

# Easy ways to cut your carbon emissions at home and at work

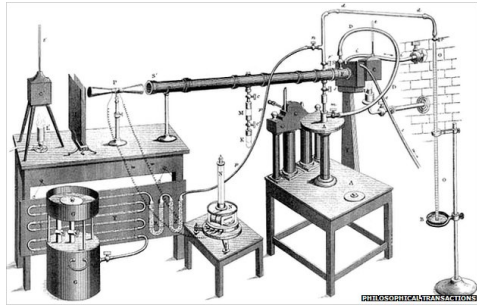
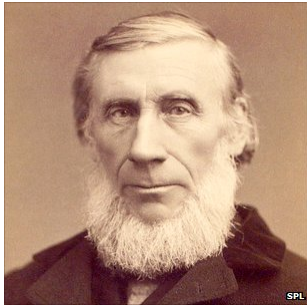
Robert McLachlan

Institute of Fundamental Sciences, Massey University

*He waka eke noa*



# The discovery of global warming: John Tyndall, 1861



Those who like myself have been taught to regard transparent gases as almost perfectly diathermanous, will probably share the astonishment with which I witnessed the foregoing effects. I was indeed slow to believe it possible that a body so constituted, and so transparent to light as olefiant gas, could be so densely opaque to any kind of calorific rays; and to secure myself against error, I made several hundred experiments with this single substance. By citing them at greater length, however, I do not think I could add to the conclusiveness of the proofs just furnished, that the case is one of true calorific absorption †.

THE  
LONDON, EDINBURGH, AND DUBLIN  
PHILOSOPHICAL MAGAZINE  
AND  
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

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APRIL 1896.

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XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS\*.

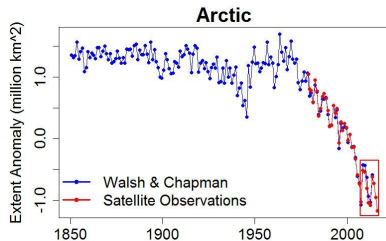
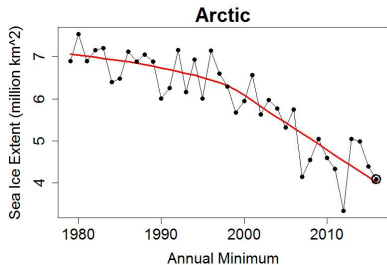
“That the atmospheric envelopes limit the heat losses from the planets had been suggested about 1800 by the great French physicist Fourier. His ideas were further developed afterwards by Pouillet and Tyndall. Their theory has been styled the hot-house theory, because they thought that the atmosphere acted after the manner of the glass panes of hot-houses.”

“Any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth’s surface by  $4^{\circ}$ ; and if the carbon dioxide were increased fourfold, the temperature would rise by  $8^{\circ}$ .”



## COAL CONSUMPTION AFFECT- ING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.



Melting north pole sea ice may have led to

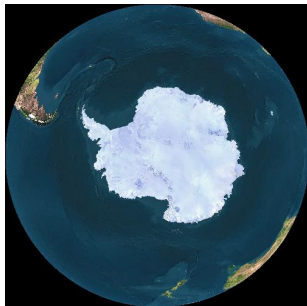
- 10 years of extreme weather in northern mid-latitudes: extreme rainfall, droughts, heatwaves, and cold spells: may be linked to loss of Arctic sea-ice (Cohen, Nature Geoscience August 2014).
- changes in behaviour of northern jet stream
- slowing of Gulf Stream, sea level rise in Eastern US 8× global average

