The Electric Cow

If livestock's emissions came from electricity, would most environmentalists listen?

Paul Mahony, 26th May 2014

terrastendo.net

The Electric Cow

If cows ran on electricity, how much would we use in order to produce a beef steak?

First, some background

Key reasons for livestock's impact

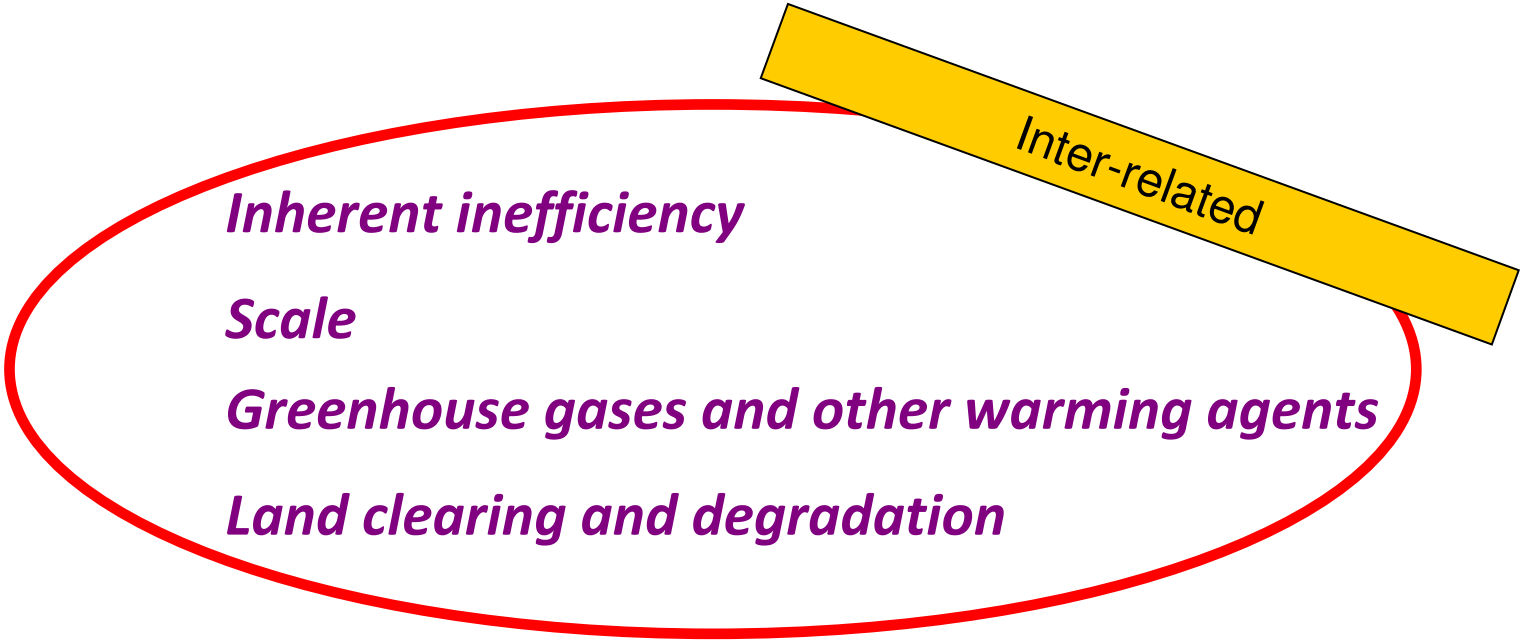
Inherent inefficiency

Scale

Greenhouse gases and other warming agents

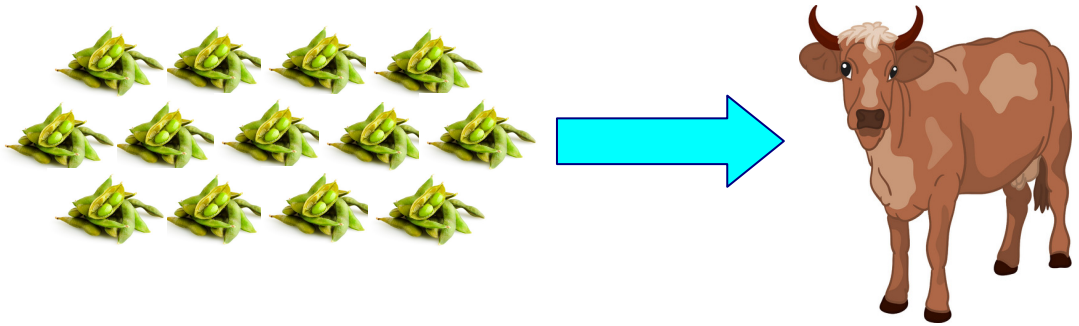
Land clearing and degradation

Key reasons for livestock's impact



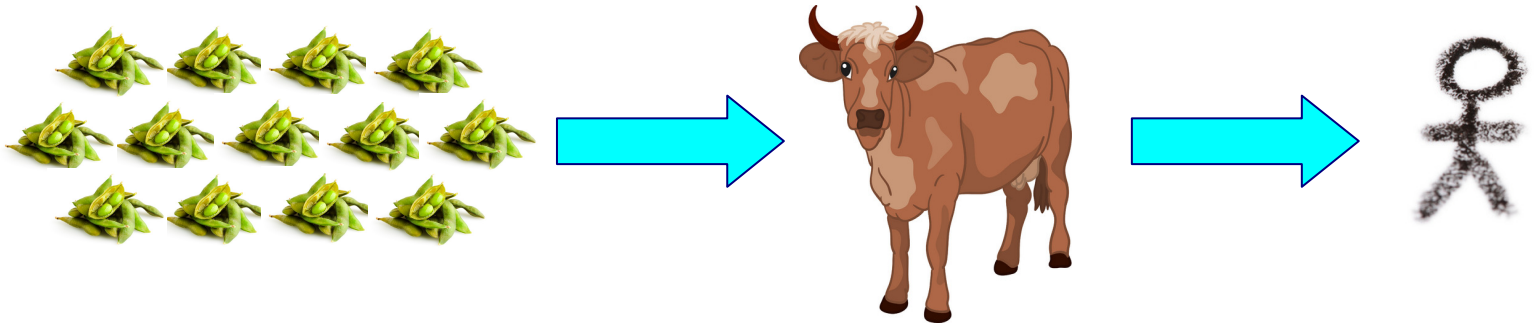
We'll focus on the inefficiency of livestock as a food source

Inherent inefficiencies



The figures depicted have been provided in beef industry material. Even a conversion factor of, say, 7 or 8 kg of grain per kg of end product would represent a grossly inefficient system.

Inherent inefficiencies



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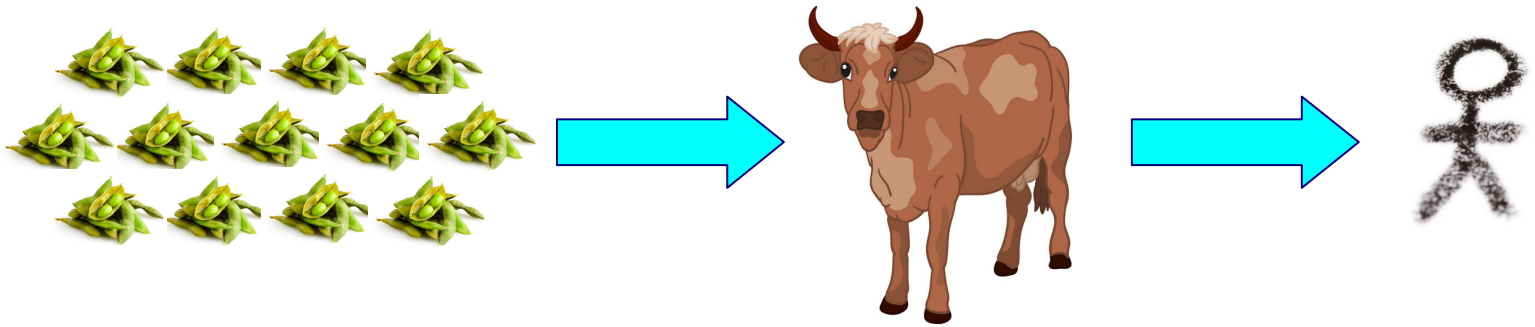

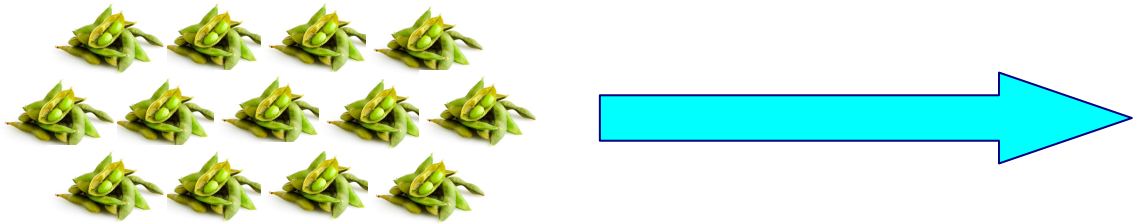

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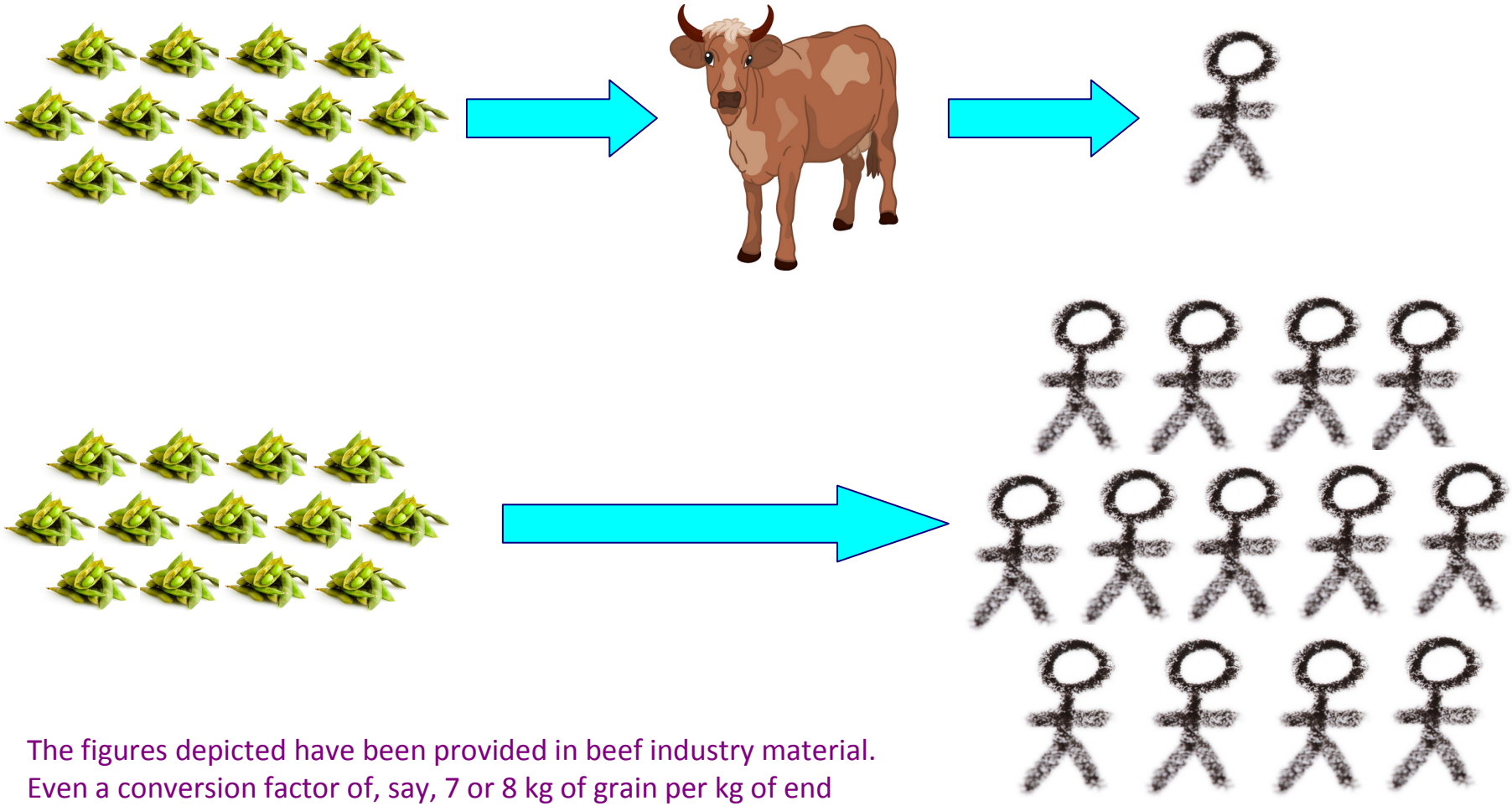

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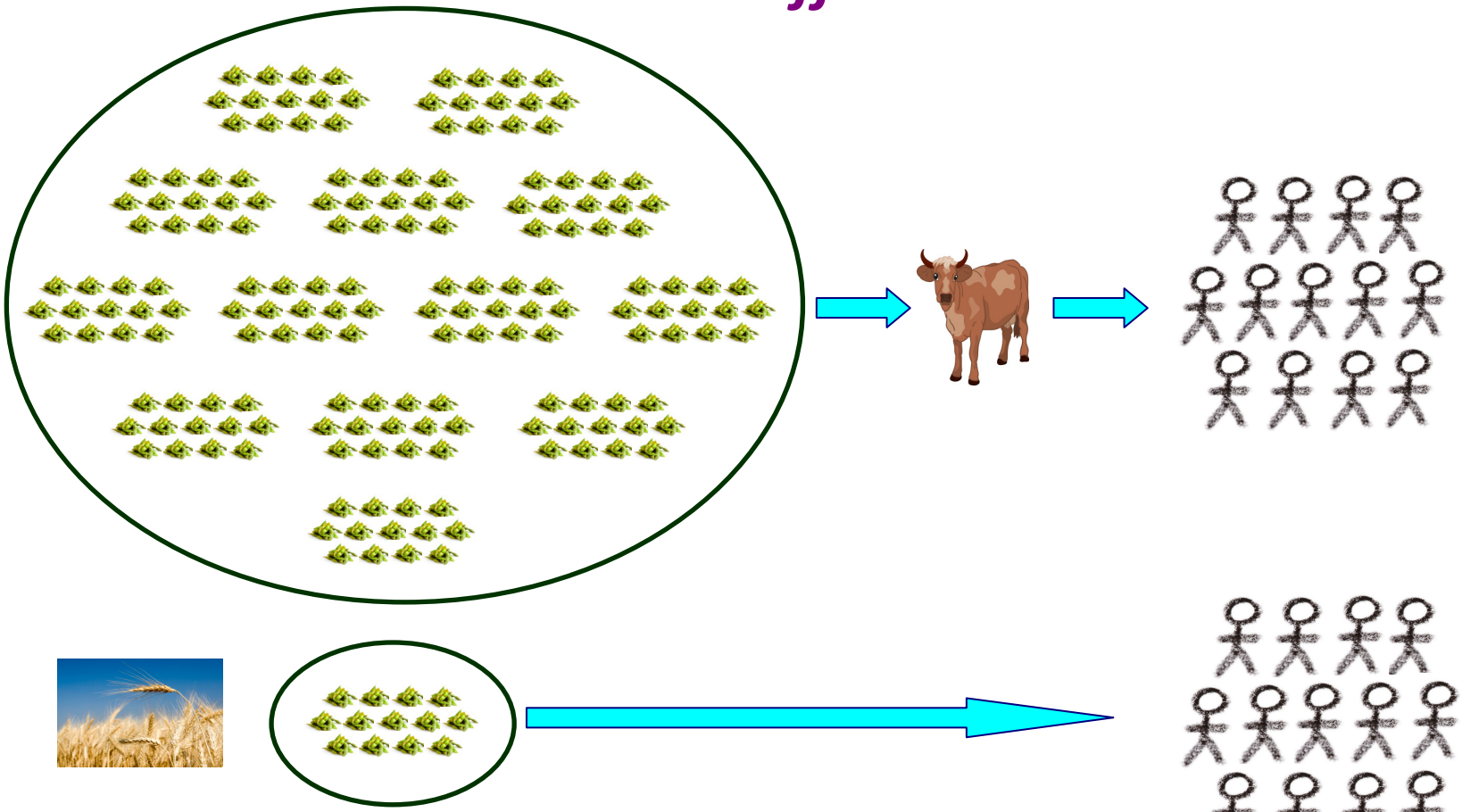
What if we wanted to feed the same number of people under each system?

Inherent inefficiencies



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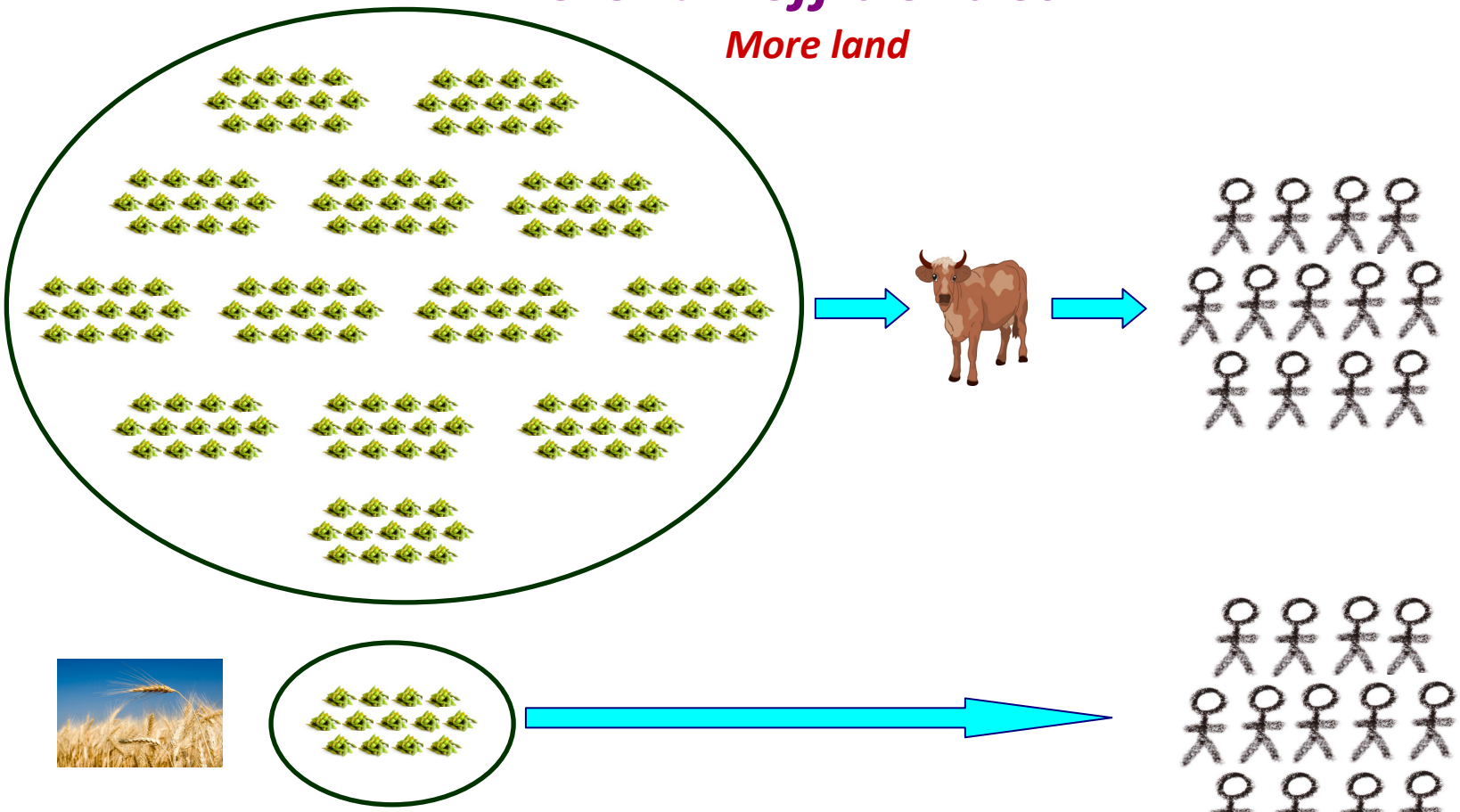
Inherent inefficiencies

More land



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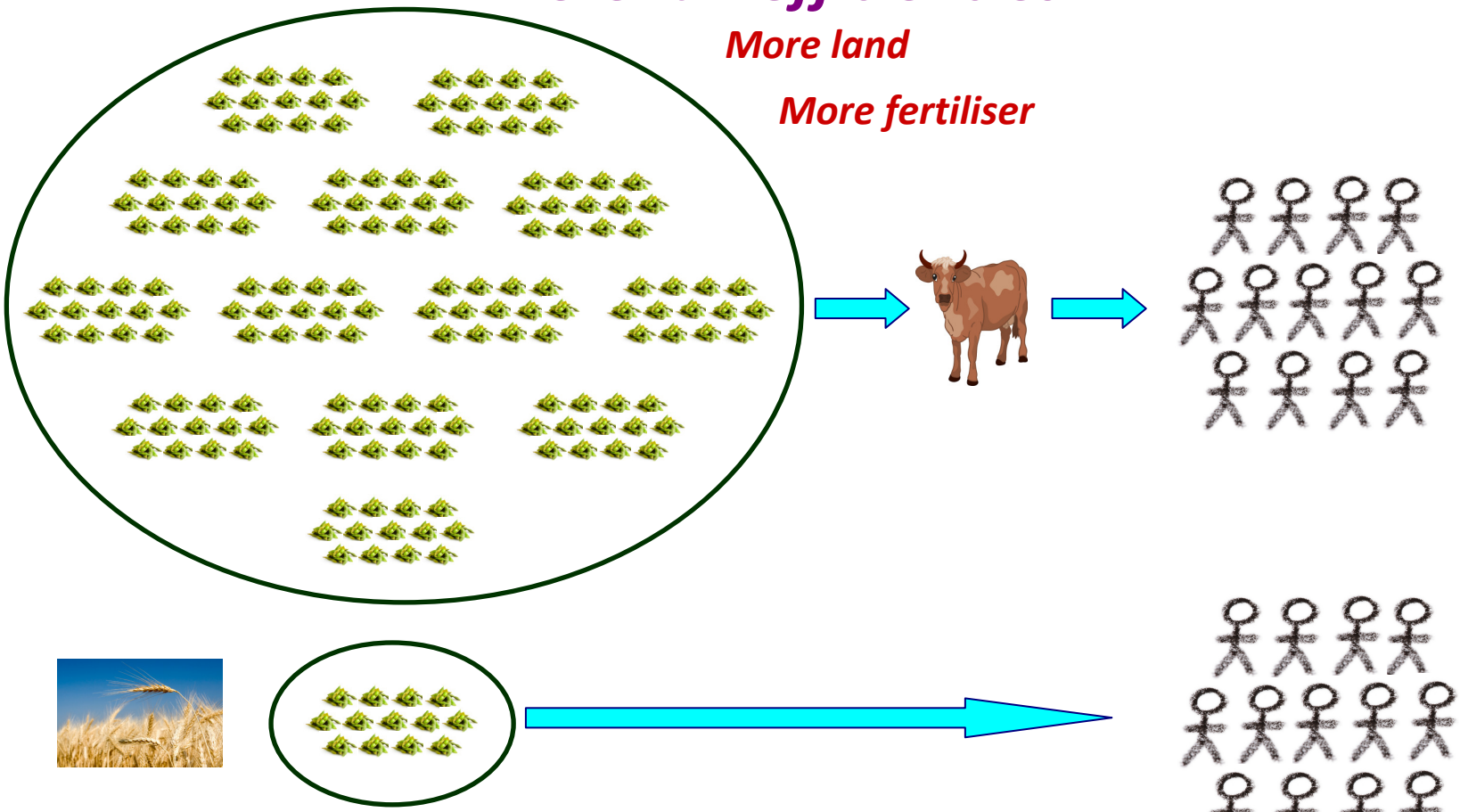
More fertiliser



