solar*

Coal
NG
Oil

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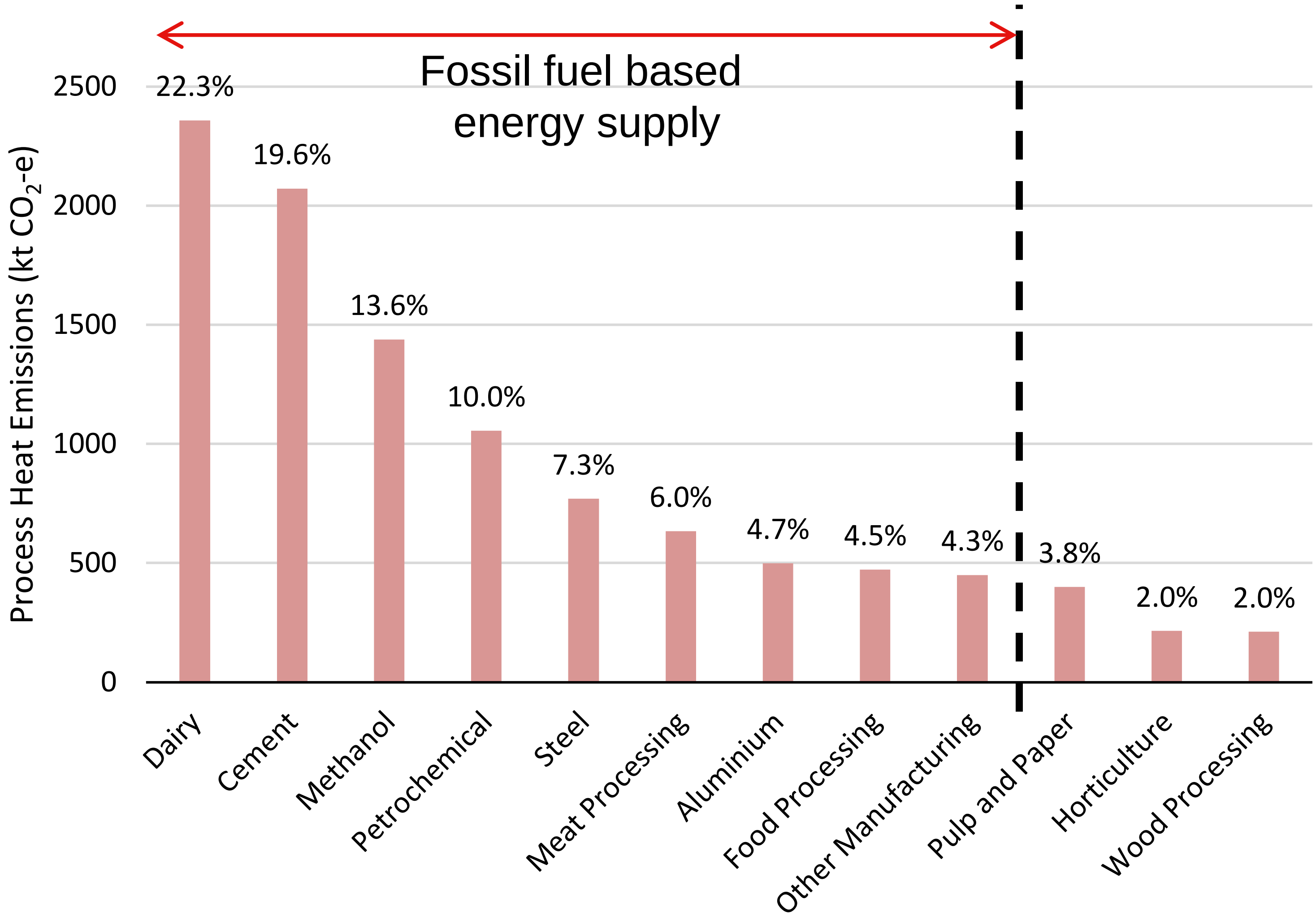
Emissions by Industry