# Miami Beach flooding during high tide

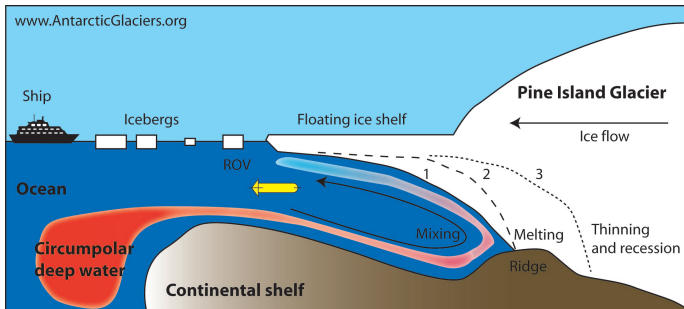




JOHN H. MERCER  
1922-1987



- In 1978, John Mercer noted that the West Antarctic Ice Sheet is unstable and deglaciation may start within 50 years.
- Called Pine Island Glacier “the weak underbelly of the WAIS”.
- No acceleration of the Pine Island Glacier was observed in 1970–1992.
- 1996: First grounding line retreat observed



1. Early 1970s. Pine Island Glacier is grounded at a bedrock ridge.
2. Warm, inflowing Circumpolar Deep Water melts the base of the glacier. The glacier steepens and accelerates.
3. Present day, observed by a remotely operated vehicle (ROV). Glacier is thinning and receding.

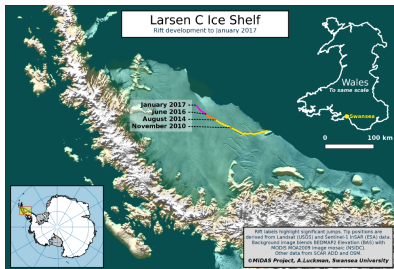
Pine Island Glacier grounding line retreated 35km in 20 years. “We conclude that this sector of West Antarctica is undergoing a marine ice sheet instability that will significantly contribute to sea level rise in decades to centuries to come.” (Rignot 2014)

One warning sign that a dangerous warming is beginning in Antarctica will be the breakup of ice shelves in the Antarctic Peninsula just south of the recent January 0 °C isotherm; the ice shelf in Prince Gustav Channel on the east side of the peninsula, and the Wordie Ice Shelf, the ice shelf in George VI Sound, and the ice shelf in Wilkins Sound on the west side

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- Prince Gustav Ice Shelf (64°S): collapsed 1992–95
- Wordie Ice Shelf (69°S): collapsed in 1980s
- Wilkins Ice Shelf (70°S): rapid calving in 1998, 2008, and 2009, 2013, overall down 30%.
- George VI Ice Shelf: (72°S) large calving event in 2010, overall down 10%

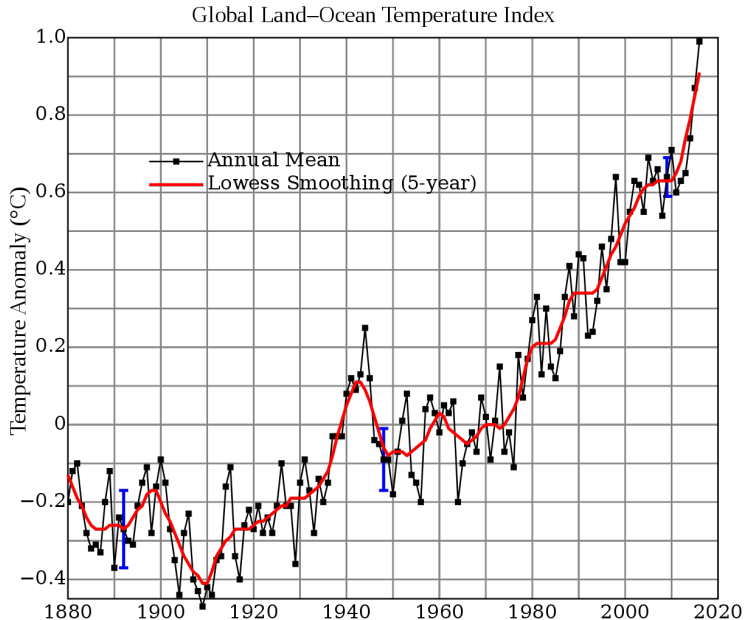
# Coming this year: possible break-up of Larsen C ice shelf



Larsen A collapsed in 1995, B in 2002.  
The 50000 km<sup>2</sup> Larsen C ice-shelf, discovered 1894, 4th largest in Antarctica.  
In 2004 it appeared to be stable.  
In 2016 a crack rapidly advanced.  
A 5000 km<sup>2</sup> section is poised to break off.  
Currently unknown whether the remainder will shatter.