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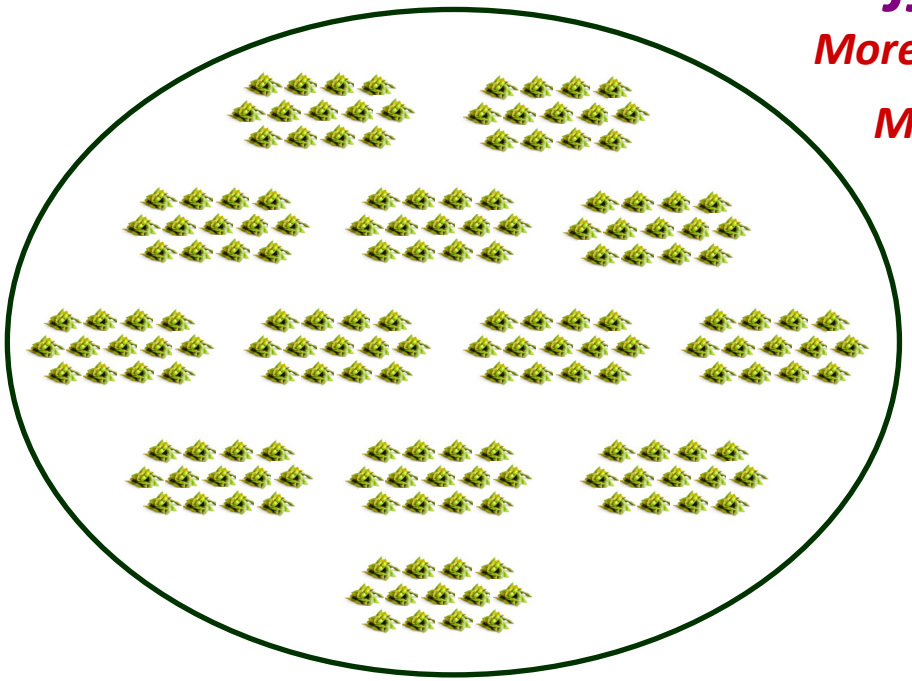
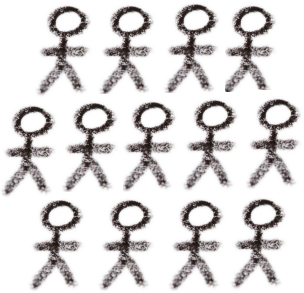
Inherent inefficiencies

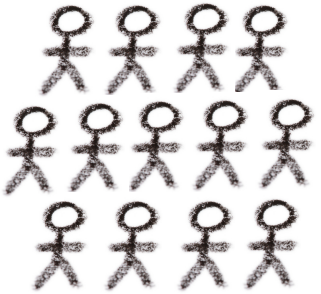
More land

More fertiliser

More energy







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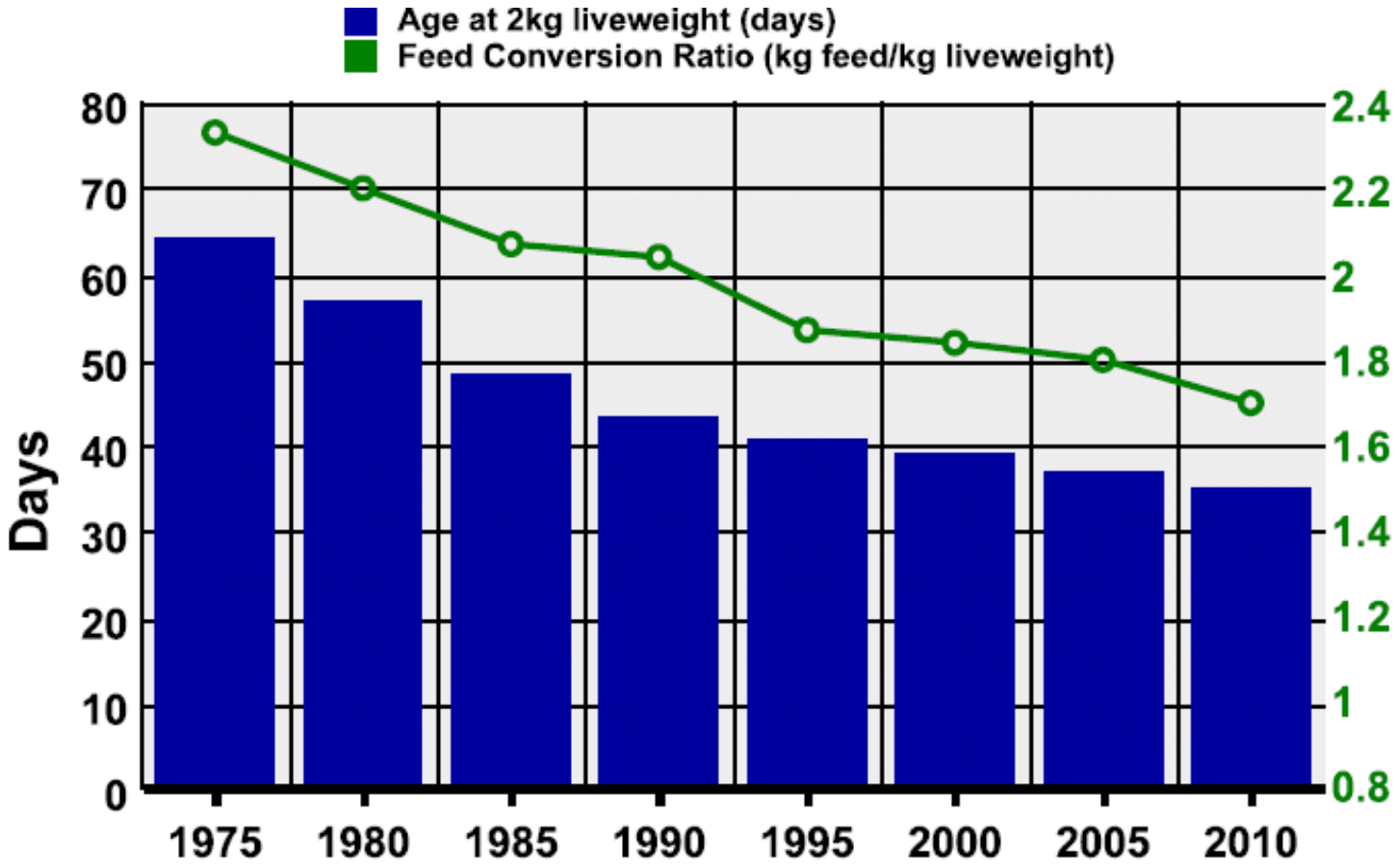
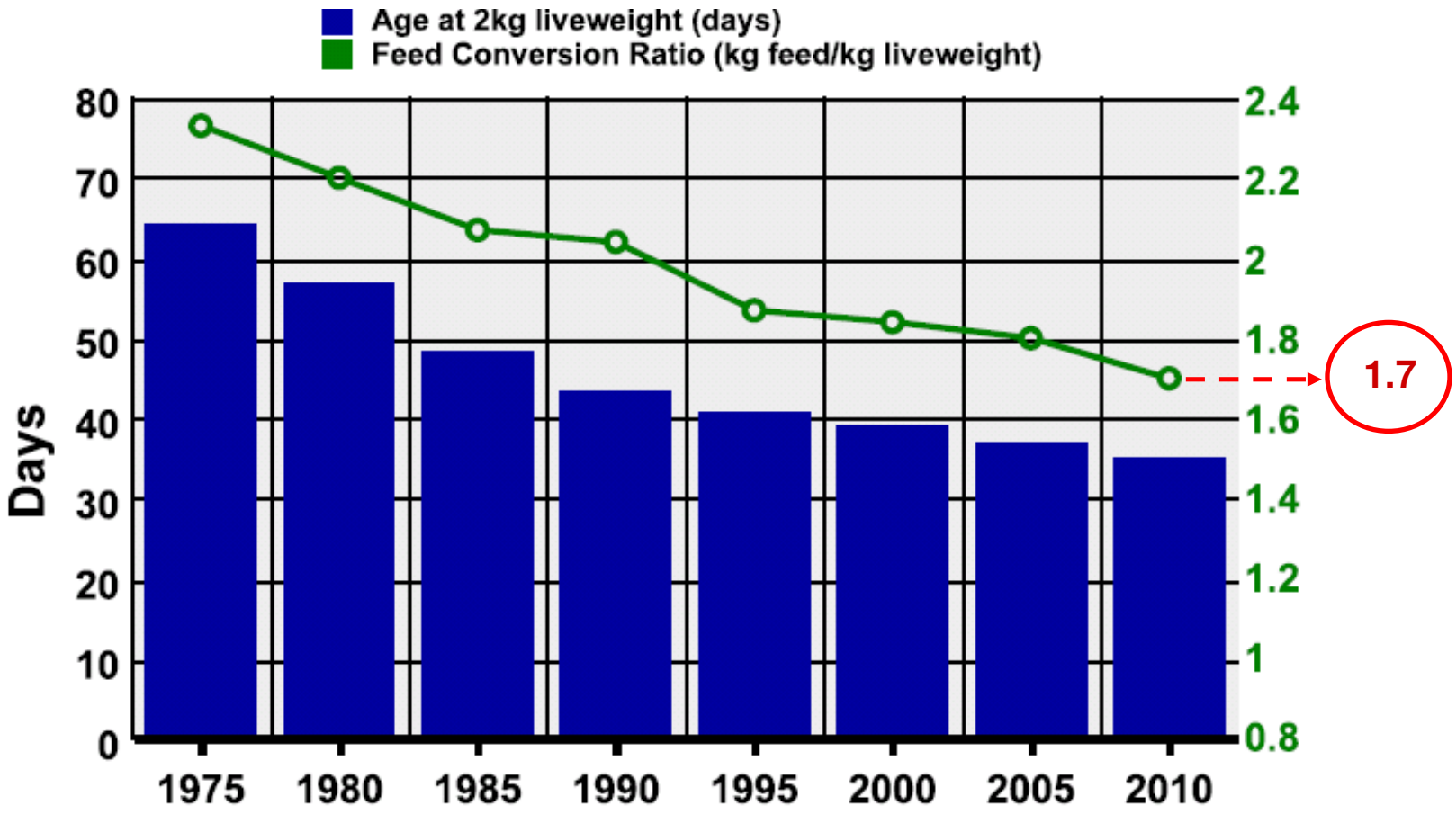
Inherent inefficiencies

Chicken meat is better, but . . . still a poor feed conversion ratio

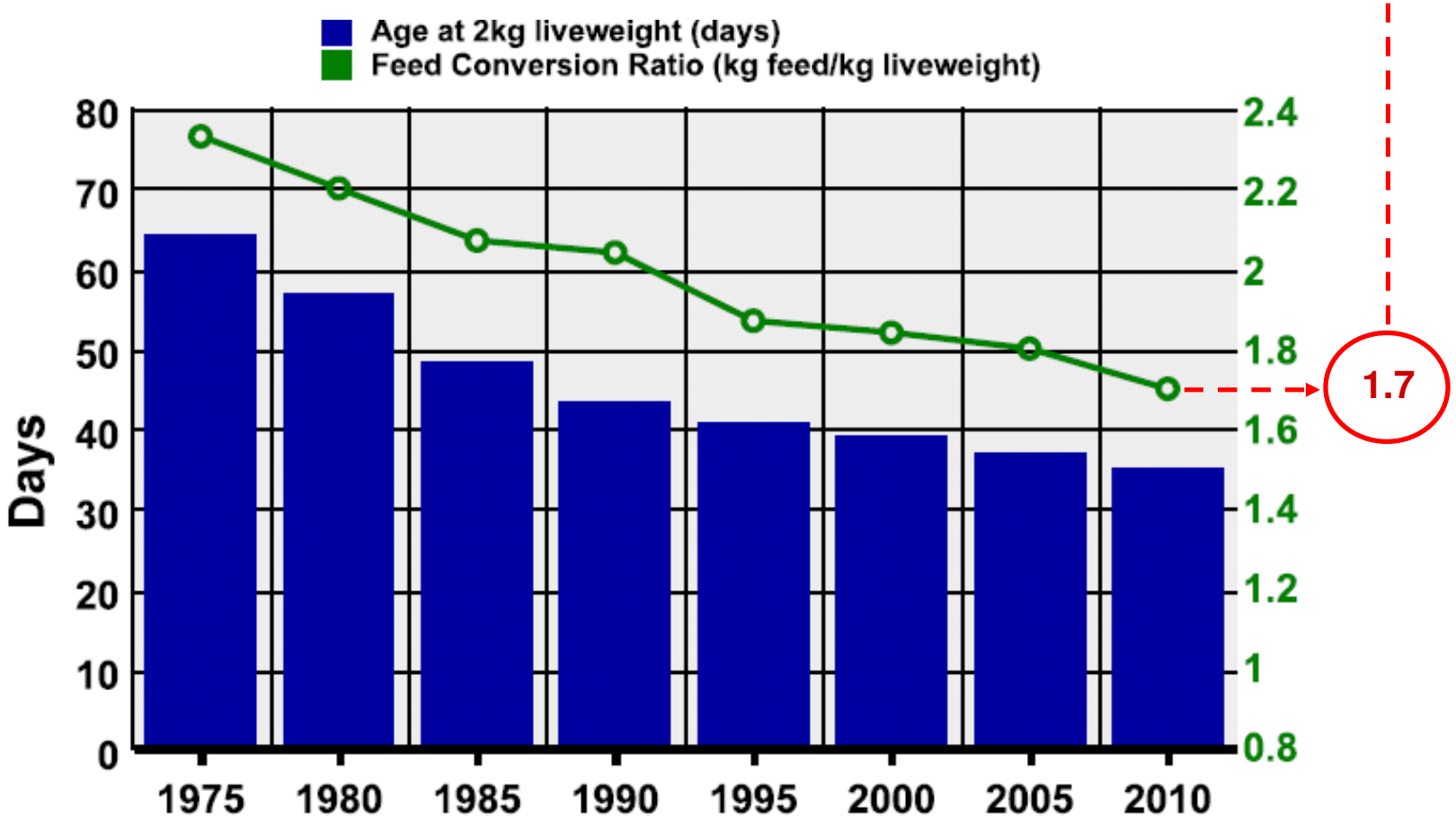


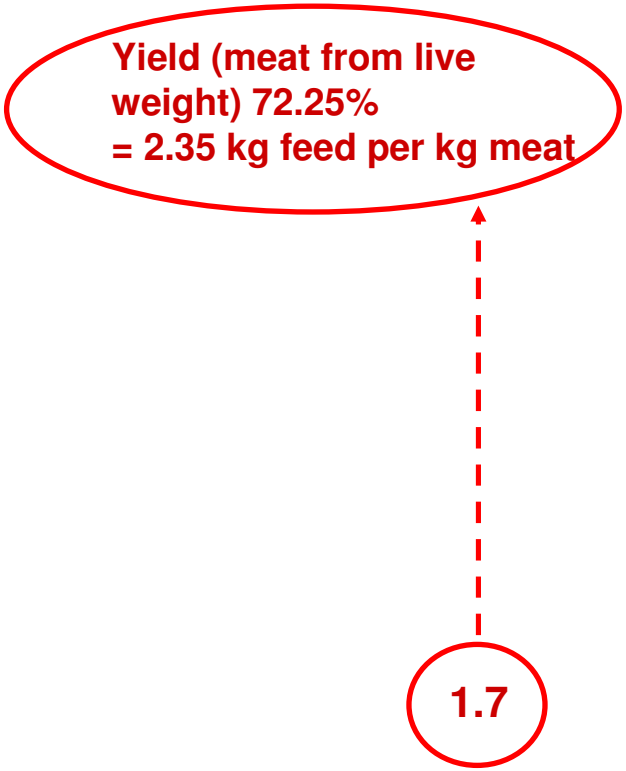
Inherent inefficiencies



Inherent inefficiencies

Yield (meat from live weight) 72.25%
= 2.35 kg feed per kg meat





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Any management team promoting this level of efficiency for a conventional business would be shown the door!

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e.g. livestock-related land clearing reported under "land use, land use change and forestry"

(c) considered but with conservative calculations

e.g. methane's impact based on a 100-year, rather than 20-year, "global warming potential"

Back to the electric cow

Back to the electric cow

If cows ran on electricity, how much would we use in order to produce a beef steak?

Specifically, what figure would we arrive at if it was based on their current level of greenhouse gas emissions?

To get some idea, we'll compare their emissions performance to:

- *Australian aluminium smelting, which consumes vast amounts of electricity*
- *Australian electricity generation, which comes largely from coal*

Firstly, aluminium

"Aluminium is the ultimate proxy for energy"

Marius Kloppers, former CEO of BHP Billiton

"To phrase it in terms of the industry joke, aluminium is congealed electricity."

Mining Weekly.com

Aluminium smelting has at times consumed 16% of Australia's electricity

. . . for less than 1% of gross domestic product

. . . and less than 0.1% of jobs.

That percentage may have reduced due to smelter closures and a reduction in emissions intensity from 20 tonnes of greenhouse gas per tonne of product in 1999 to 15.6 tonnes in 2011, but its contribution is still extremely significant.

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Emissions intensity represents the unit weight of CO2-equivalent greenhouse gases per unit weight of end product for any given commodity.

Let's compare the emissions intensity of aluminium smelting to that of various plant-based food products, i.e.:

- sugar,

- wheat,

- other grains,

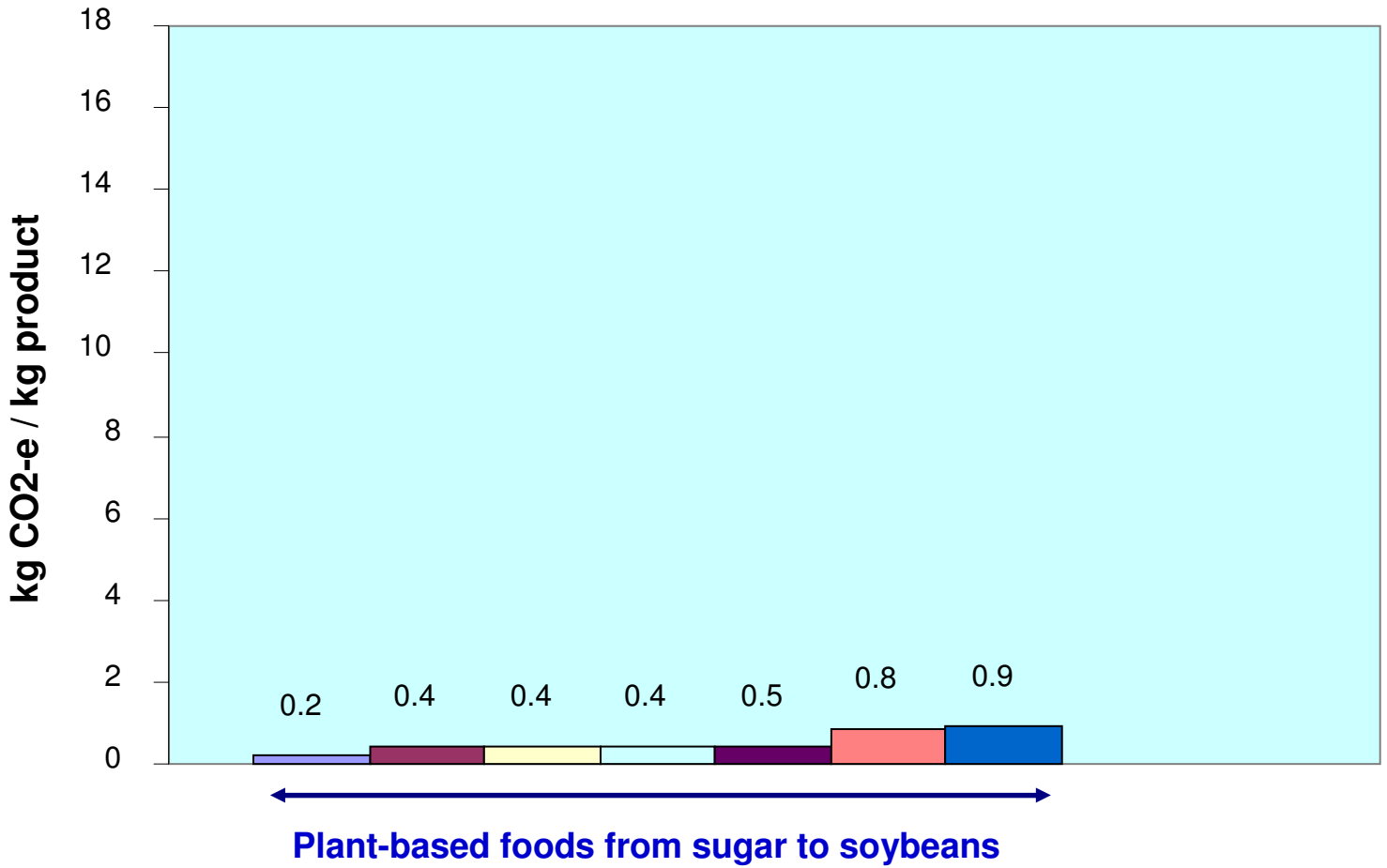
- carrots,

- potatoes,

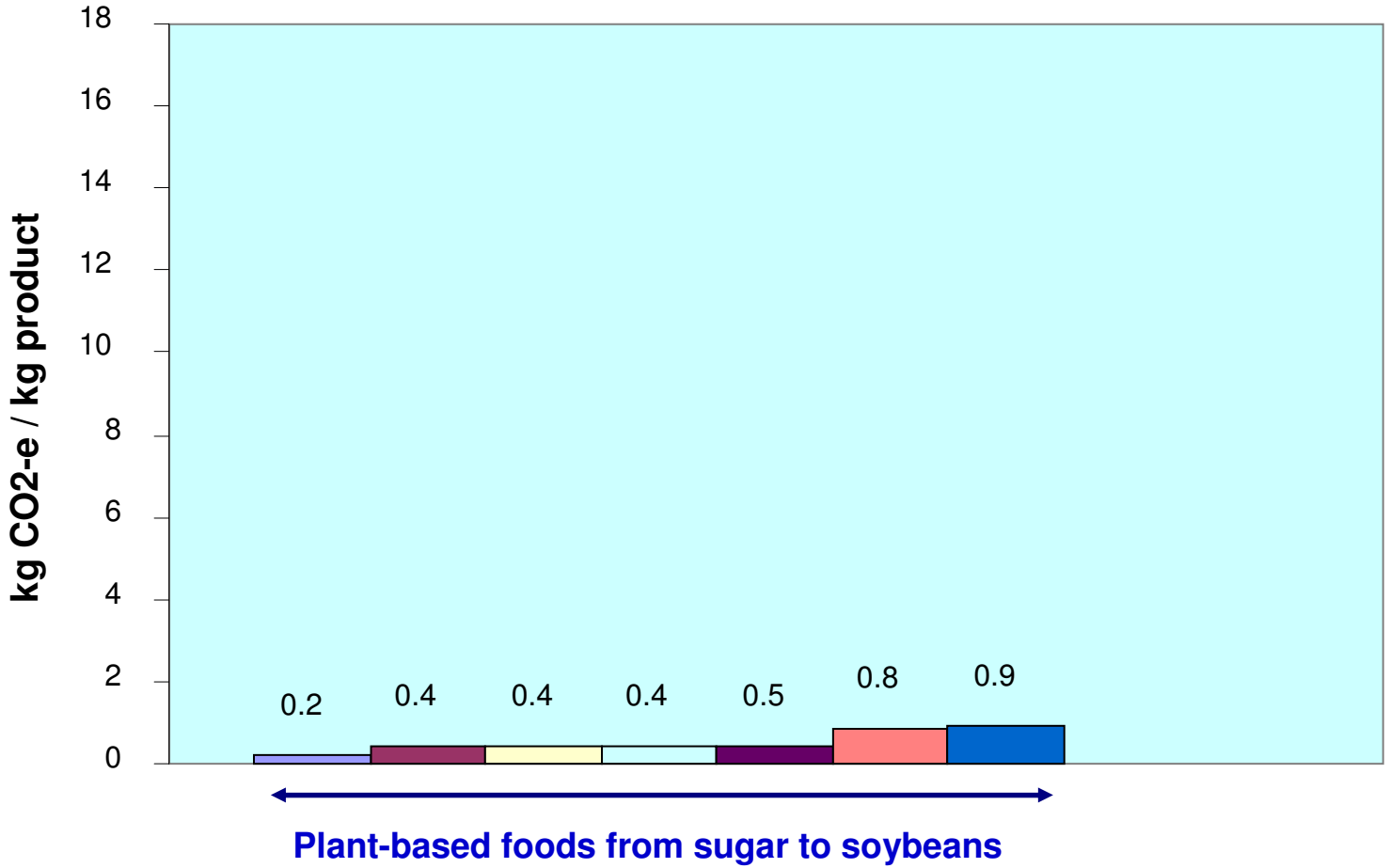
- apples and

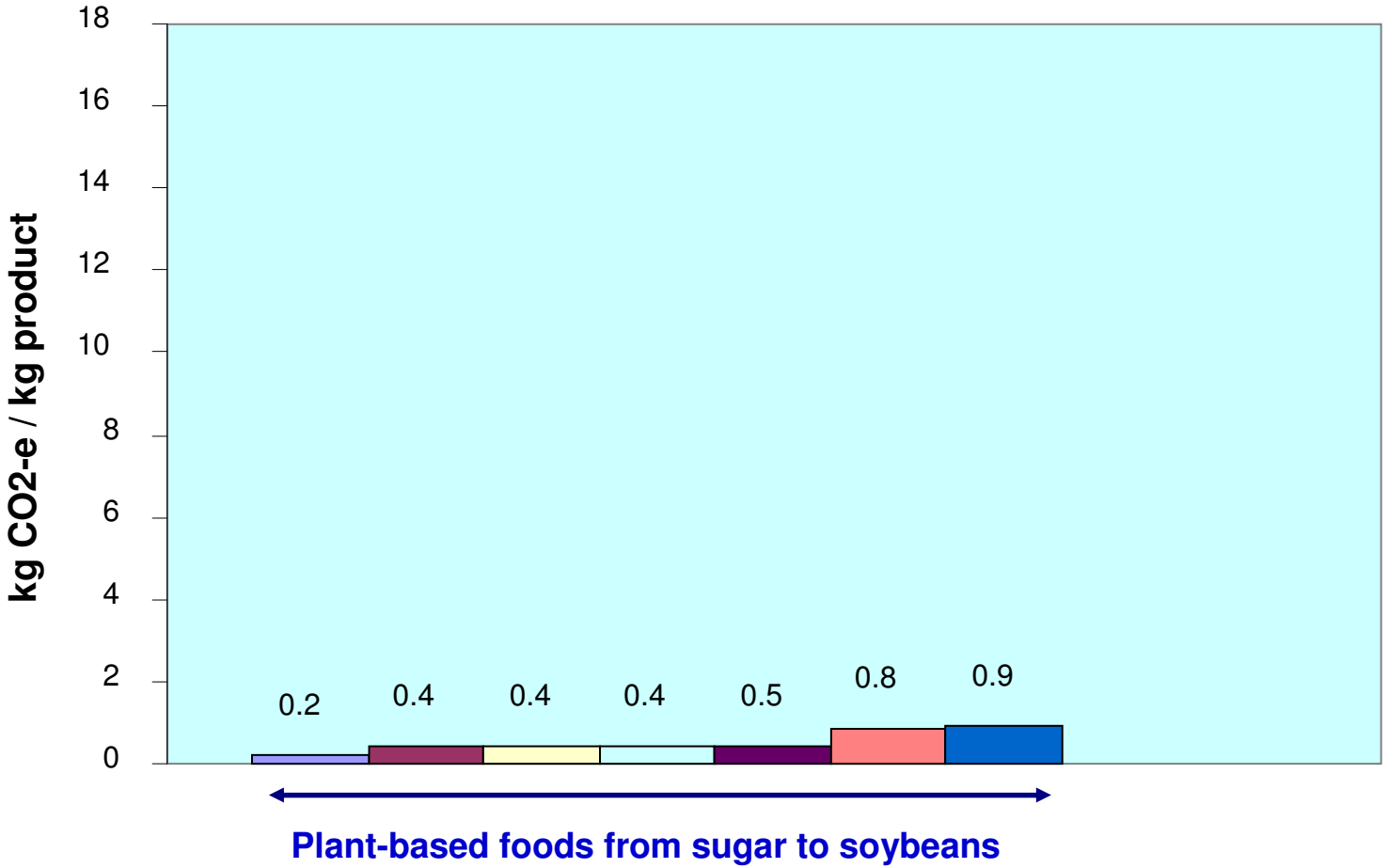
- soy beans.

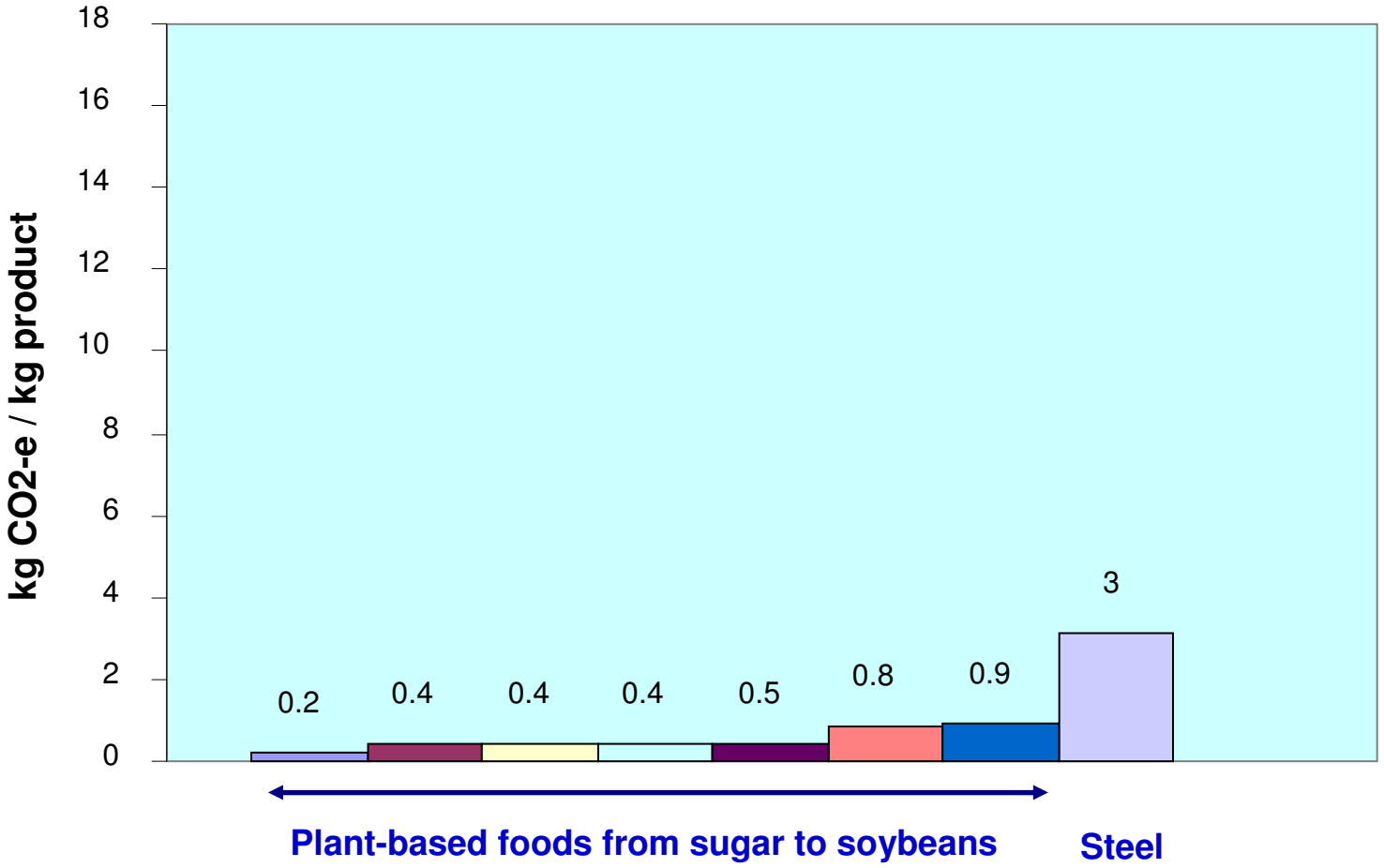
Here are emissions intensity figures for various plant-based food sources

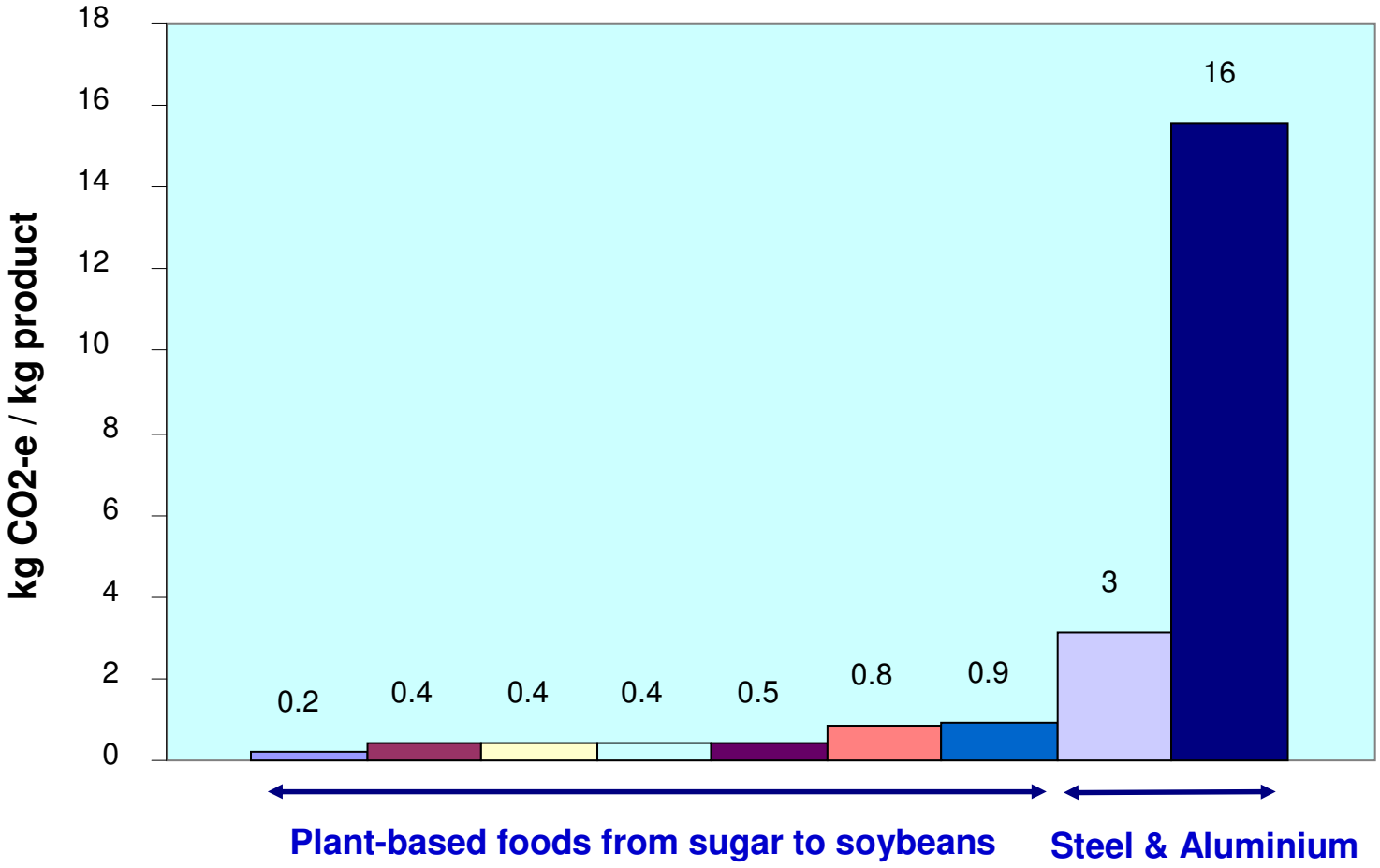


Let's then see how steel production and aluminium smelting compare (rounded up to zero decimal places).