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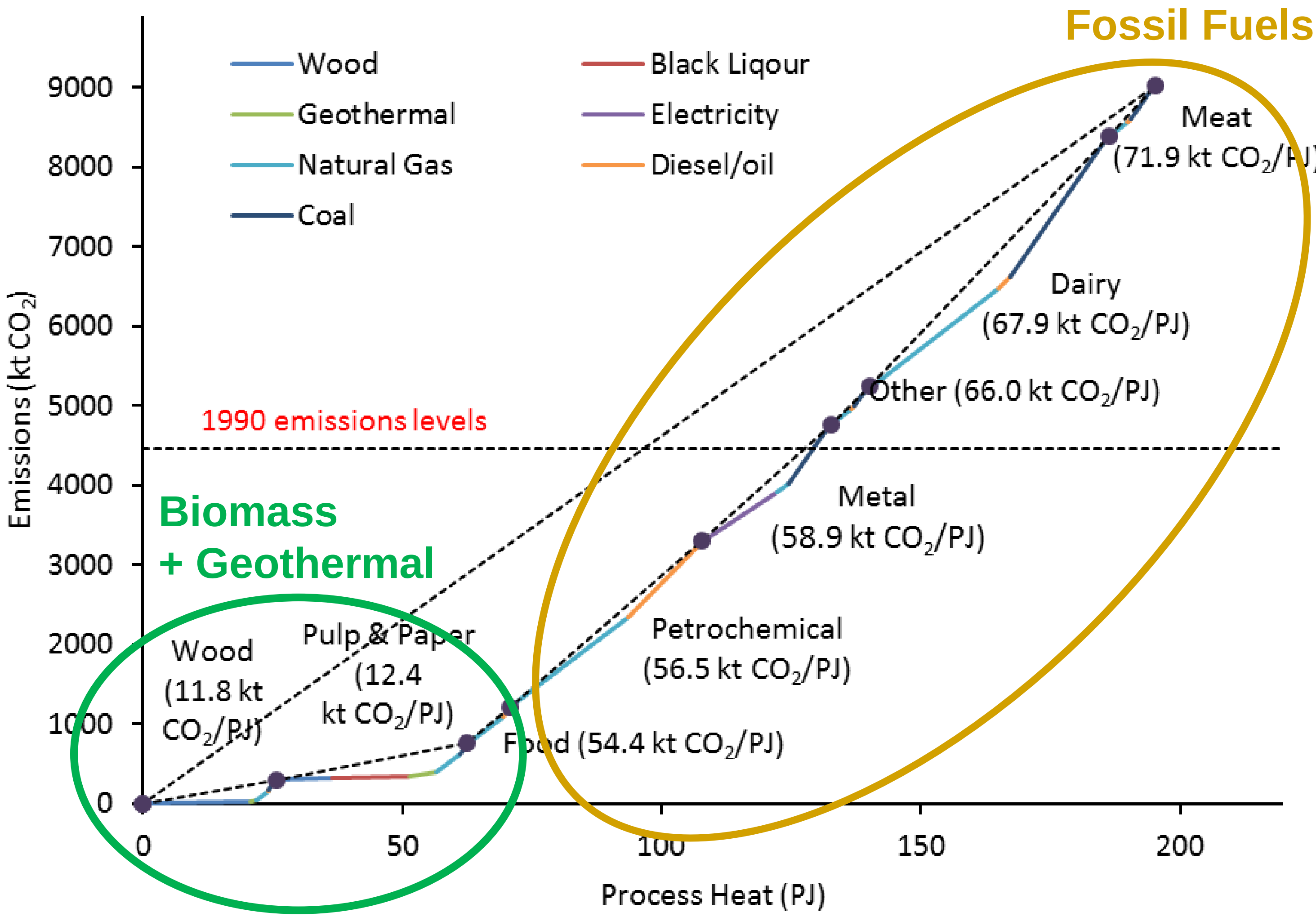
Process Heat use by Industry and Fuel Type in 2014