# Recent behaviour of the Earth's temperature



- 1 higher temperatures (+1°C so far)
- 2 sea level rise (+20cm so far)
- 3 ocean acidification ( $\Delta\text{pH} -0.1$  so far)
- 4 agriculture (OK so far)
- 5 weather extremes: floods, droughts, tropical storms (evidence emerging)
- 6 ecosystems & mass extinction (???)

- Warming trend + El Niño → 3rd consecutive record high
- Record sea temps, highest in Indonesia, Australia, and Tasman
- Led to global coral bleaching, incl. almost all of the Great Barrier Reef  
(Nature 15 March 2017 – 25% now dead)
- extreme drought in California, Brazil, south & east Africa, Chile, Peru
- extreme floods in US, China, south Asia, France
- Hurricanes Matthew (\$15b), Winston (strongest ever in South Pacific)
- US & Canada both had most destructive wildfires in history
- All-time record temperatures for Thailand (45°), India (51°), Iran (53°), Kuwait (54°), 7 others.

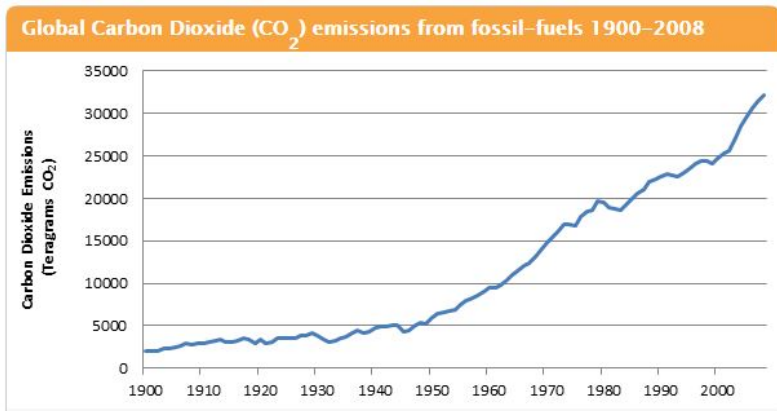


CO<sub>2</sub> accumulates in the atmosphere

# Kashagan oil field, Caspian Sea, Kazakhstan

Developed since 1990s, production began October 2016, cost US\$116 billion.

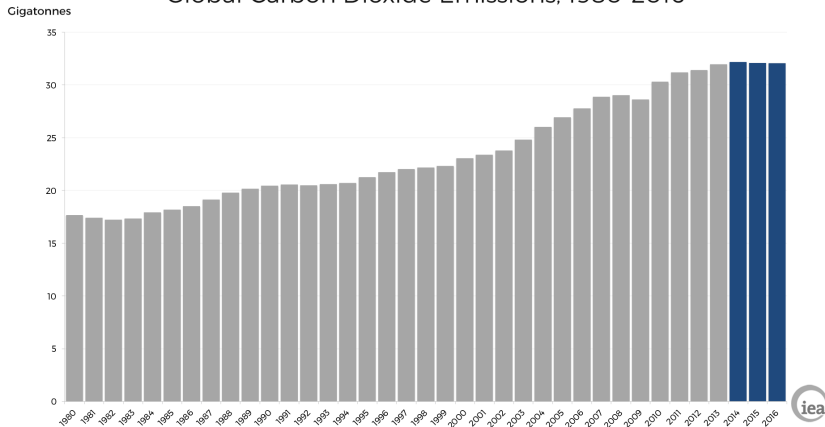




## Tasks:

- 1 stop CO<sub>2</sub> accelerating
- 2 stop CO<sub>2</sub> increasing
- 3 start CO<sub>2</sub> decreasing
- 4 eliminate virtually all fossil fuel use for energy
- 5 get CO<sub>2</sub> out of the atmosphere