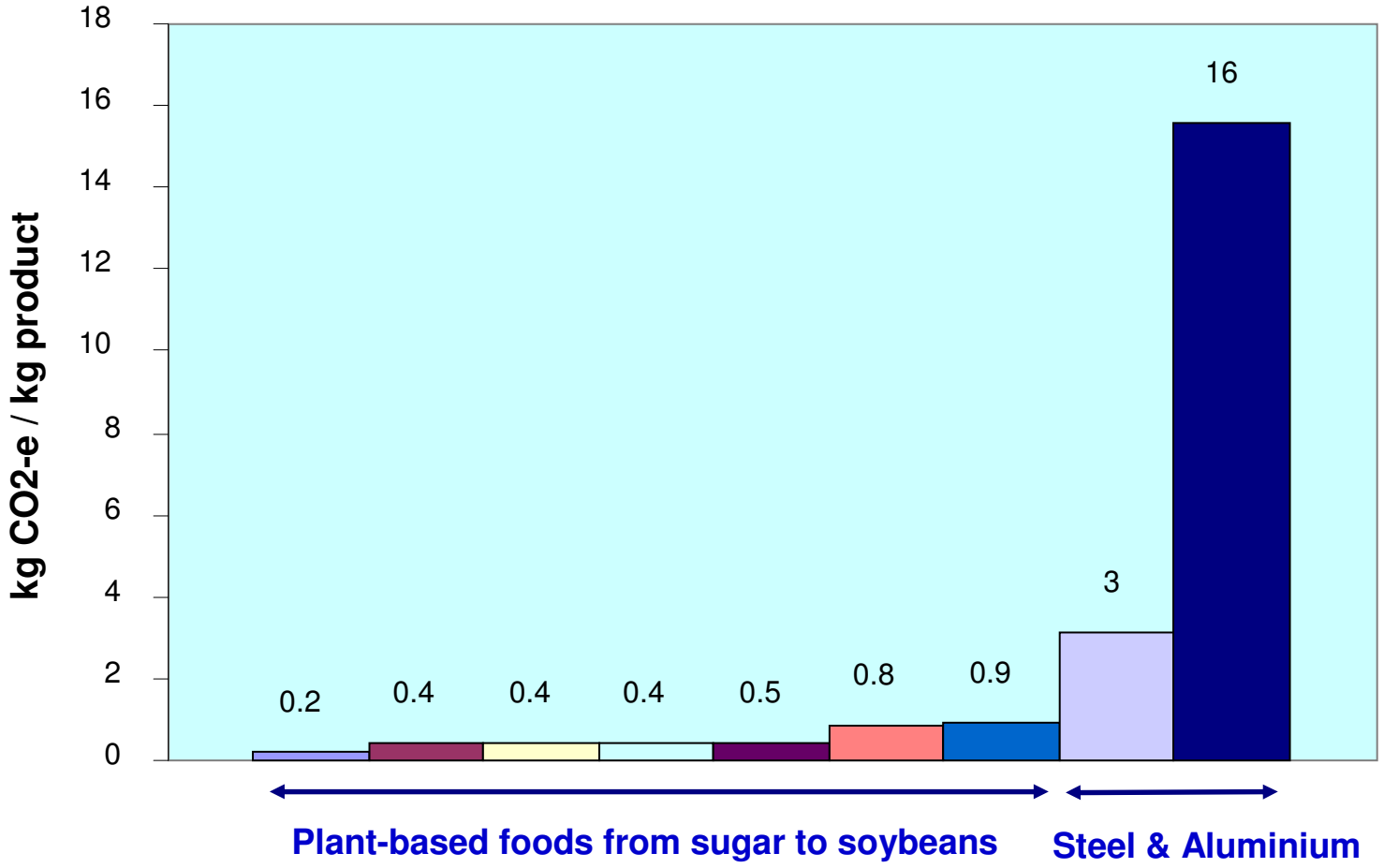


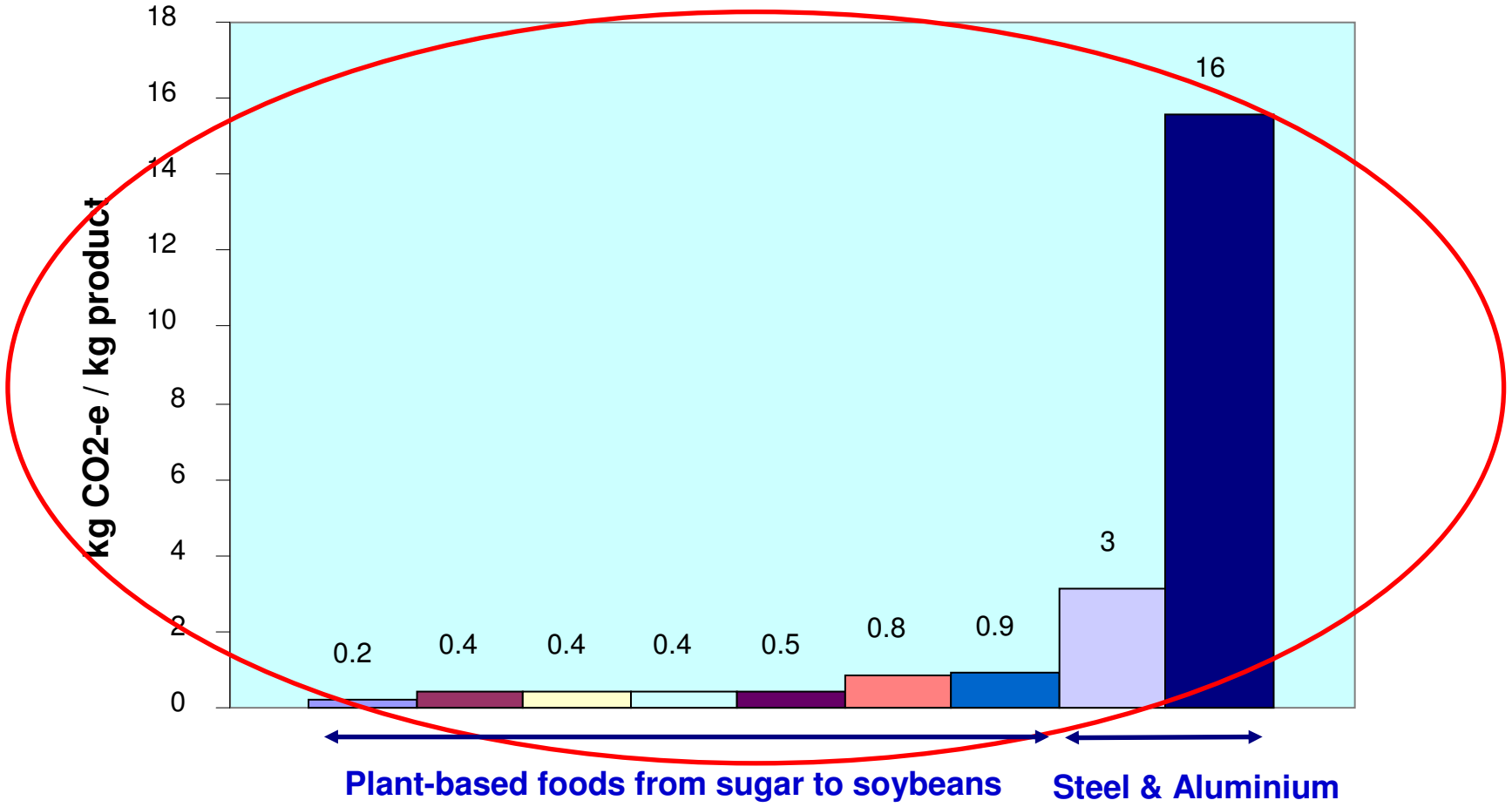


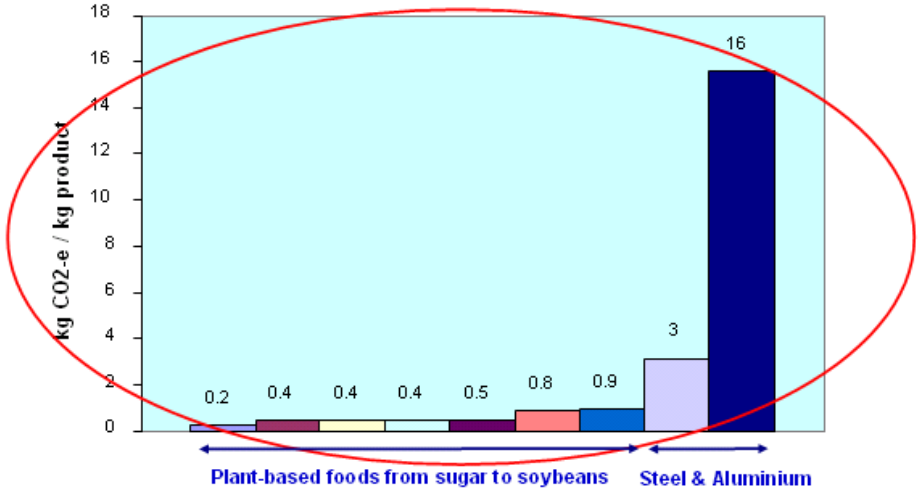


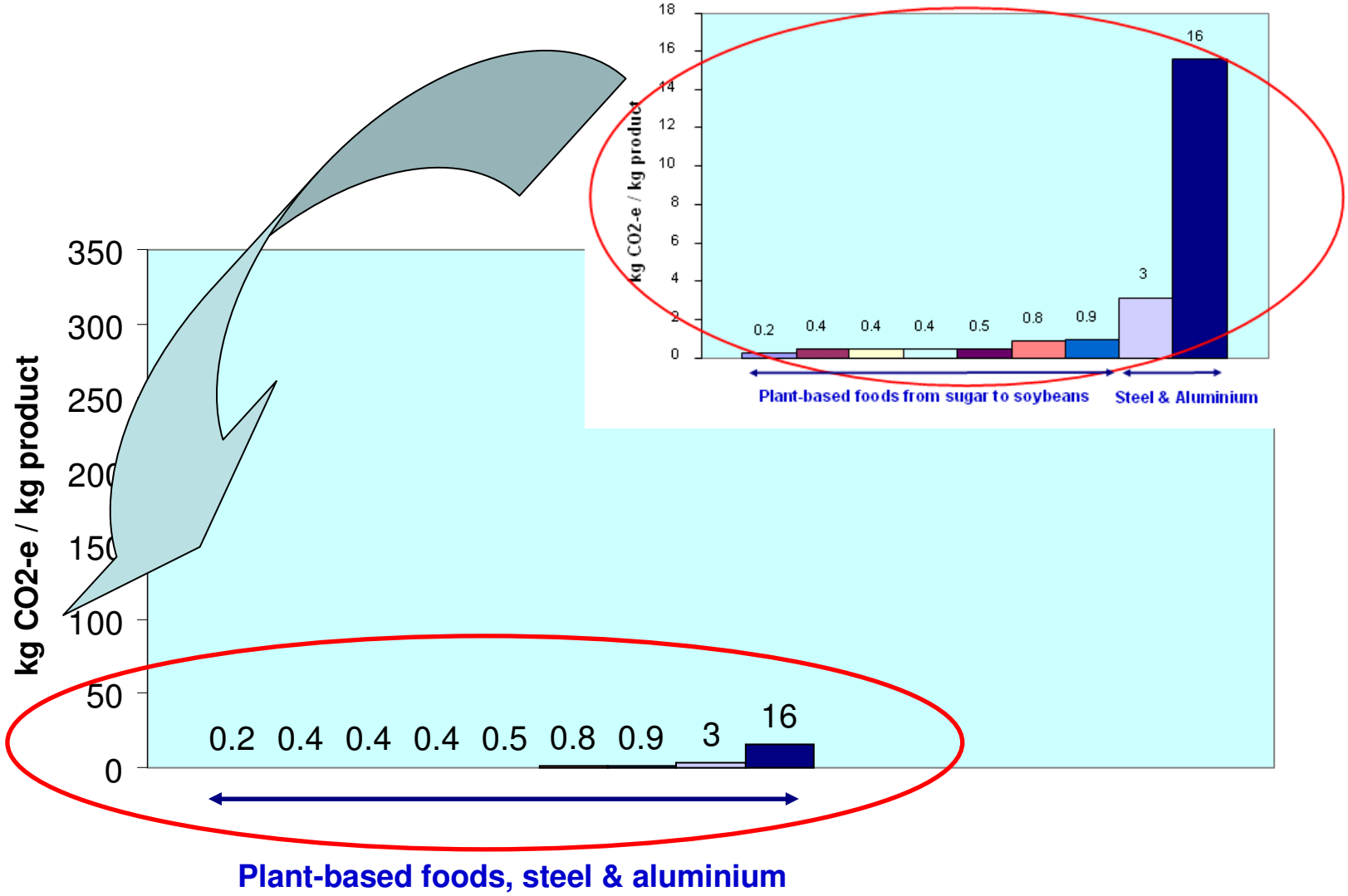


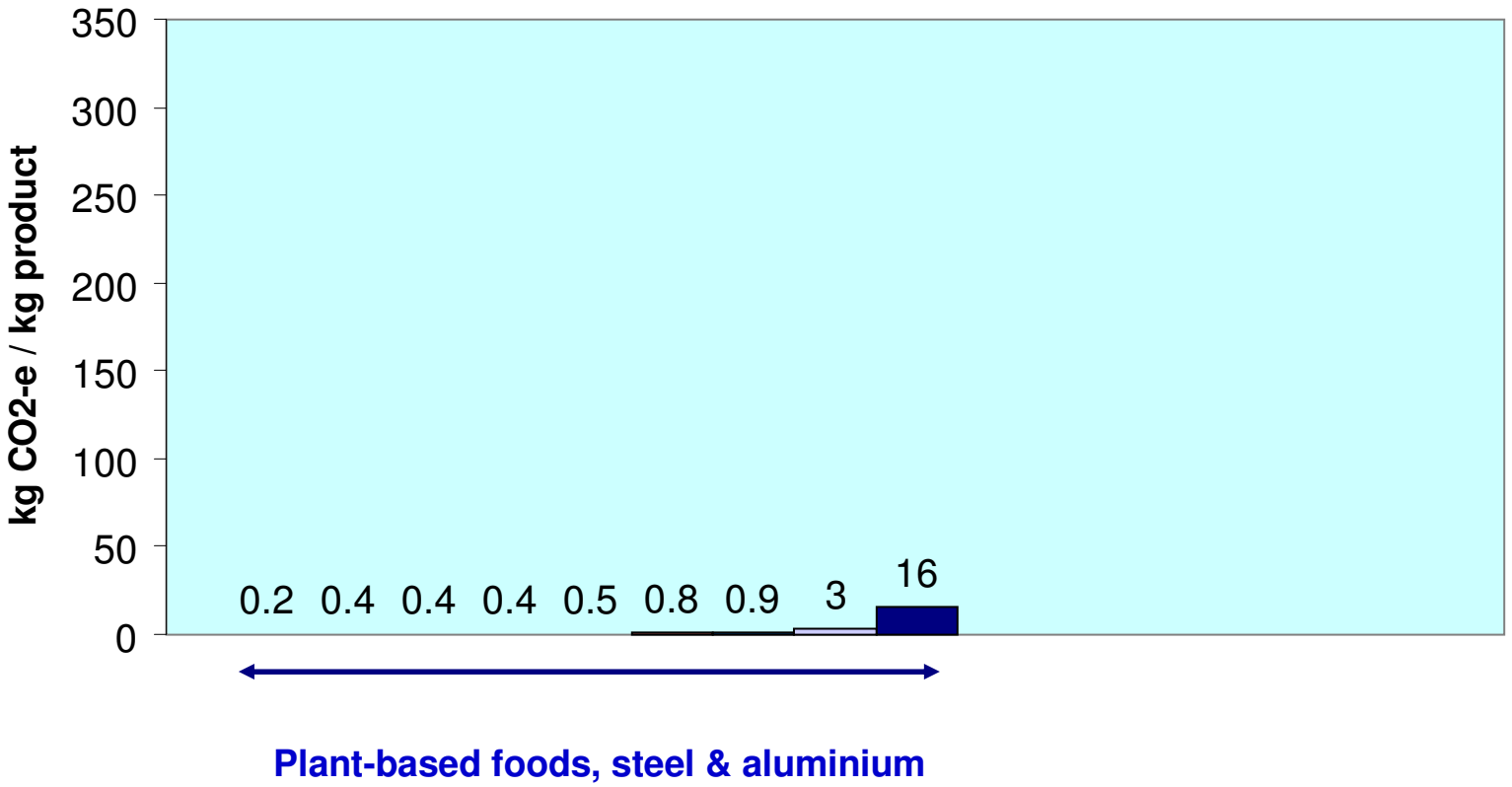
We'll now consider beef production, but first we need to change the scale of the chart.

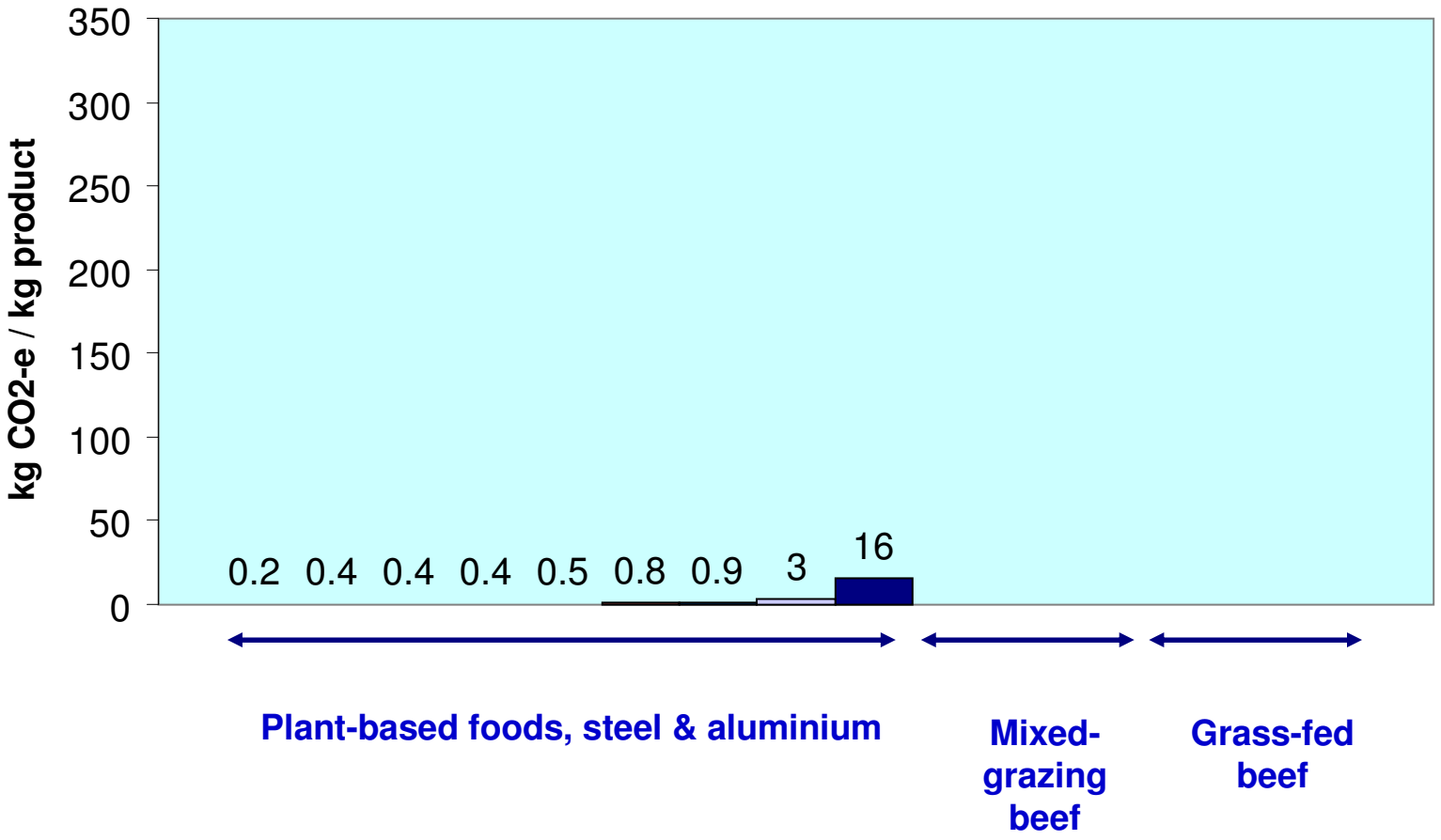




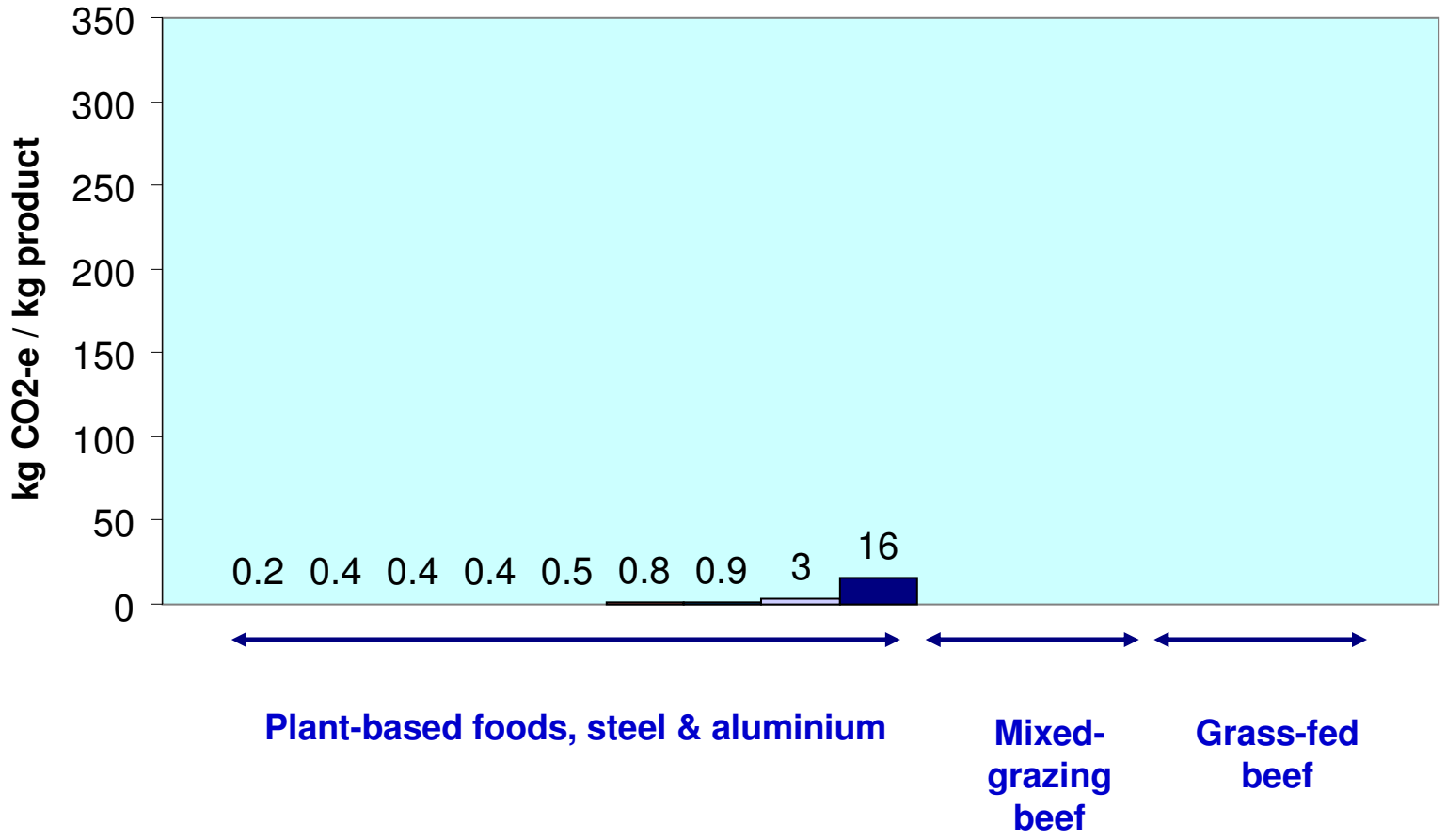


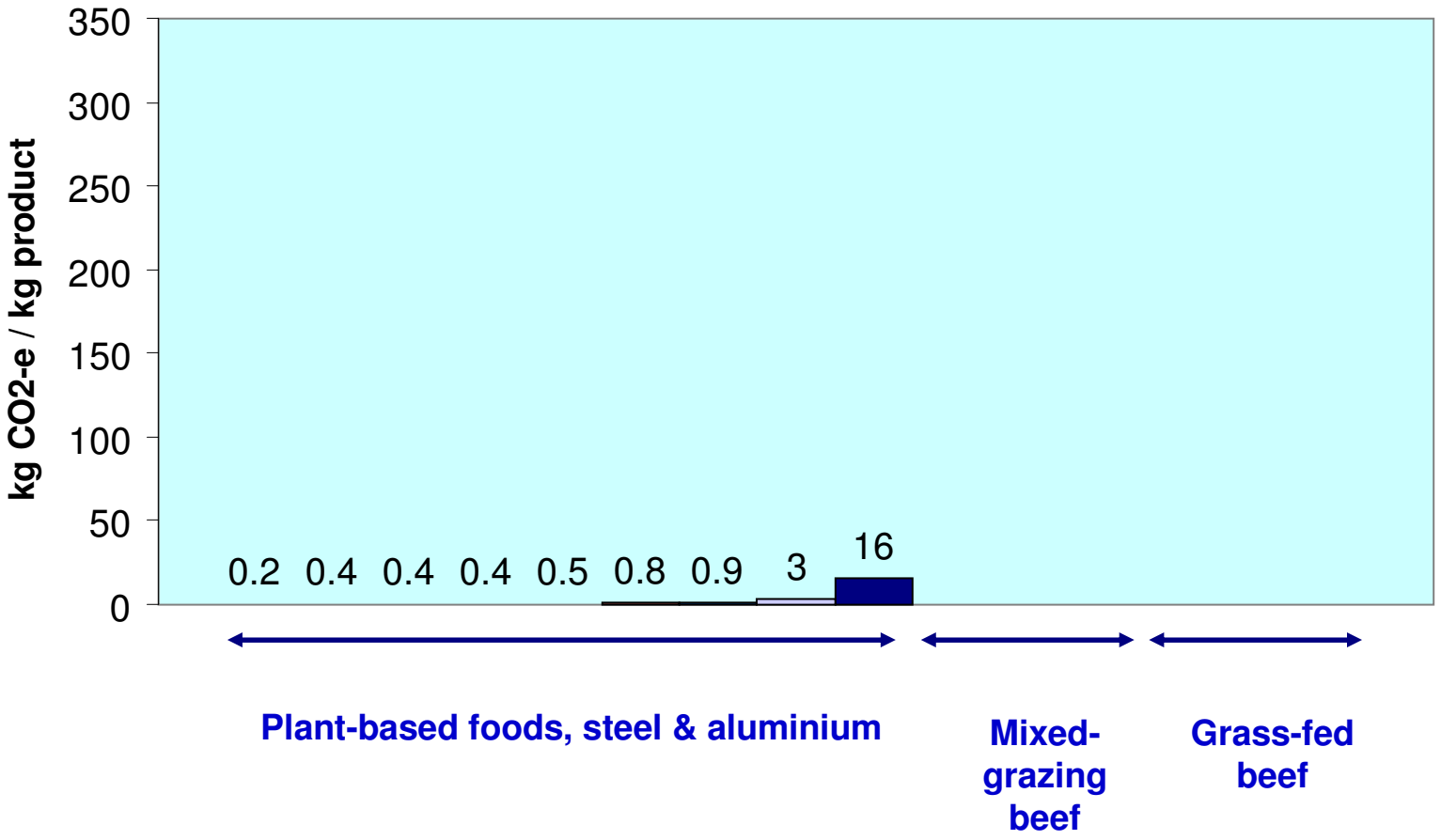


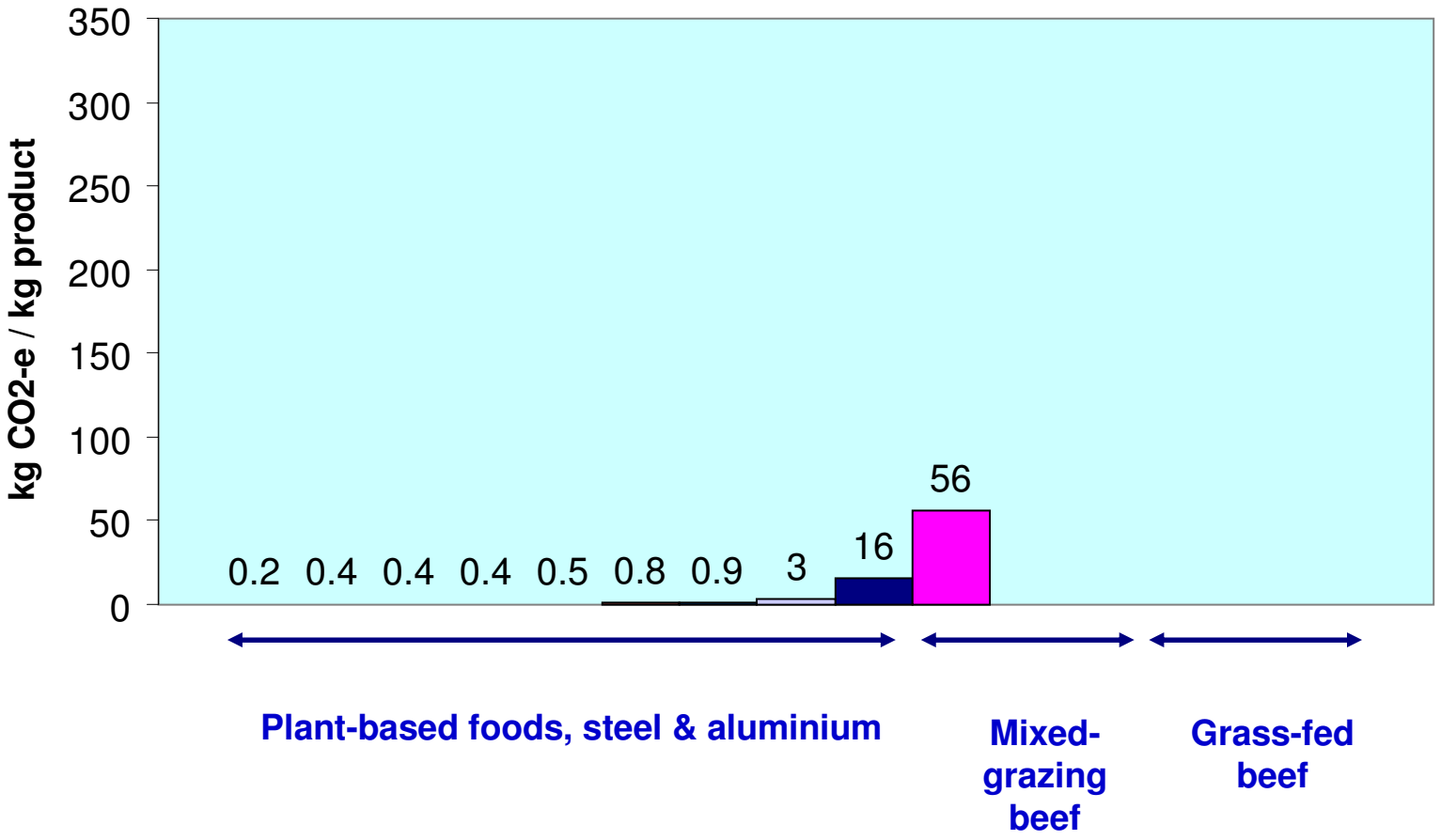


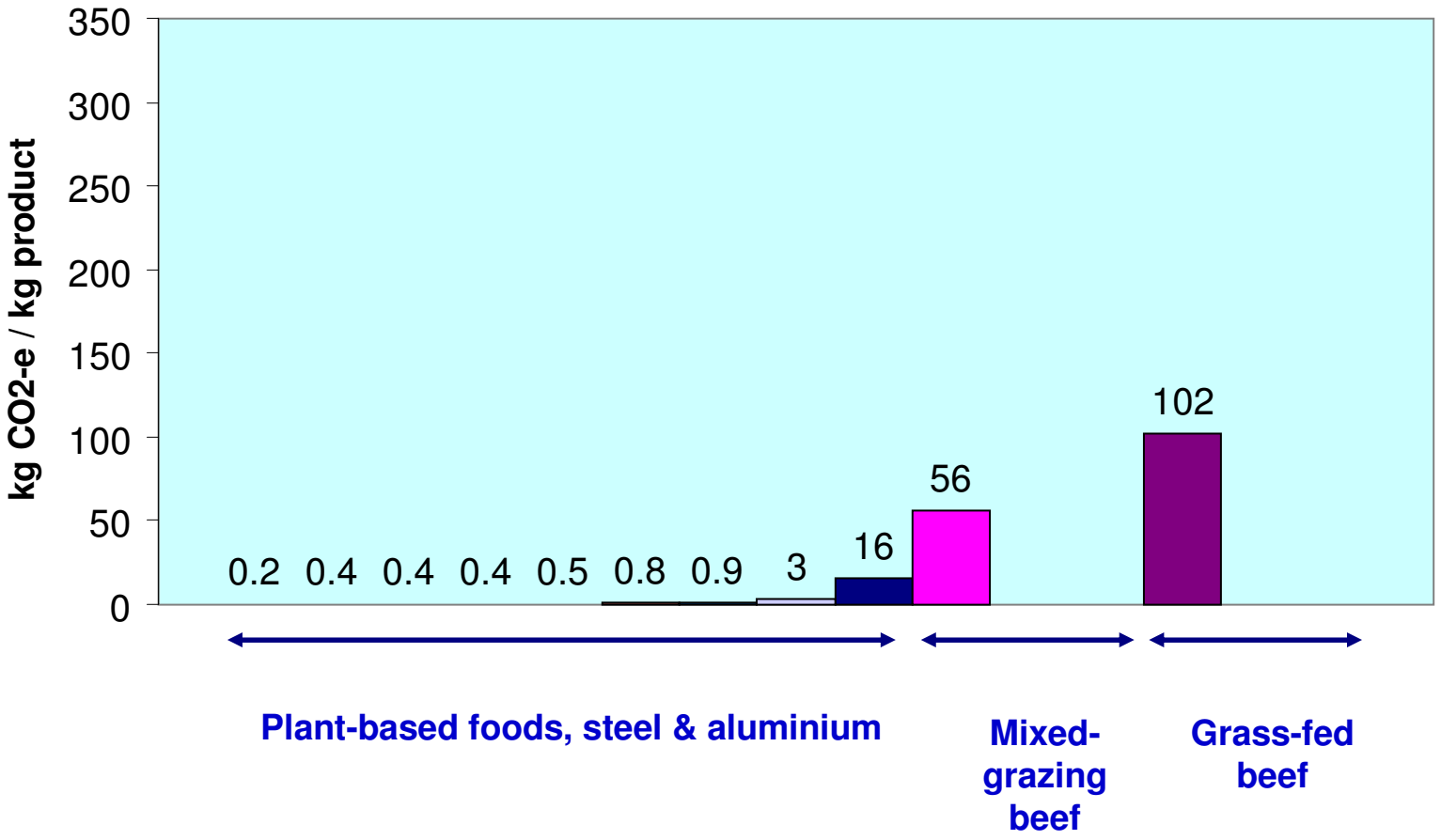


The first figures are global average figures based on carcass weight, published by the Food & Agriculture Organization of the United Nations in Dec, 2013.