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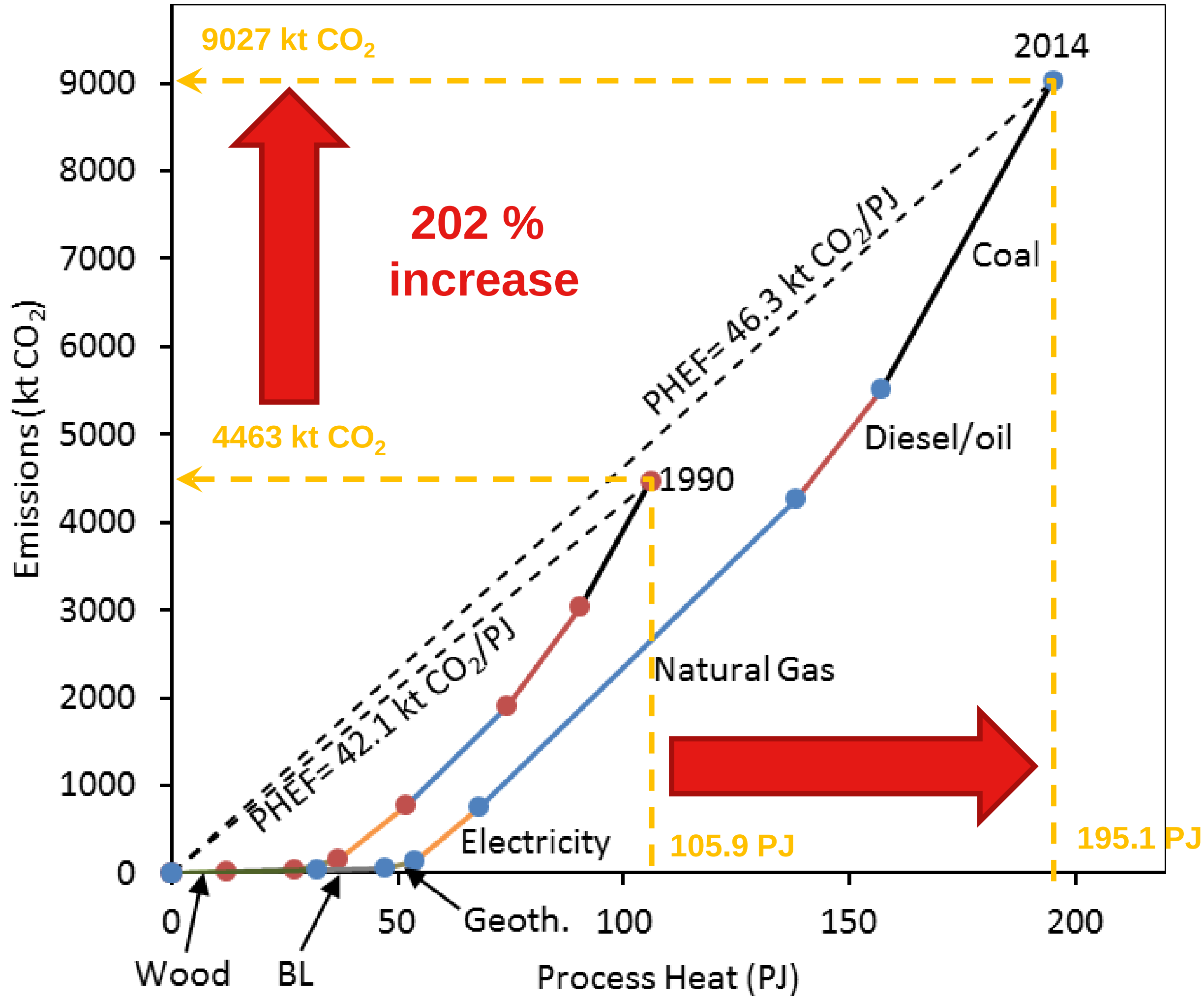