## Global Carbon Dioxide Emissions, 1980-2016

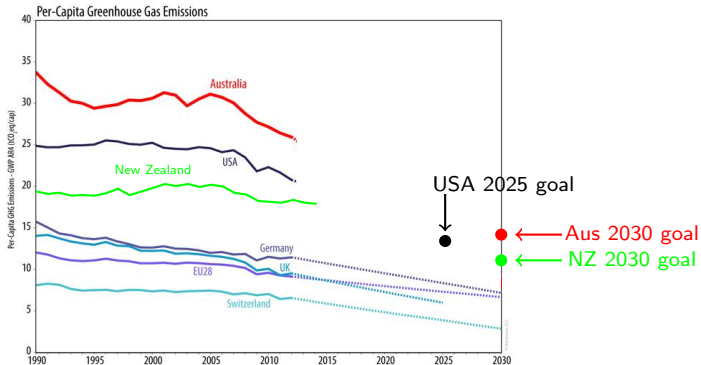


- Paris agreement: limit warming to 2° C; preferably to 1.5° C (currently 1° C)
- Safe limit by 2050: 1.5–2 tonnes per person
- New Zealand: about 18 tonnes per person
- So we need to cut by about 90%



# Per capita CO<sub>2</sub> emissions

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Things not in NZ's favour:

- rapid population growth
- growing economy
- large agricultural emissions
- some oil and gas production

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Things not in NZ's favour:

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Things in NZ's favour:

- high emissions = big scope for reduction
- plenty of clean energy + massive potential
- not too cold or too hot

## What can we do?

- stop investing in oil & gas infrastructure
- electrify everything

Transport

Buildings

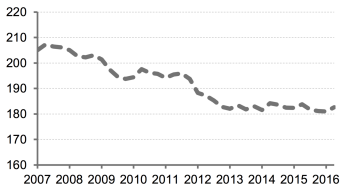
Food

In NZ in 2013, of people who went to work on census day,

- 7% walked
- 3% biked
- 6% took public transport
- 82% went in a car

## NZ

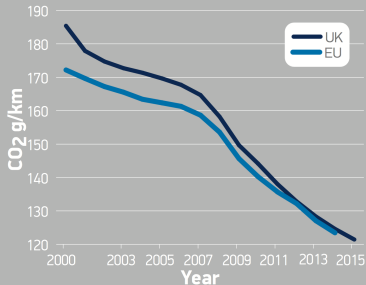
CO2 g/km of light vehicles registered



	mpg	L/100km	g/km
NZ	36	7.9	183
UK	54	5.2	121
EU 2020 goal			95

## UK

CHART 20 | UK VS EU NEW CAR CO<sub>2</sub> PERFORMANCE



## Buy an electric vehicle!

I bought an electric car, a 2014 Nissan Leaf.



# Buy an electric vehicle!

I bought an electric car, a 2014 Nissan Leaf.

- IT WAS SO EASY
- \$4K less than 2014 Honda Civic hatchback, same kms
- Unbelievably quiet, even on highway
- Instant response, great acceleration
- Costs 1.7c/km to run (petrol 13c/km) – down 87%, save \$1400/yr
- Emissions 17g/km – down 90% – save 2 tonnes CO<sub>2</sub>/yr
- No oil, filters, spark plugs, exhaust, transmission



Case study: buy a new car, drive 12000km/year for 12 years.

Nissan Leaf:  $7 + 0.2 \times 12 = 9$  tonnes CO<sub>2</sub> in total

Toyota Starlet:  $6 + 2.2 \times 12 = 32$  tonnes CO<sub>2</sub> in total.



# Electric buses are here now



## Electric trucks were here years ago (*Zero Emission Vehicles, PN*)



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Kāpiti Coast District Council carbon plan: –46% achieved in first 5 years.

Electricity generation emits 4 million tonnes of CO<sub>2</sub> per year in NZ.

**Bad:** Contact. Genesis.

**Good:** Meridian. Mercury. Trustpower.

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By switching to Ecotricity, I saved money and eliminated about 1 tonne of CO<sub>2</sub>/year by a single email.



IT WAS SO EASY!



## How about solar panels?

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Solar panels at work are even better.

Palmerston North City Council installed 100 kW, earning 9% p.a.