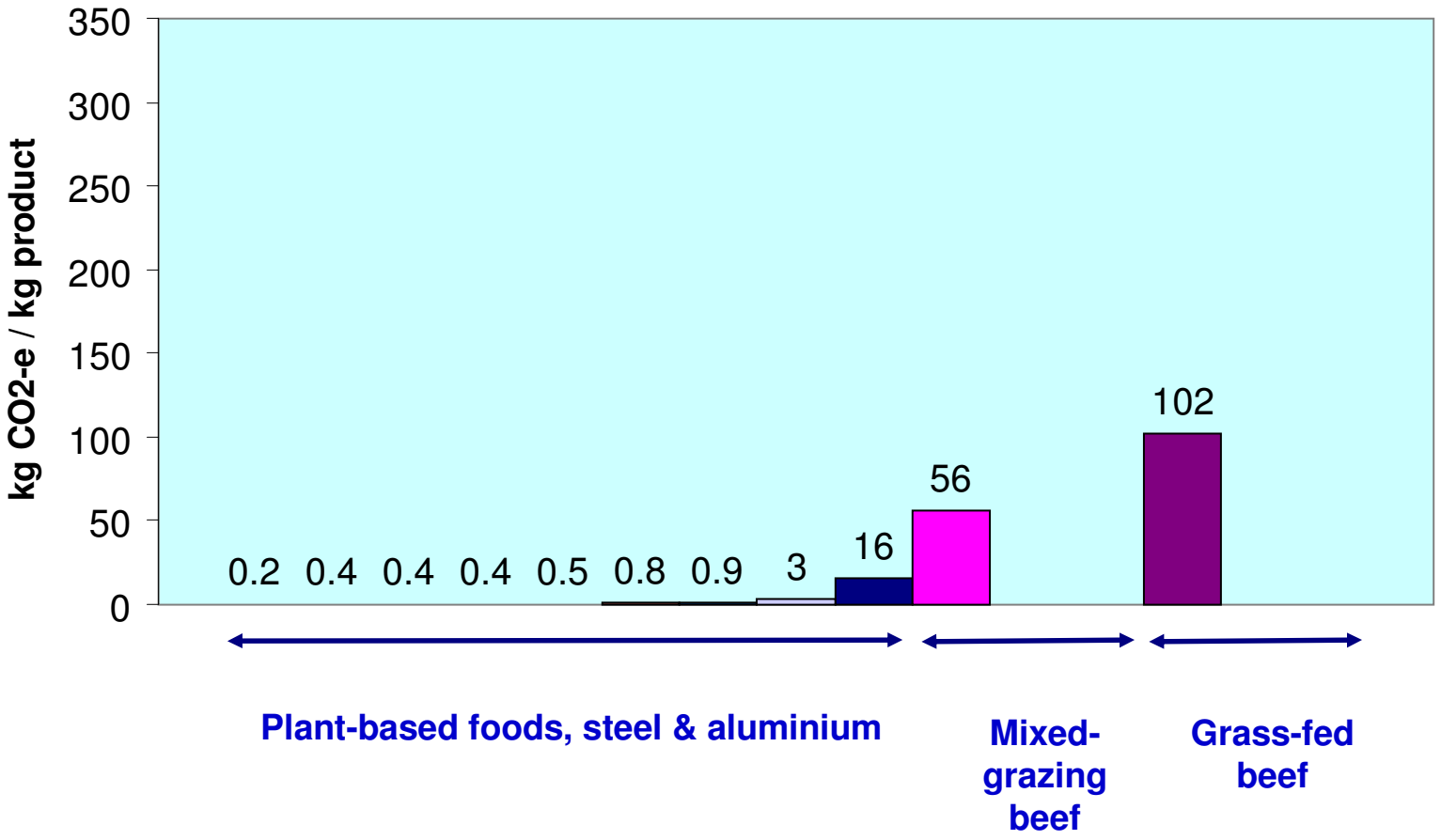




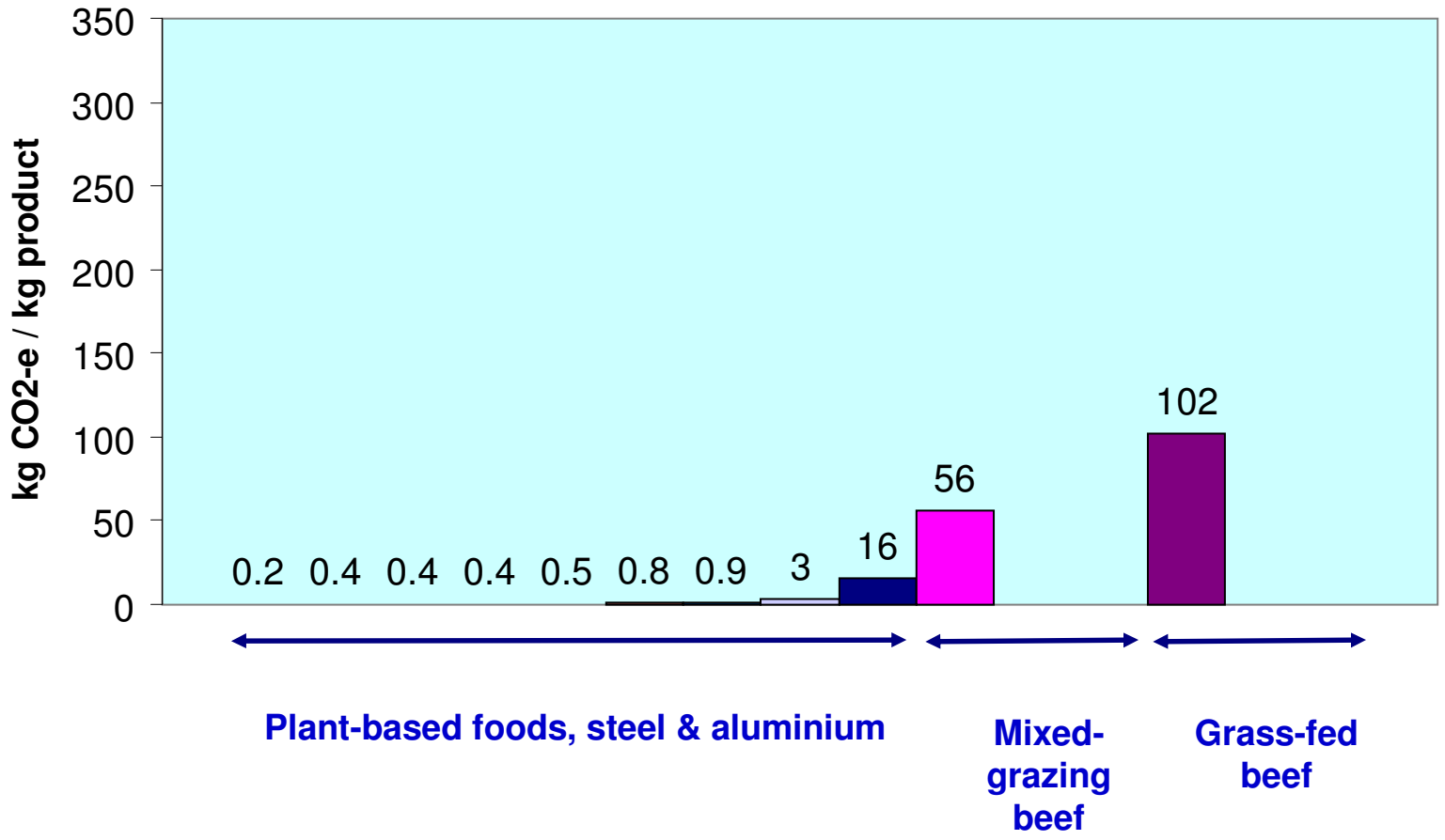


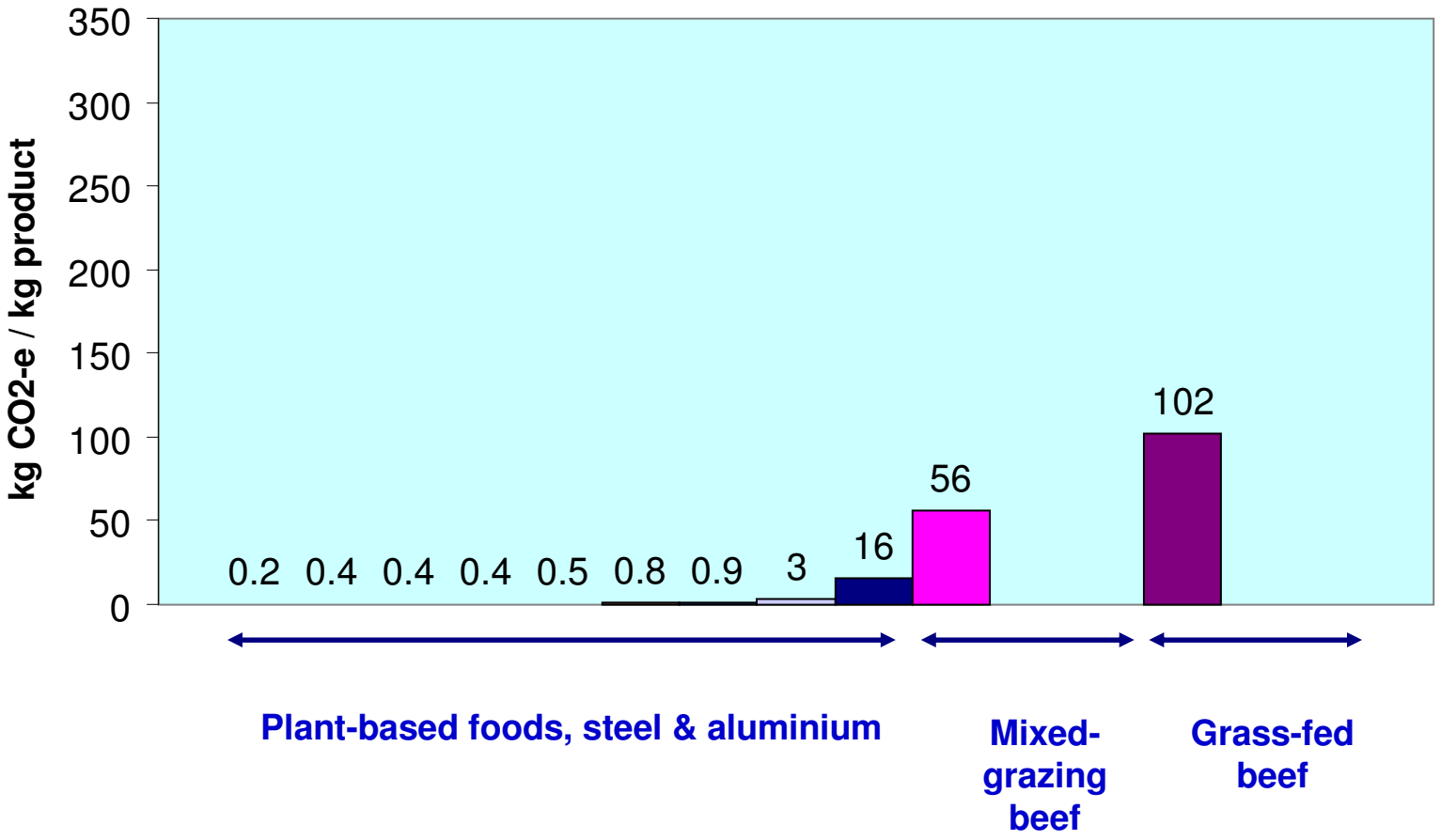


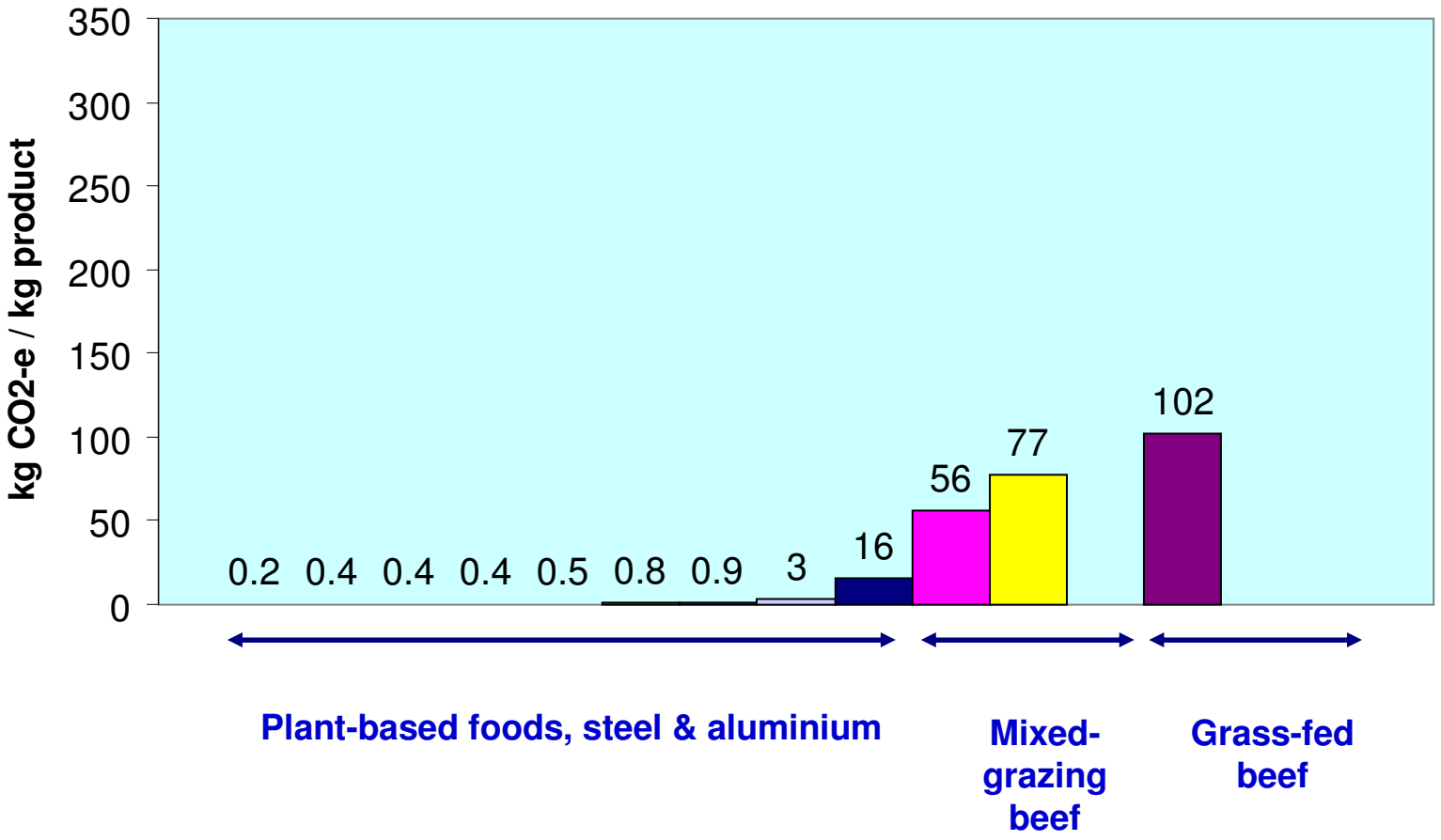
Now let's consider emissions intensity based on the weight of the retail product (representing the yield), rather than the weight of the carcass.

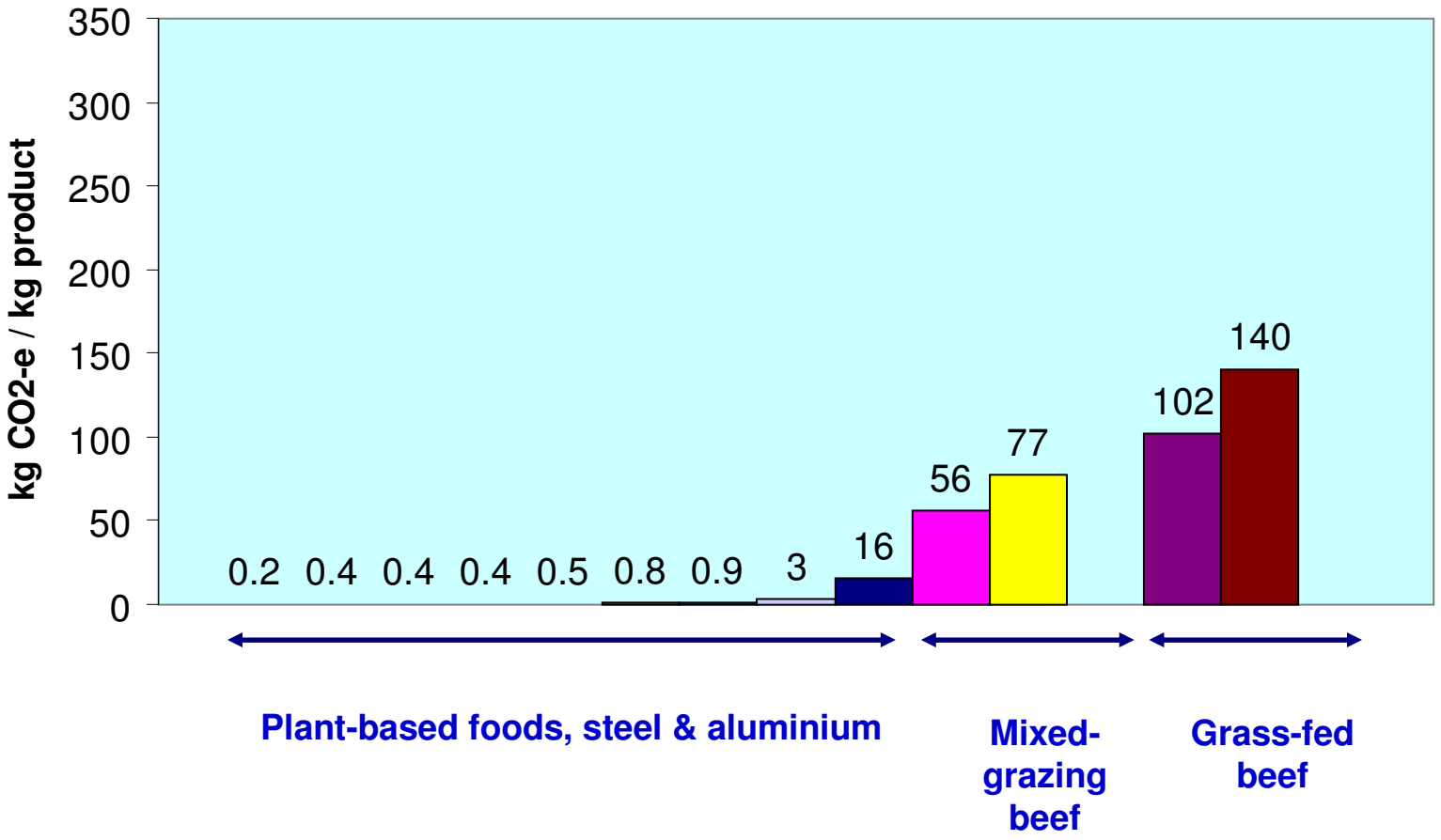


The emissions relating to the cow haven't changed, but the "end product", retail meat obtained from the carcass, is lighter than the carcass itself, so the emissions intensity increases.