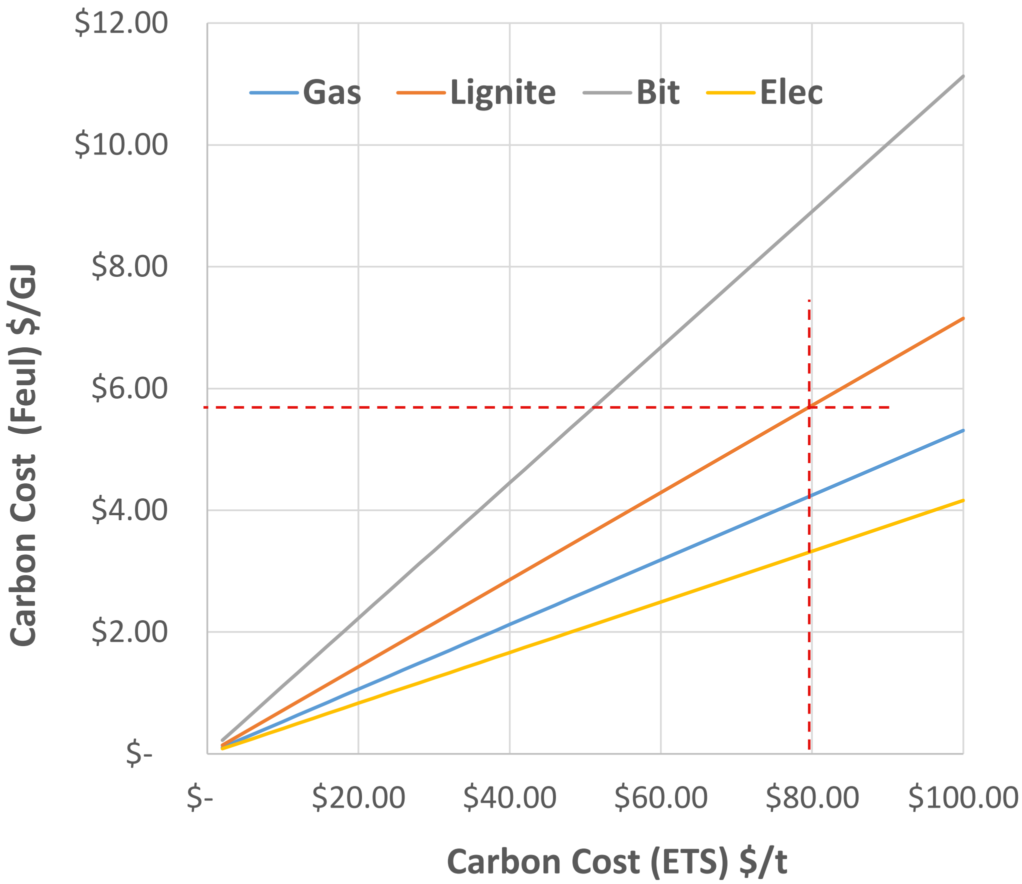
Process Heat Emissions by Fuel Type