411 kW, 1314 panels – largest in New Zealand



Case study: Heating a 185 m<sup>2</sup> NZ home – takes 12000 kWh/year

	CO <sub>2</sub> /year
gas	2.4 tonnes
electricity	1.3 tonnes
heat pump	0.3 tonnes
wood	0.3 tonnes

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### Challenge

The gas boilers in BP House had come to the end of their useful working life and required replacement. BP wanted to have new boilers that could show a substantial saving on their running costs. The two original 450kW cast iron boilers were located on the top floor and had to be cut up to remove them from the boiler room and craned down from the building.

### Solution

Central Heating New Zealand offered a solution of a state-of-the-art Baxi Boiler Cascade System using six Baxi Power HT 150kW condensing boilers connected together to produce 900kW of power.



## Solutions:

- hot water heat pump to low temperature radiators
- log burner to radiators
- wood chip/pellet boiler



## DIESEL BOILERS

An energy efficient, effective heating option for any home.

### THE BENEFITS OF DIESEL BOILERS

#### The Advantage of Diesel Boilers

Diesel boilers are a cost-efficient heating option for many homeowners because they are very energy efficient and have relatively low running costs, ranging from 14.8-16.5¢/kW depending on the boiler and the location of the home. They are also a versatile heat source in that they can heat both radiator and underfloor systems, and they can be placed inside or outside the home according to the needs of the homeowners.



#### Browse Diesel Boilers

##### RESIDENTIAL

[STANDARD EFFICIENCY  
DIESEL BOILERS](#)

[DIESEL BOILER FLUES](#)

[CONDENSING DIESEL  
BOILERS](#)

[CONDENSING DIESEL  
BOILER FLUES](#)

[DIESEL BOILER FUEL  
ACCESSORIES](#)

## GLOBAL WARMING

### Carbon Dioxide, Global Warming or Climate Change, what about it?

While the available information is still contradictory and confusing there is however, some clear guidance from the scientific community about what you can do to help reduce greenhouse gases. Just lower your CO<sub>2</sub> contribution by 10-15%.  
How? Easy;

- Drive a vehicle that goes further per litre,
- Walk where practical,
- Heat with electricity or, better still, use a wood based fuel.

## fuel price per unit

<input checked="" type="radio"/> LPG	2.25 kg
<input type="radio"/> Natural Gas	2.25 kg
<input type="radio"/> Diesel	1.58 litre
<input type="radio"/> Wood Pellets	560 tonne
<input type="radio"/> Coal	140 tonne
<input type="radio"/> Slab Wood	85 m <sup>3</sup>

## Tonnes of CO<sub>2</sub> per person per year

	liquid	coal	gas	total
commercial & residential	0.1	0.05	0.2	0.25
international transport	0.9			0.9
ag, forestry, fishing	0.3	0.06	0.6	1.0
electricity		<b>0.6</b>	<b>0.8</b>	1.4
industry	0.3	<b>1.1</b>	0.8	2.2
land transport	<b>3.3</b>			3.3
<b>totals</b>	<b>4.9</b>	<b>1.8</b>	<b>2.4</b>	<b>9.1</b>

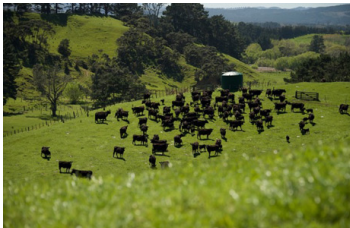
Coal in industry: 0.6 dairy, 0.35 NZ steel, 0.05 coal mining, 0.1 other

Gas in agriculture: mostly for making fertilizer



## CO<sub>2</sub>e/year of some typical diets:

meat lovers	3.3 tonnes
no beef	1.9 tonnes
vegetarian	1.7 tonnes
vegan	1.5 tonnes





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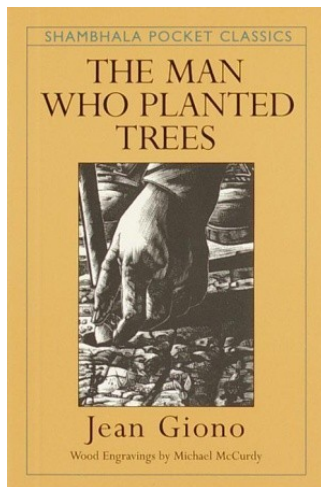