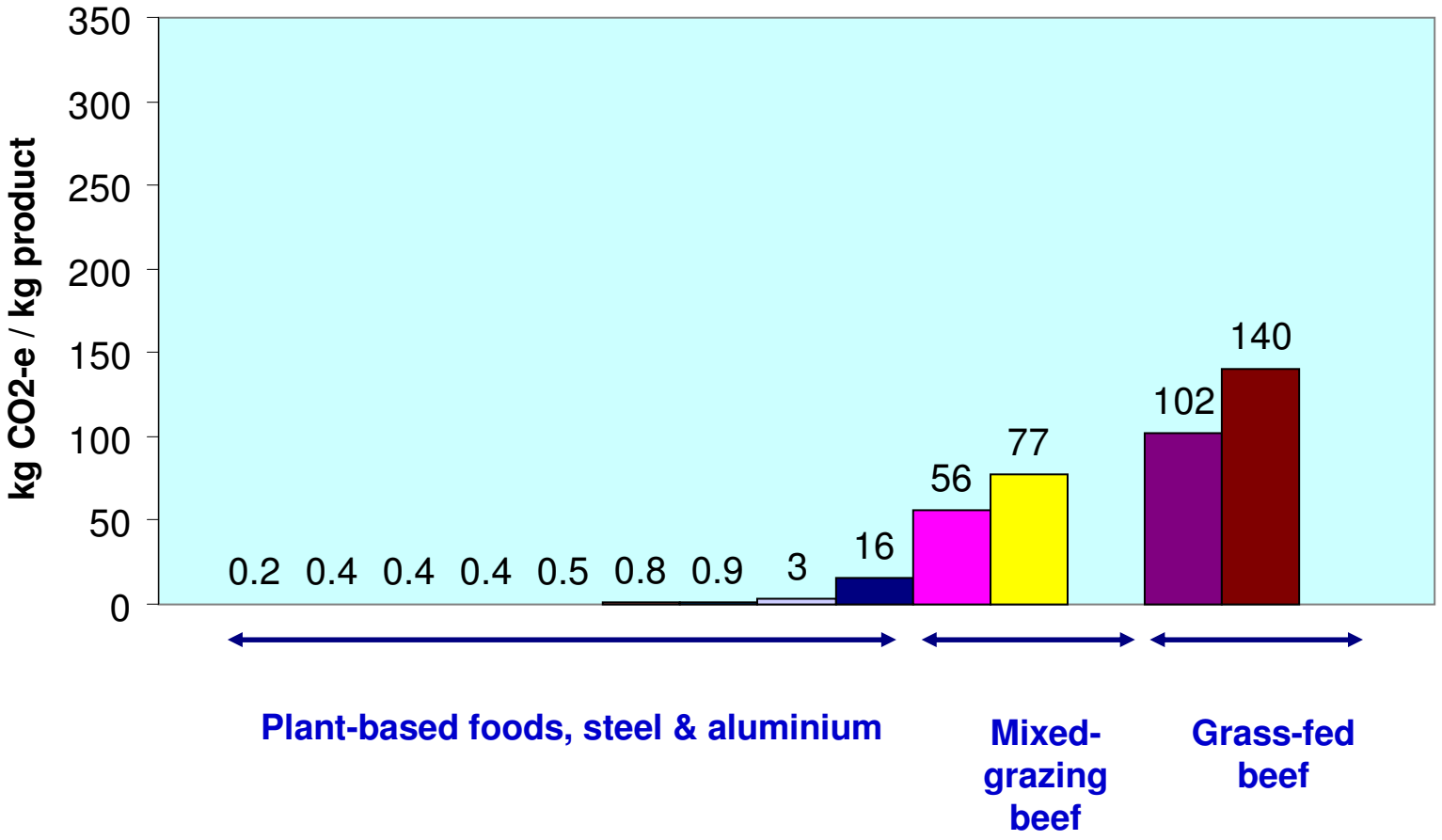








Now let's adjust for a 20-year "global warming potential" (GWP) for methane, but first an explanation.



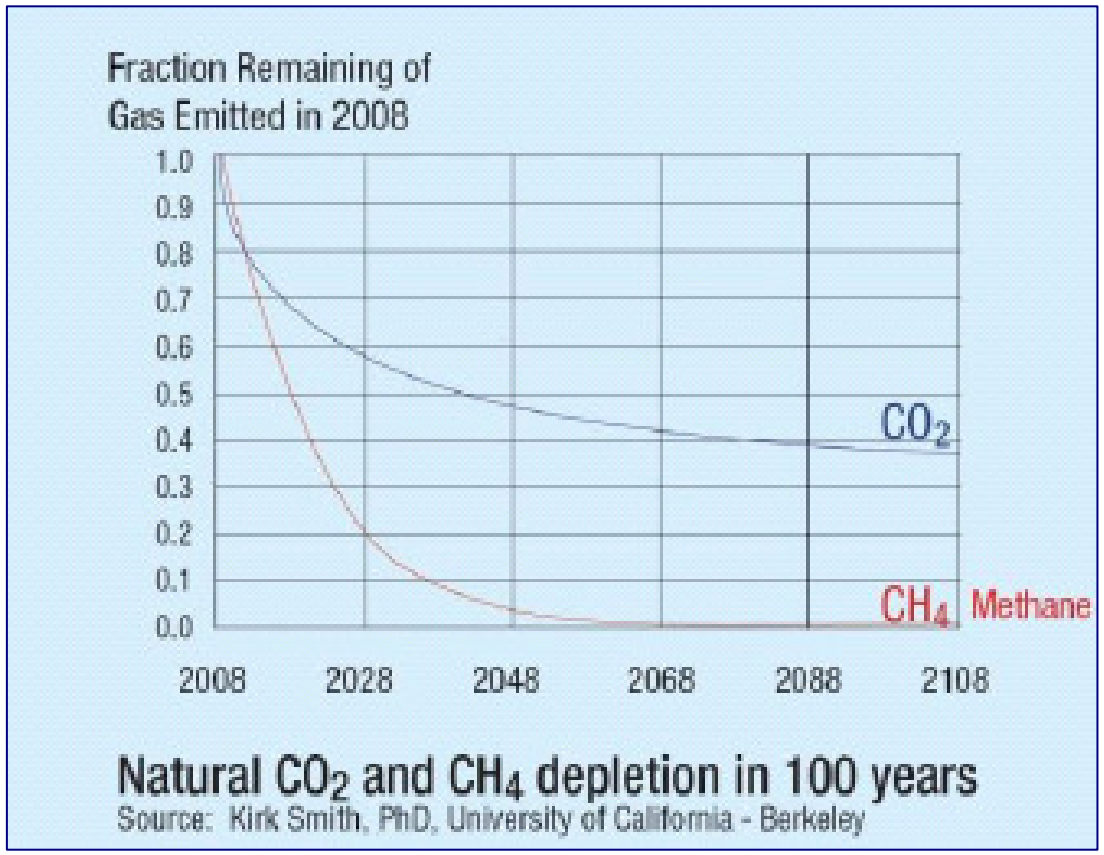
The emissions of different gases can be aggregated by converting them to carbon dioxide equivalents (CO2-e). It is like a common denomination for greenhouse gases.

They are converted by multiplying the mass of emissions by the appropriate global warming potentials (GWPs).

GWPs represent the relative warming effect of a unit mass of the gas when compared with the same mass of CO2 over a specific period.

CO2-e equivalent (CO2-e) emissions from livestock

20-year "Global Warming Potential" (GWP)



Traditional reporting of methane's global warming potential has understated its shorter-term impact, as it breaks down in the atmosphere much faster than carbon dioxide.

The IPCC's 100-year GWP for methane was increased to 34 (with carbon cycle feedbacks) in 2013.

The figure for a 20 year timeframe is 86.

NASA reports figures of 33 for 100 years and 105 for 20 years.

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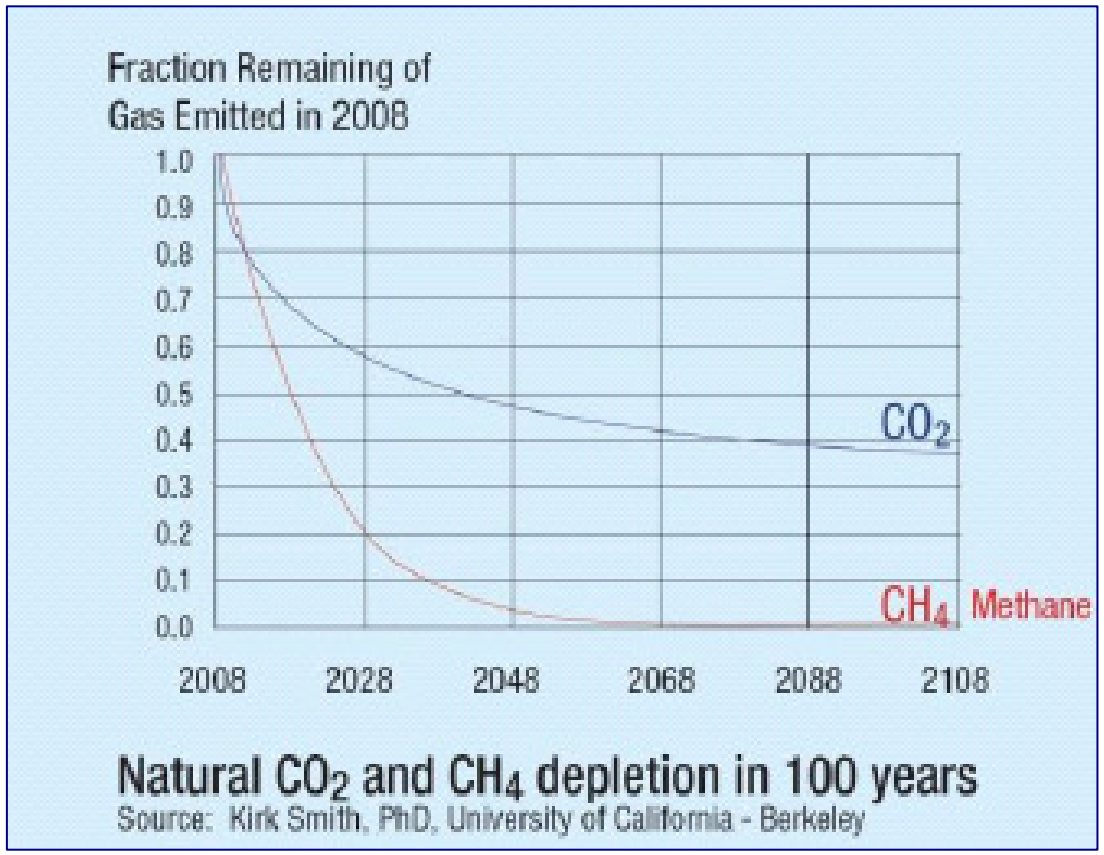
20-year "Global Warming Potential" (GWP)



Methane's shorter-term impacts can become long-term to the extent that they contribute to us reaching climate change tipping points with catastrophic and irreversible consequences.

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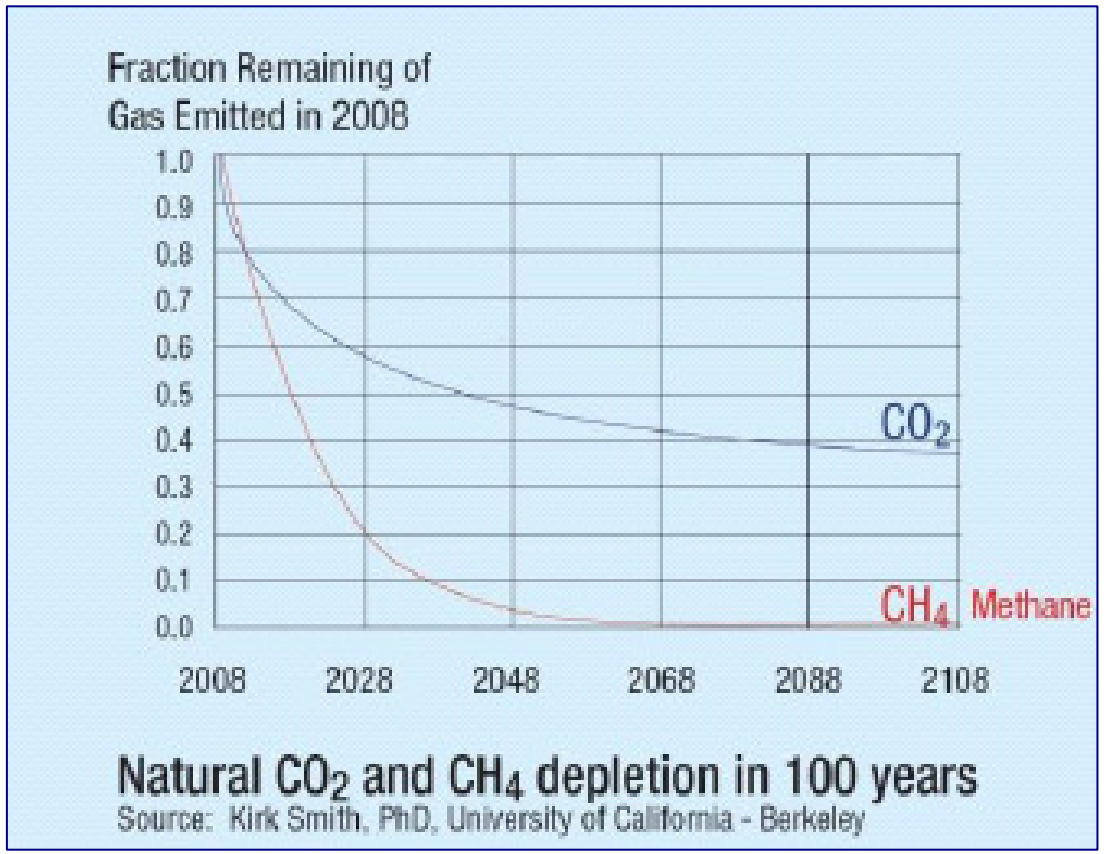

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Meaningful action in regard to key sources of methane can represent a significant mitigation measure with a relatively fast response time.

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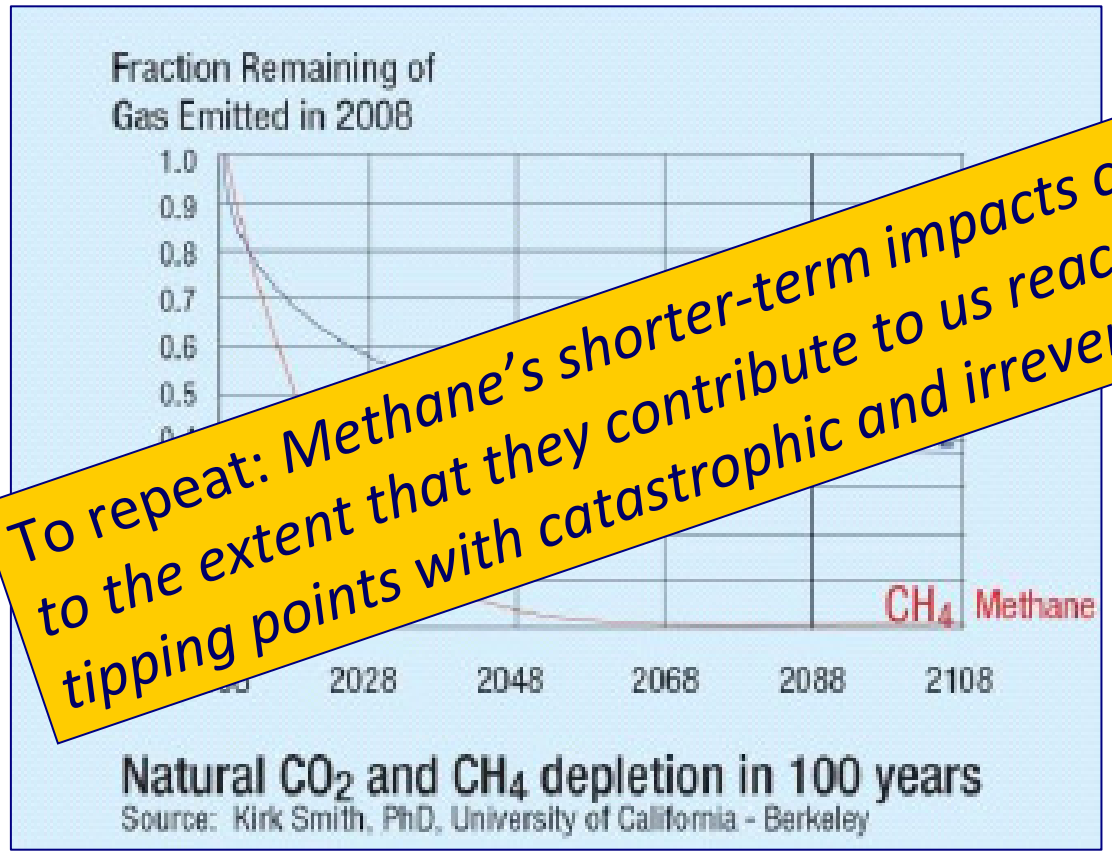

To repeat: Methane's shorter-term impacts can become long-term to the extent that they contribute to us reaching climate change tipping points with catastrophic and irreversible consequences.