184 % increase

Additional Fuel Cost Component (Heat)



Lignite @ $8/GJ

Carbon @ $80/t

Lignite
$8 + $5.72 = $13.72/GJ

Process Heat Emissions Reduction Options

➢ **Fuel switching** away from fossil oil

- Switch to a fuel with a lower emissions
- Coal to natural gas is a good transition option!
- Fossil fuel to geothermal direct use or electricity
- Heat pumps – excellent potential for process heat <100 °C) in conjunction with chiller units
- Meat and dairy use

Process Heat Emissions Reduction Options

- **Energy conservation and efficiency** of process and utility systems
  - Minimise emissions and resource use
  - Cogeneration of heat and power – low emissions factor
  - Many opportunities for process heat reduction, but companies lack the capital to fund longer-term payback projects (>1 year)
  - New technology – takes resources and time to roll out, exisiting infrastructure is valuable

Reduction Potentials

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Agriculture	2.0 (5.1%)	8.0 (20.4%)
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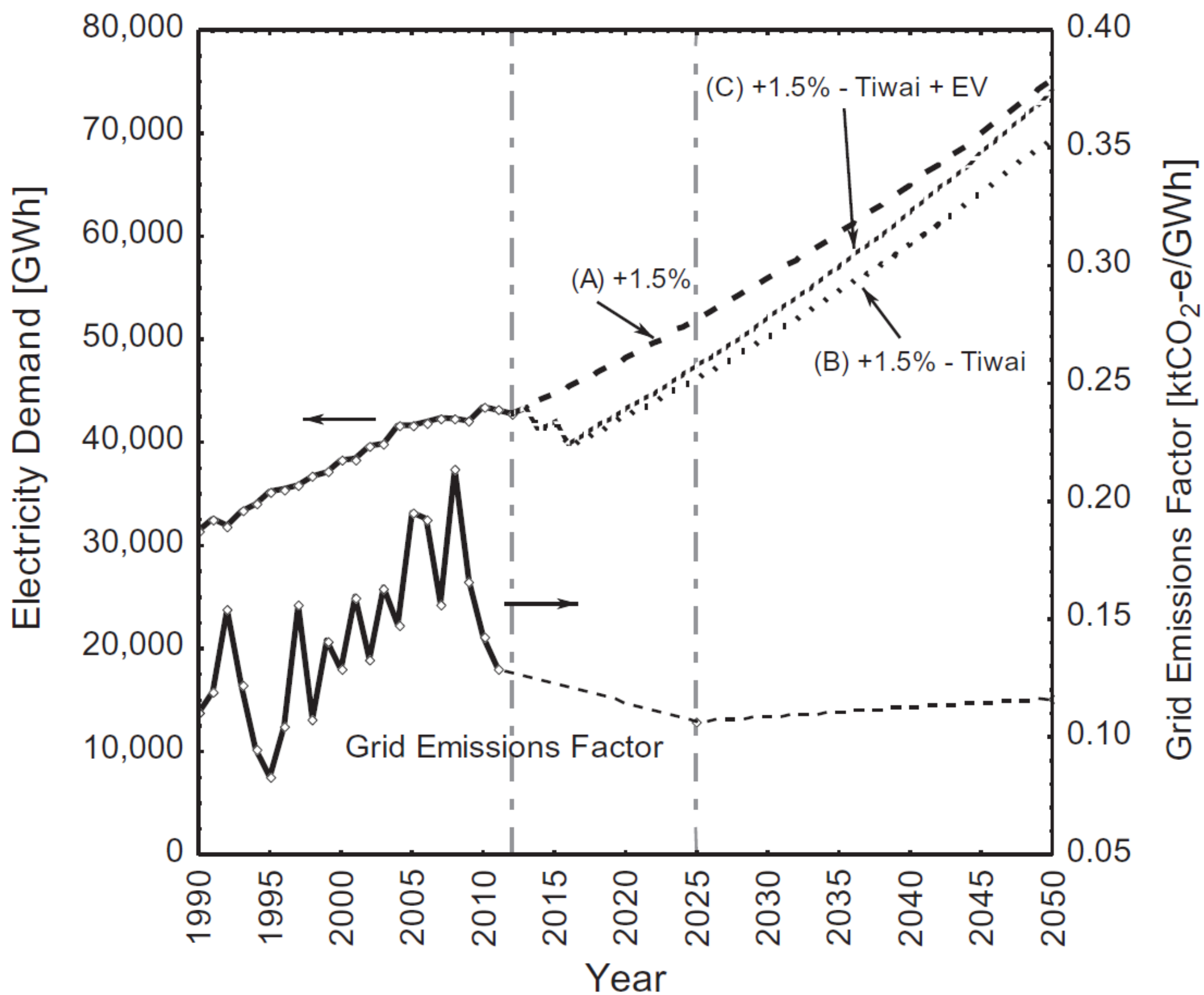
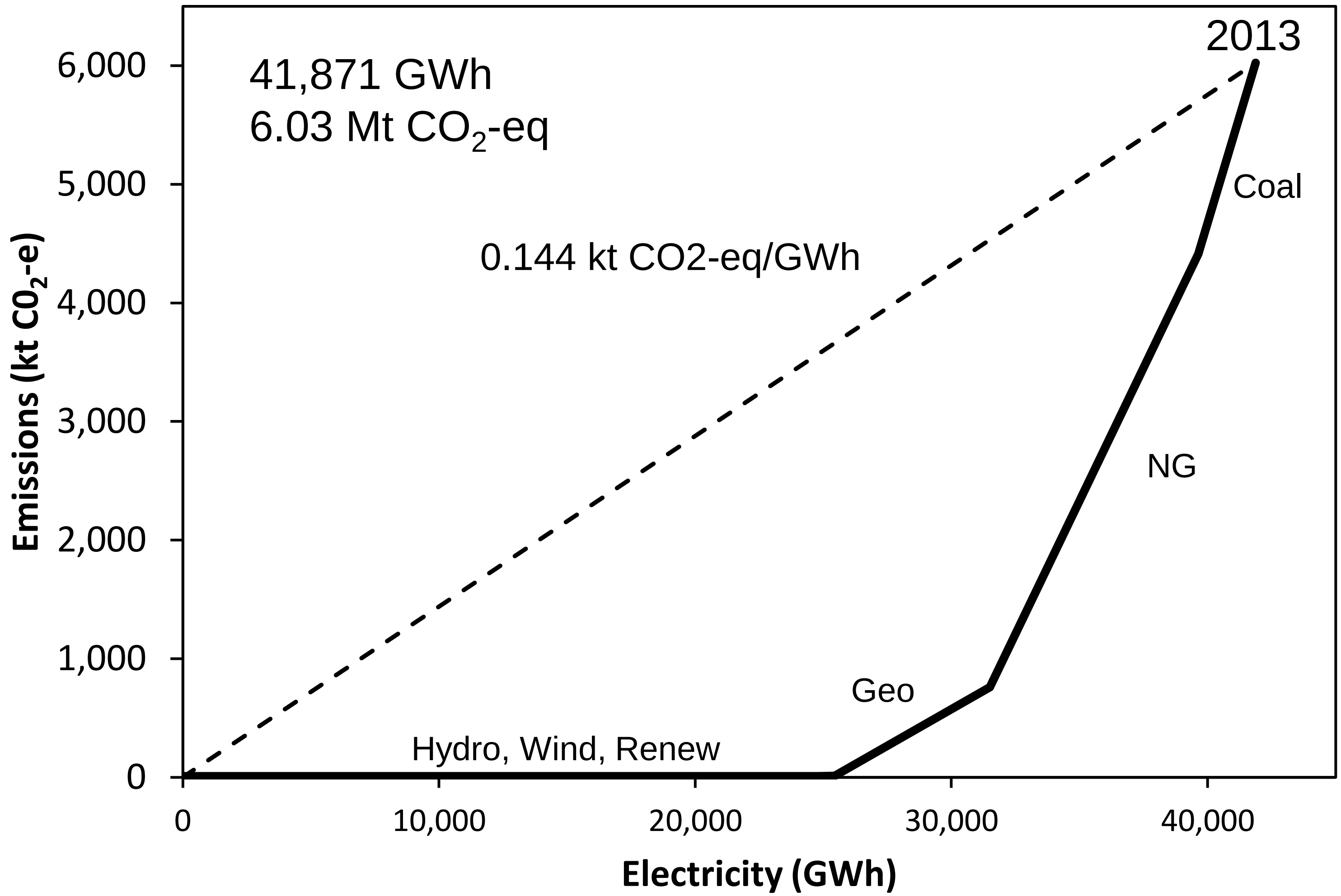
ELECTRICITY SECTOR