100 kg CO<sub>2</sub>e/kg

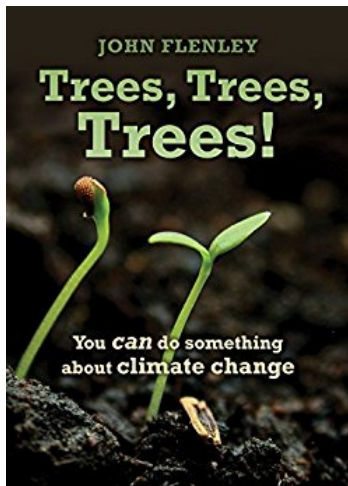


20 kg CO<sub>2</sub>e/kg

NZers eat 43 kg of beef & lamb each year, almost 1 tonne of CO<sub>2</sub>e.



*When I reflect that one man, armed only with his own physical and moral resources, was able to cause this land of Canaan to spring from the wasteland, I am convinced that in spite of everything, humanity is admirable.*





One hectare of growing trees stores about 8 tonnes CO<sub>2</sub> per year.

- Heat pump or wood chip space heating
- No free parking
- Low or zero emission vehicles
- Solar panels
- CarboNZero or EnviroMark certification

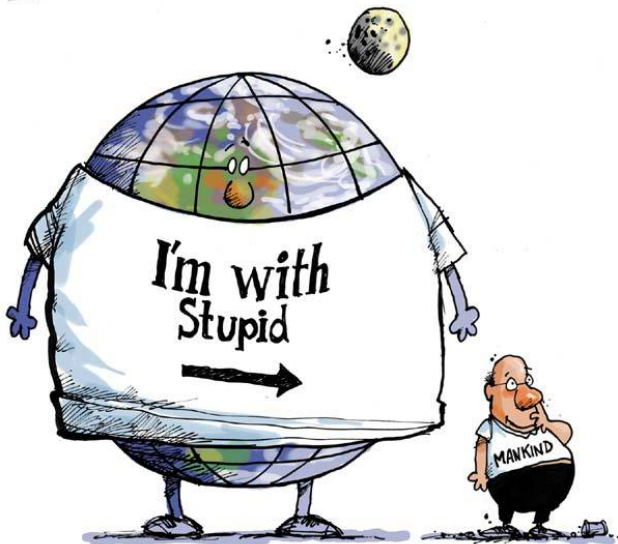
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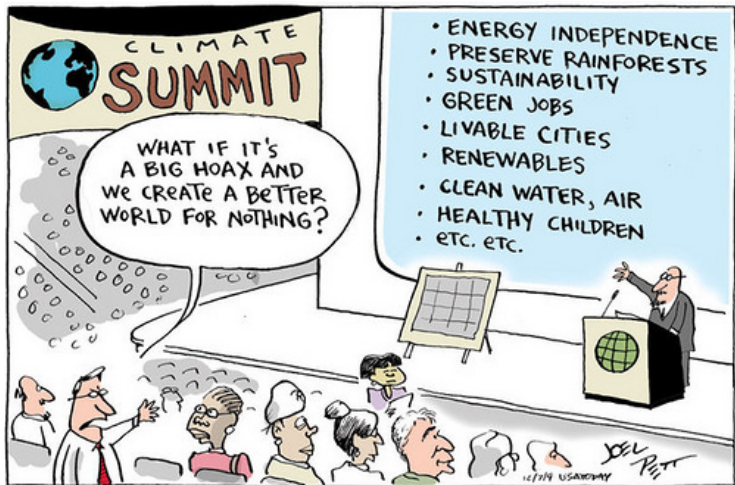
## Case study: Massey University

	tonnes CO2e
electricity	4000
gas	4000
fuel	4000
farms	3000
air travel	6000
commuting	12000
total	33000



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*Thank you for your attention.*