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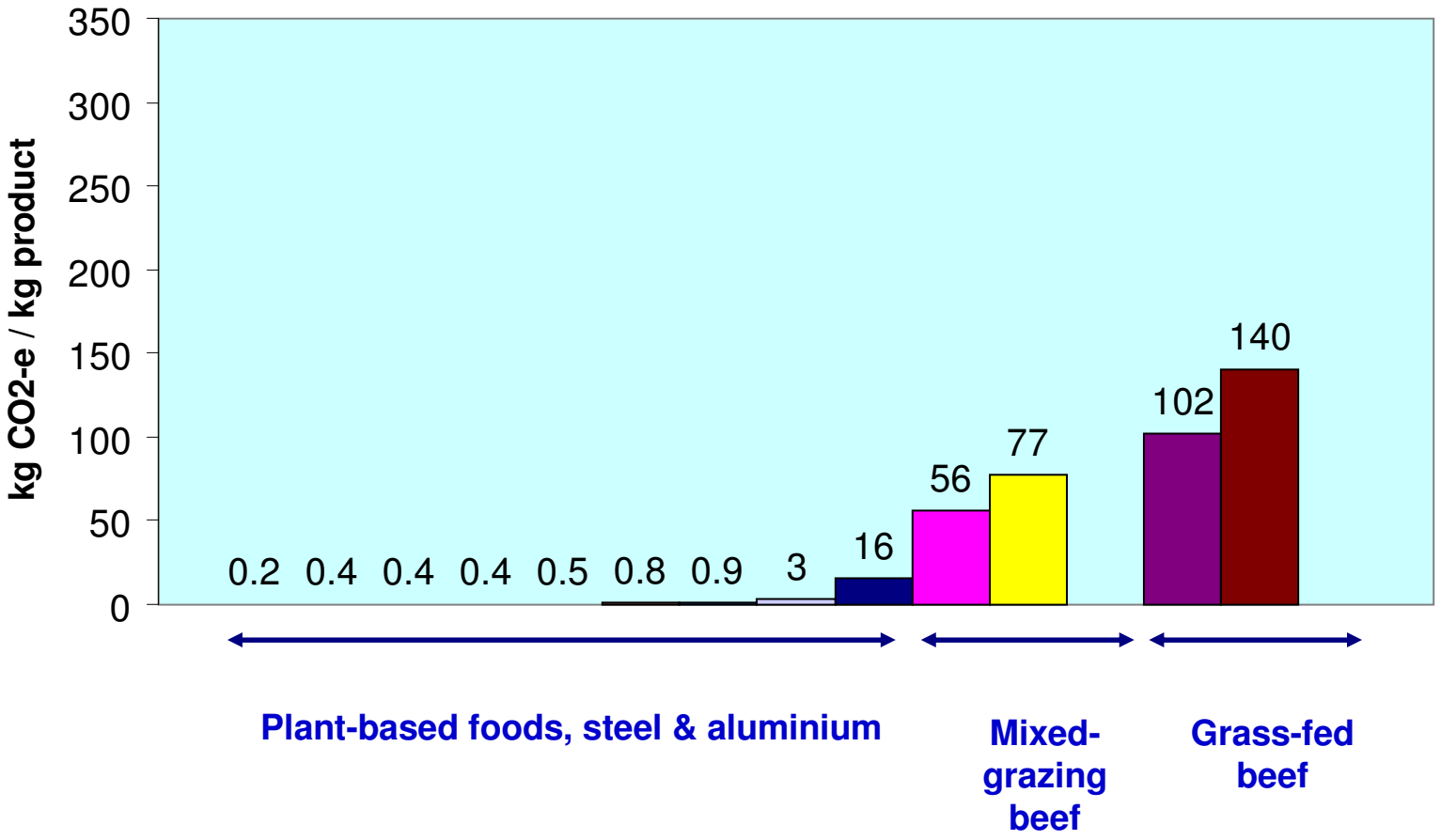
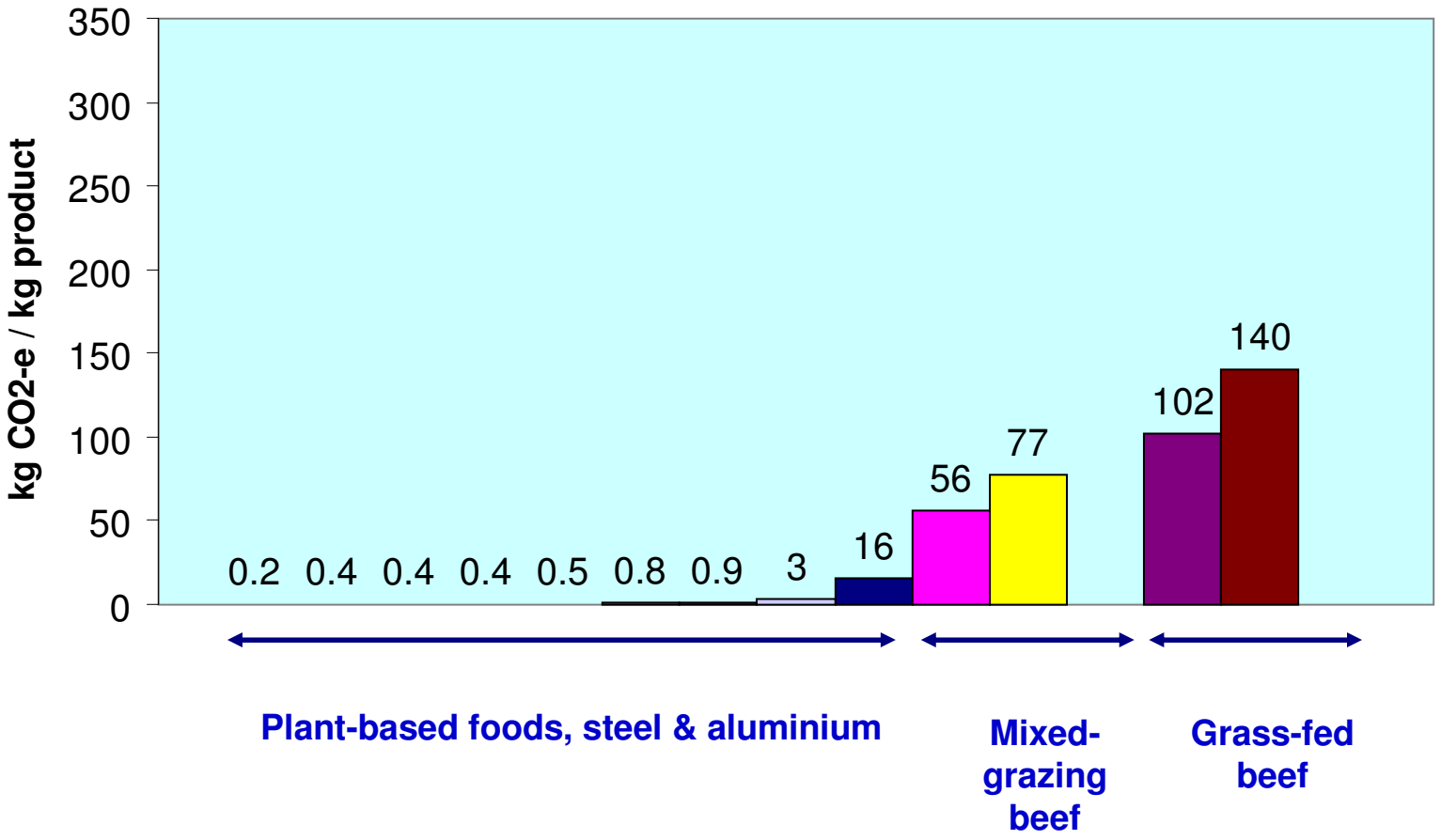
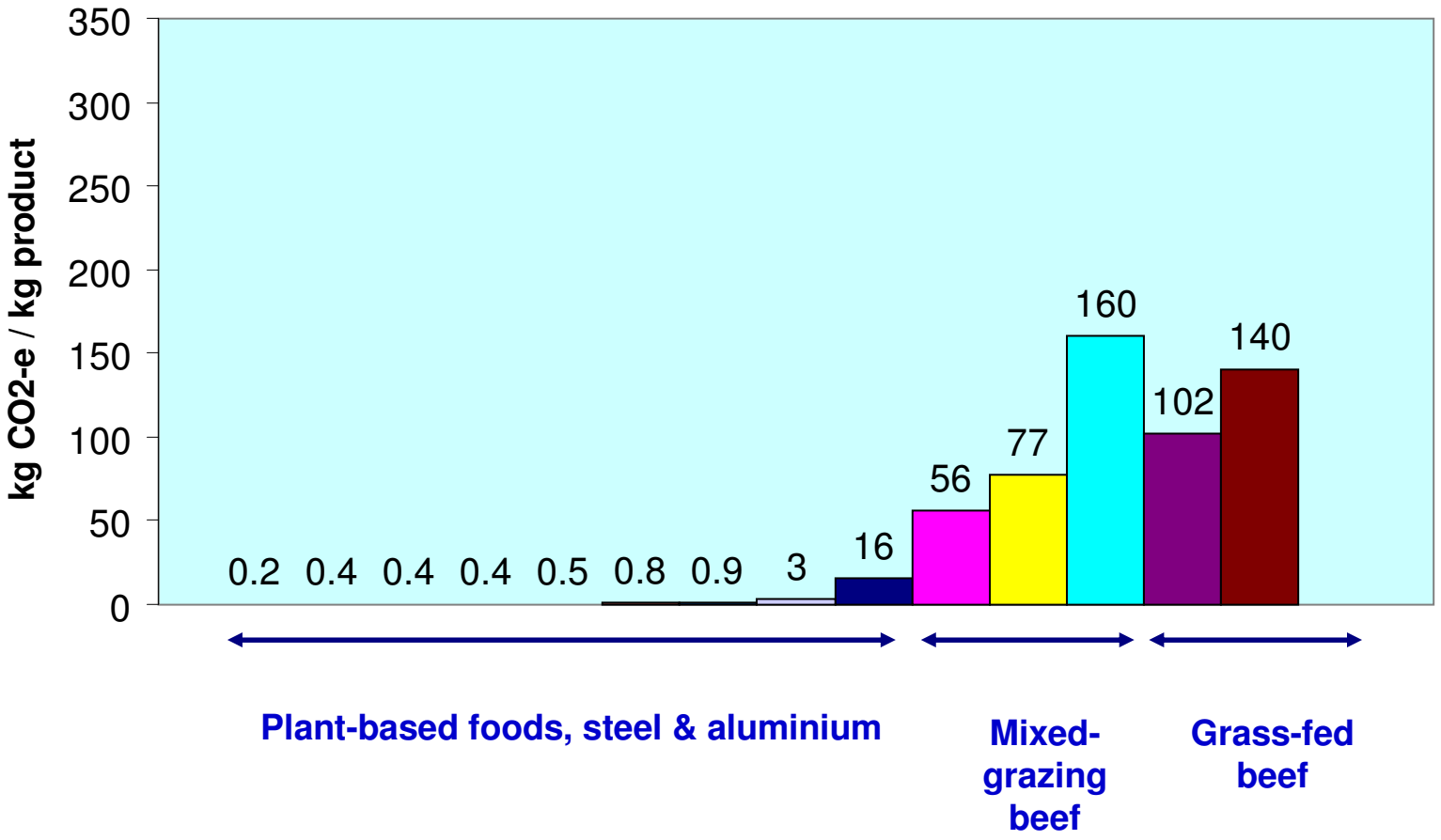
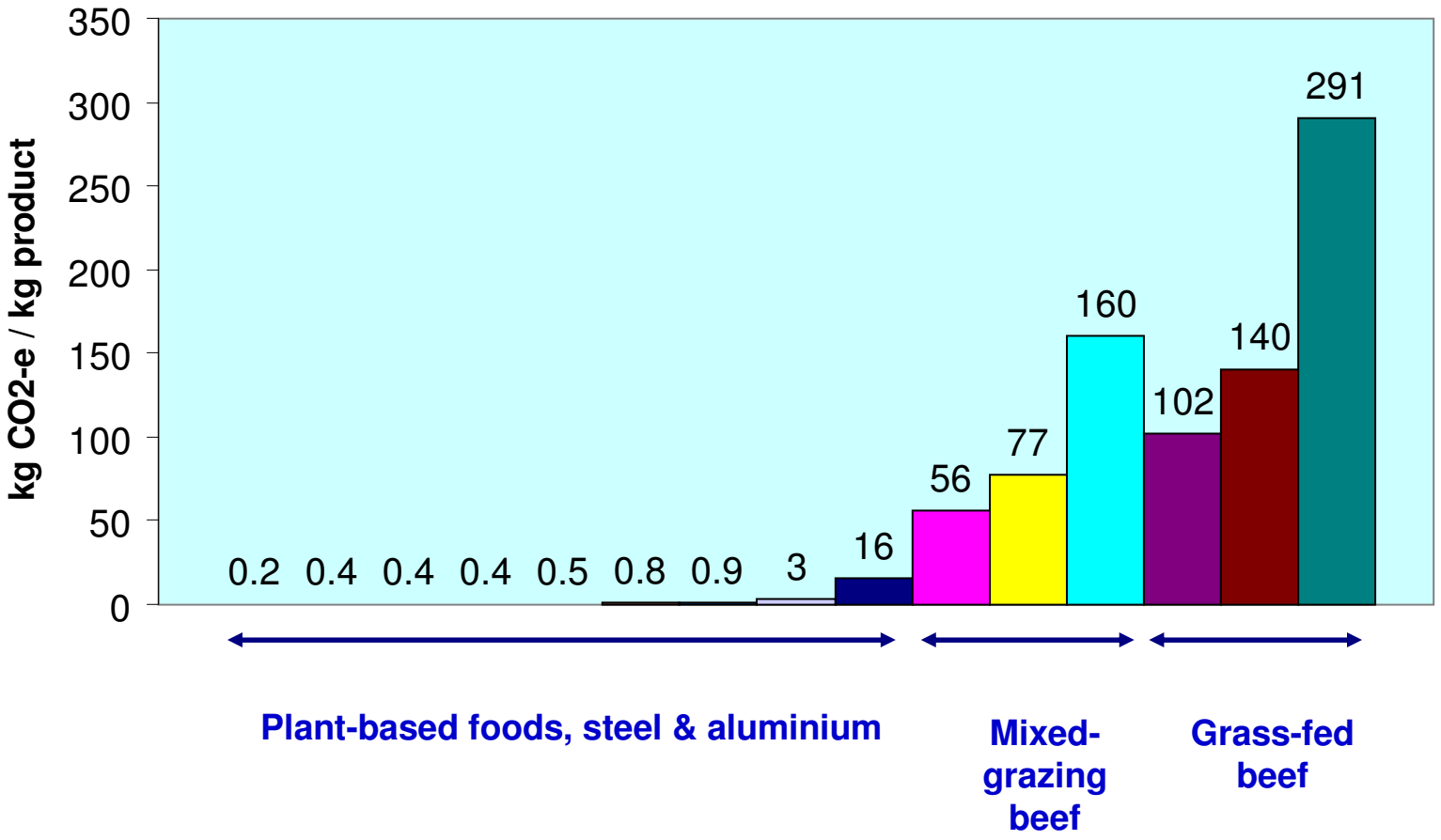
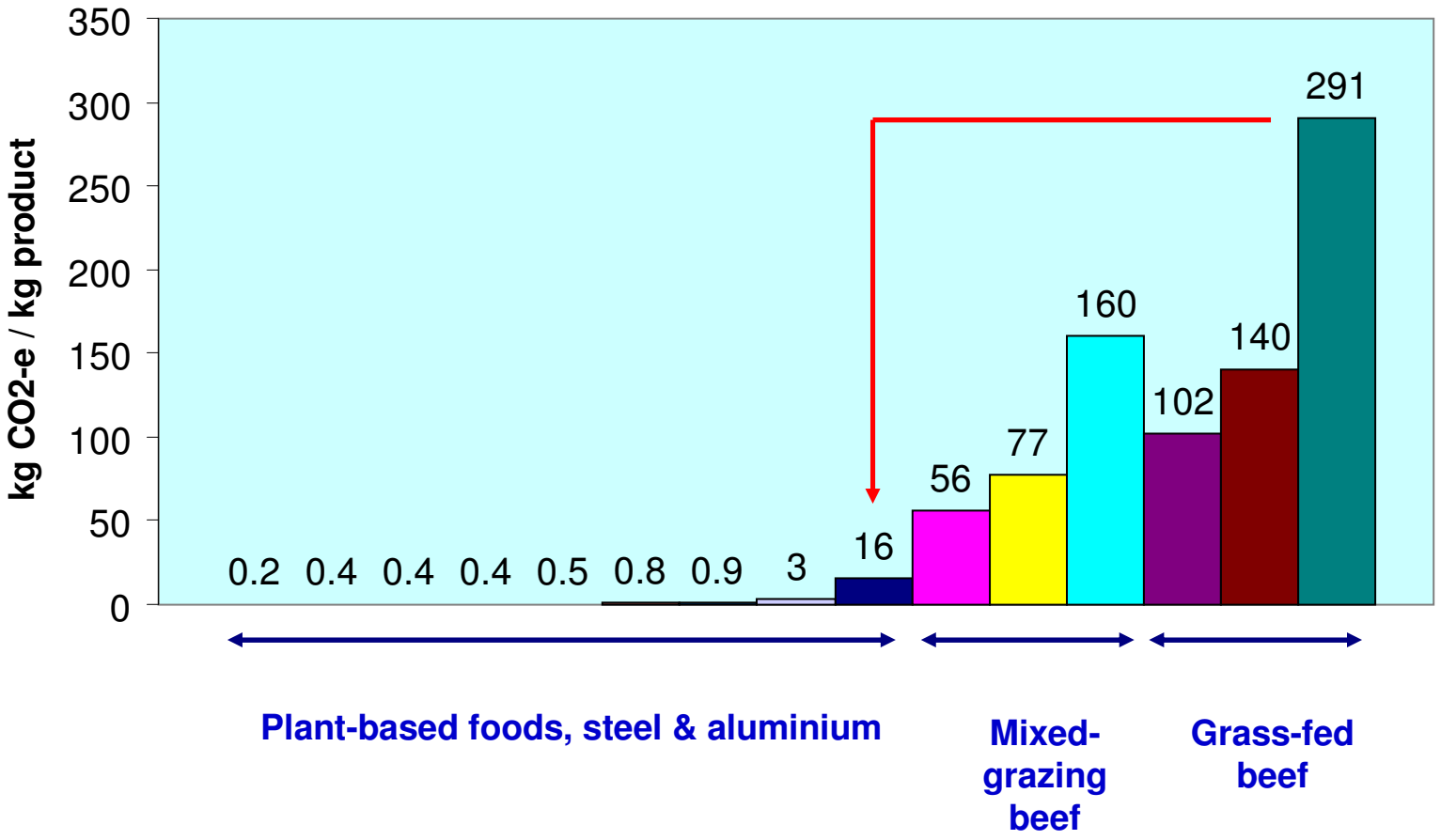
So now we'll insert figures based on a 20-year GWP



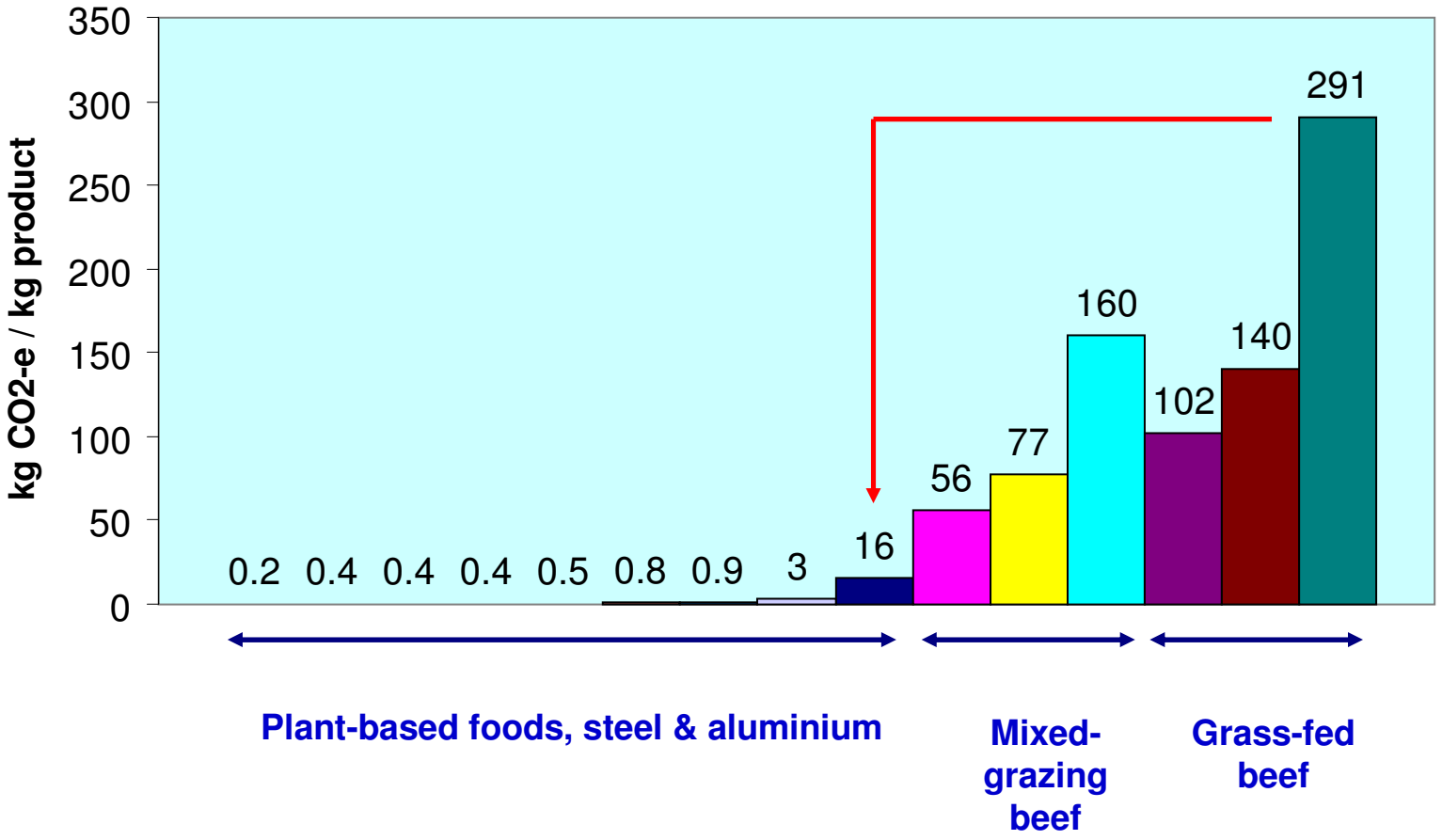




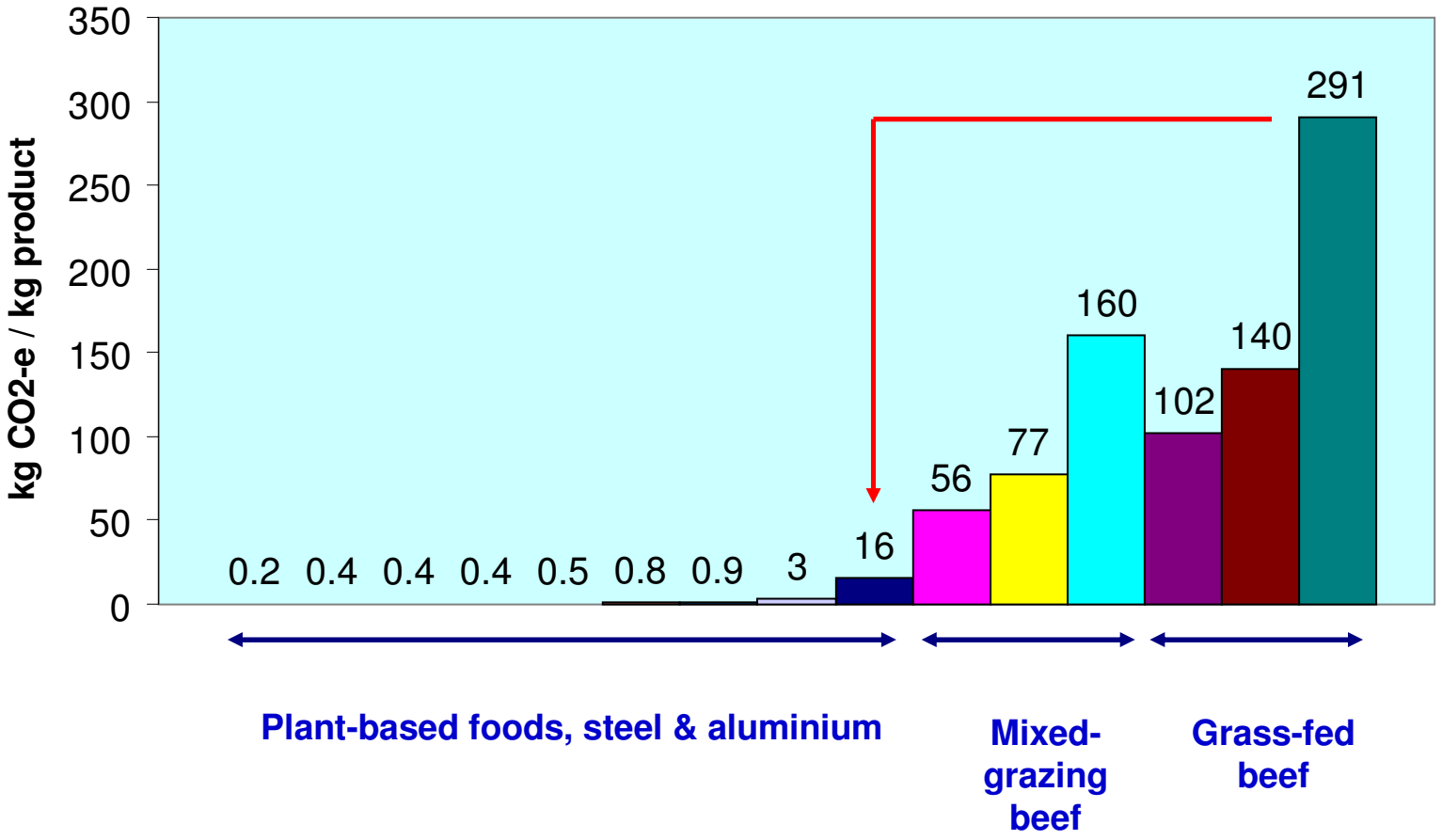




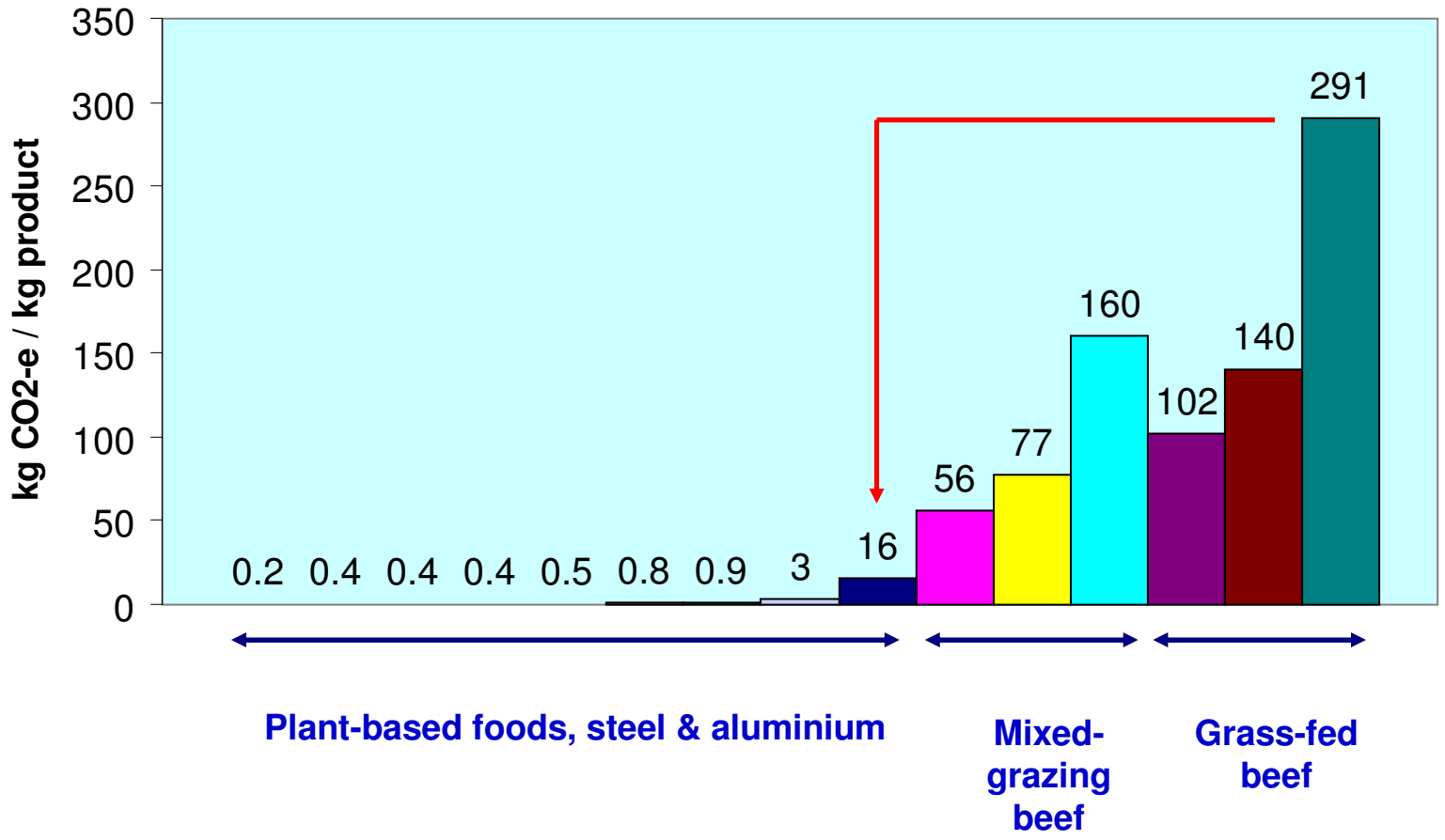
On that basis, the global average emissions intensity of beef from grass-fed cows is more than 18 times that of Australian aluminium smelting.