NZ Electricity Demand



NZ 2013 Generation Mix



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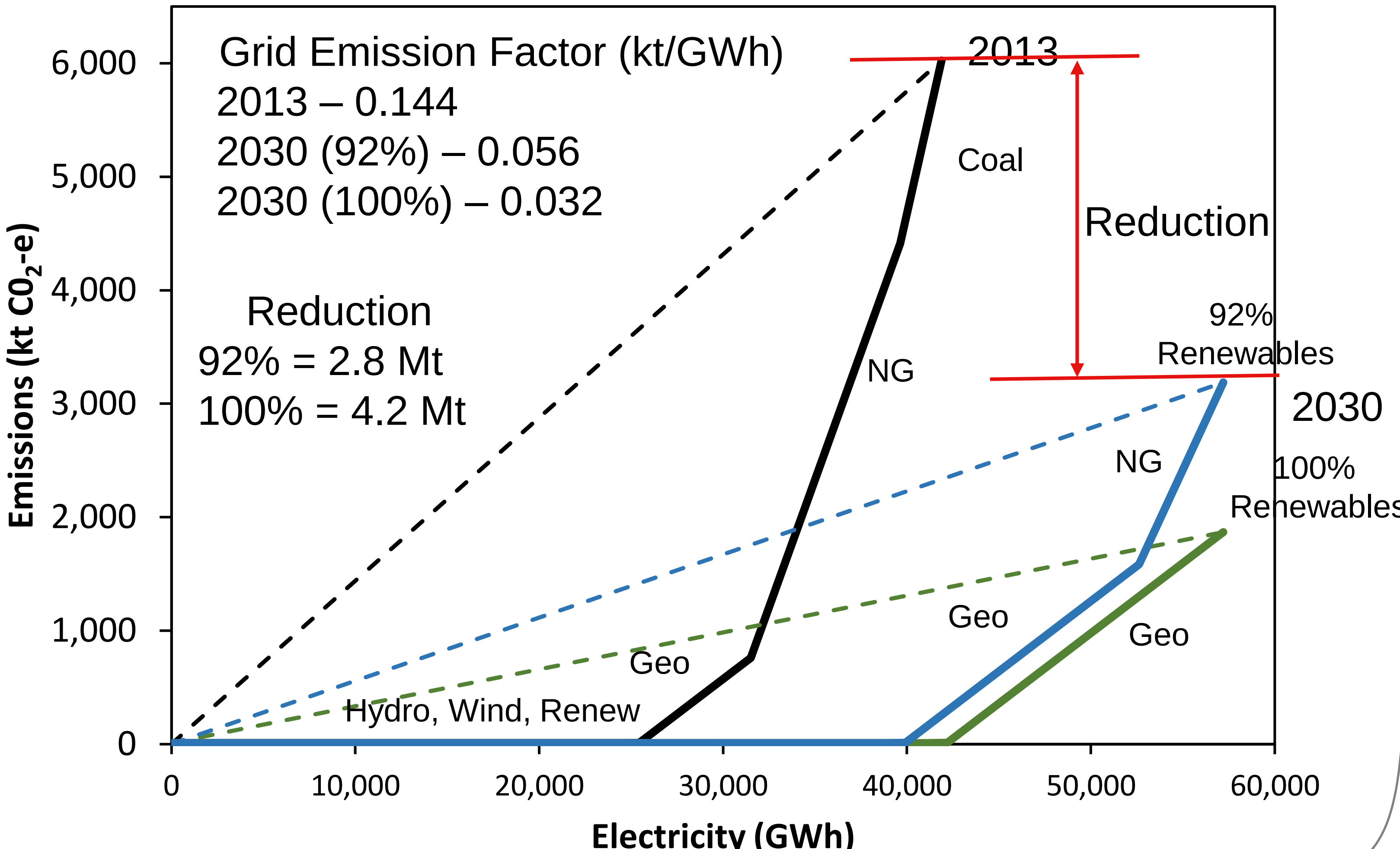
Possible Future Generation Mix



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Reduction Options

- Efficiency Measures
- No new thermal generation (from fossil fuels)
- Reduced thermal generation
  - More geothermal, wind, hydro, solar, bioenergy
- Only emissions reduction if:
  - Replace current thermal generation
  - Displace future thermal generation

Reduction Options

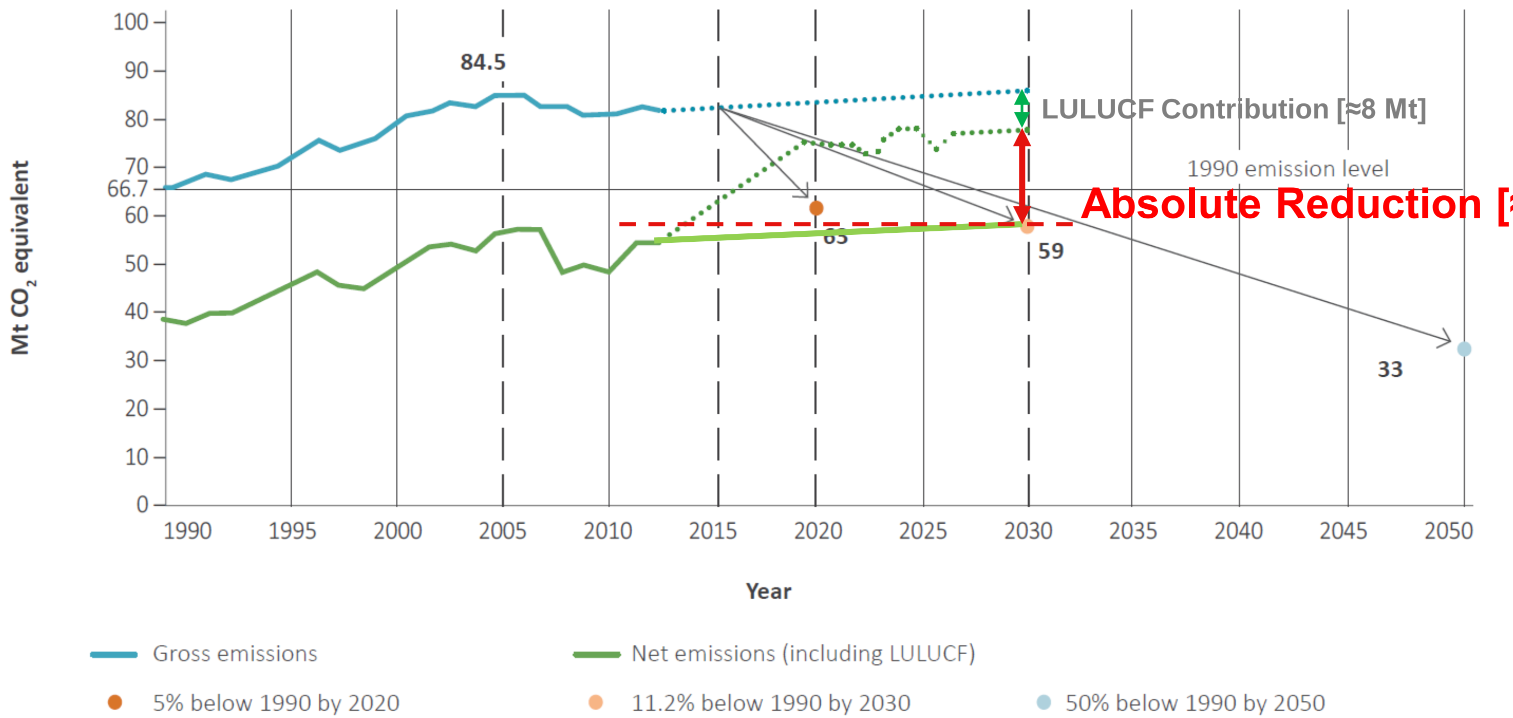
- Carbon Capture and Sequestration
  - Only feasible to capture up to 90% of CO_2
  - Not likely in timeframe
  - Extremely expensive
  - Not in commercial use
  - Lots of scale back in research $$$
  - Net Energy Return / Systems Analysis missing
    - Enhanced oil recovery

Reduction Potentials

Sector	Low Estimate [Mt CO_2-eq]	High Estimate [Mt CO_2-eq]
Agriculture	2.0 (5.1%)	8.0 (20.4%)
Transport	2.8 (20.0%)	5.3 (37.6%)
Process Heat	1.5 (16.7%)	3.0 (33.3%)
Electricity	2.8 (46.7%)	4.2 (70.0%)

NZ Emissions Reduction Target

Figure 3.5 New Zealand's gross and net emissions from 1990 to 2013, future projections and national emission reduction targets for 2020, 2030 and 2050.



Note: The 2020 conditional target range of 10–20% below 1990 is not shown.

Source: Based on MfE (2015e).

Royal Society, 2016

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Reduction Potentials - Summary

Sector	Low Estimate [Mt CO_2-eq]	High Estimate [Mt CO_2-eq]
Agriculture	2.0 (5.1%)	8.0 (20.4%)
Transport	2.8 (20.0%)	5.3 (37.6%)
Process Heat	1.5 (16.7%)	3.0 (33.3%)
Electricity	2.8 (46.7%)	4.2 (70.0%)
Total	**9.1**	**20.5**

Major Effort Required
and need clear Sector Pathways to meet target.

Forestry has to make a large contribution.