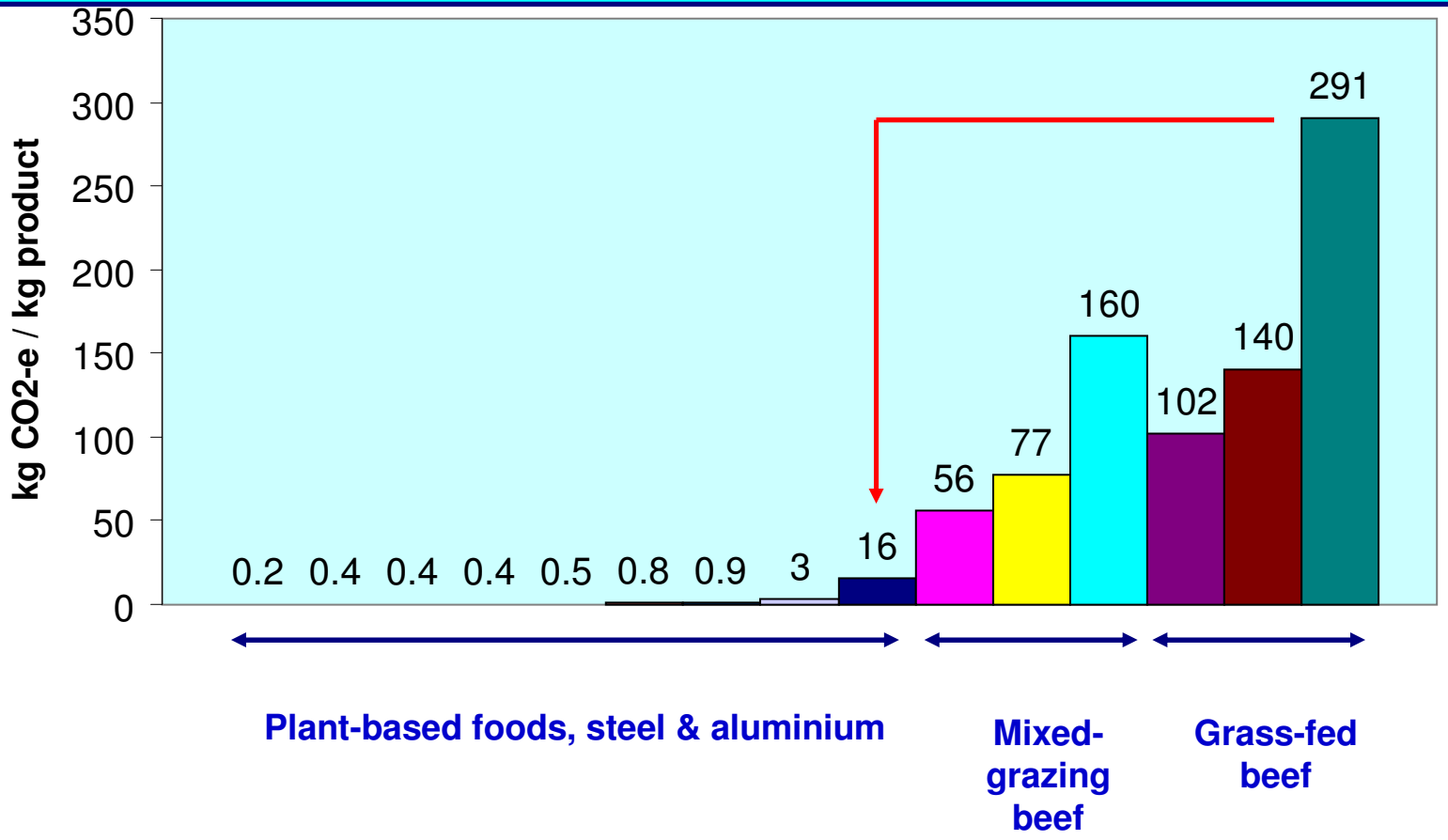
As mentioned, Australian aluminium smelting has been 2.5 times as emissions intensive as the global average.



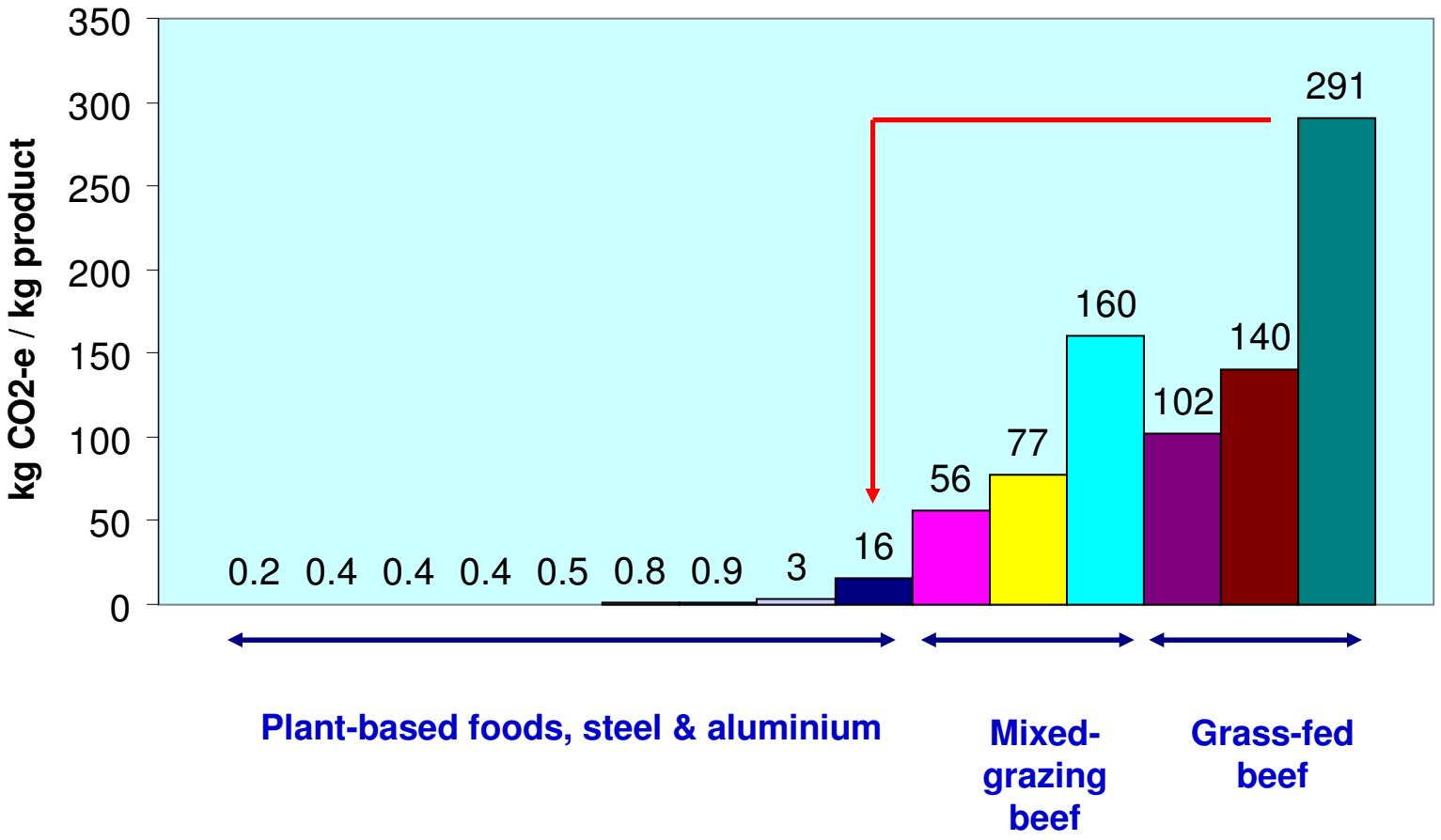
The "20-year GWP" figures are based on the global average percentage split of the various factors contributing to beef's emissions intensity.



As methane's percentage contribution would be lower in mixed systems than in grazing systems, they may be over-stated for the former (160 kg) and under-stated for the latter (291 kg). They are intended to be approximations only.



The figures also vary by region.
As stated, those shown here are the global average.



Here's how meat from small ruminants (primarily sheep & goats) compares

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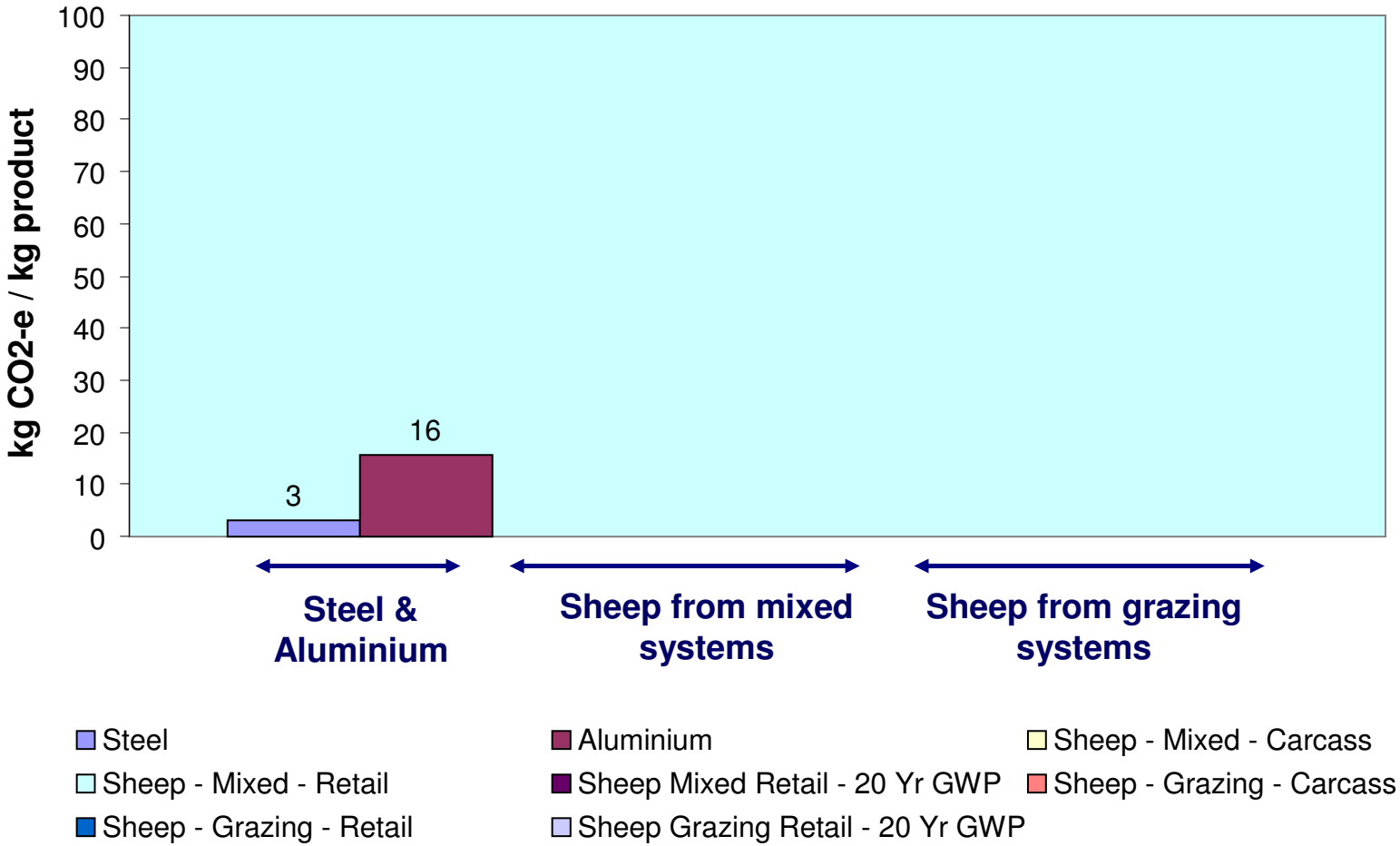

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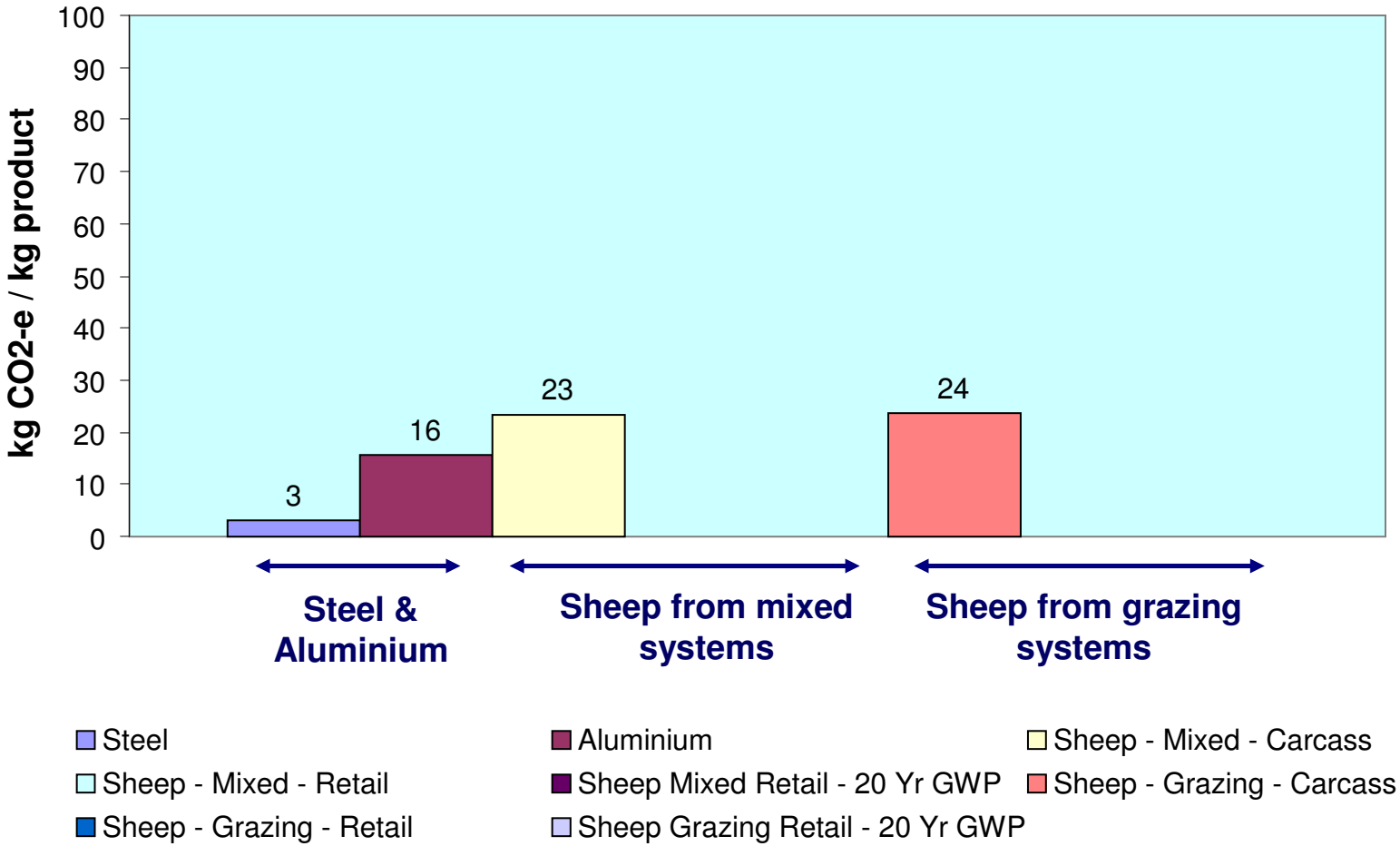

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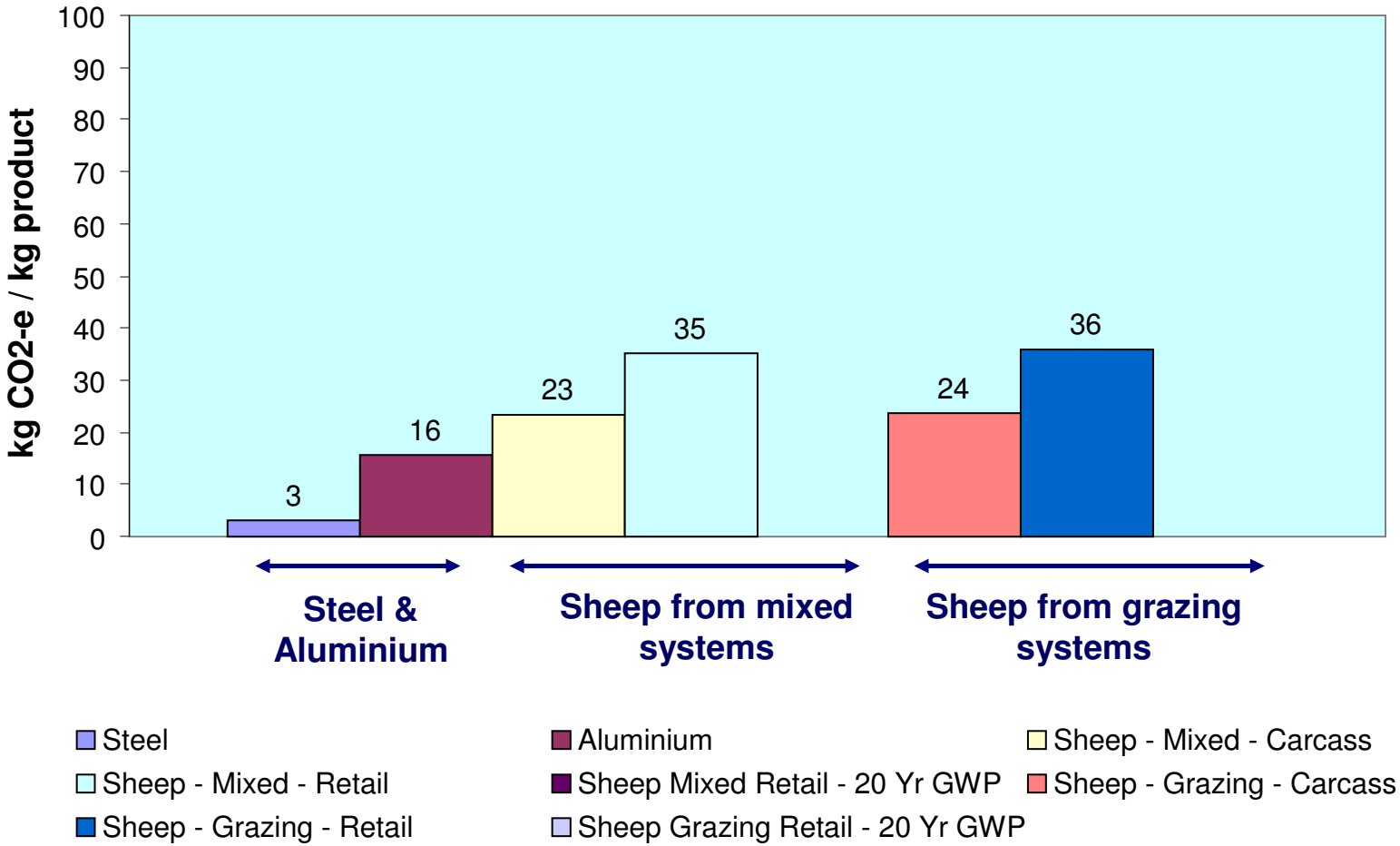

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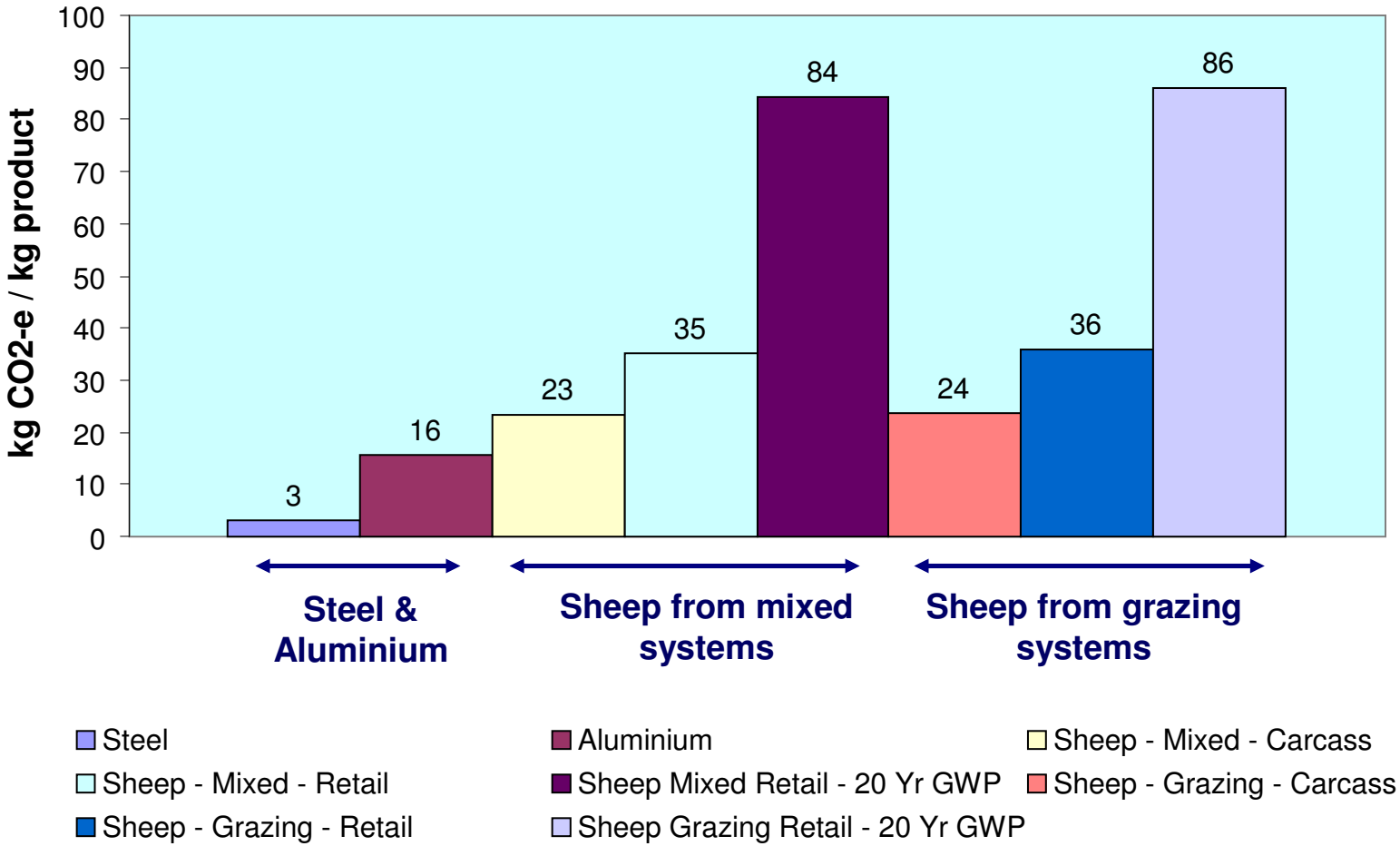
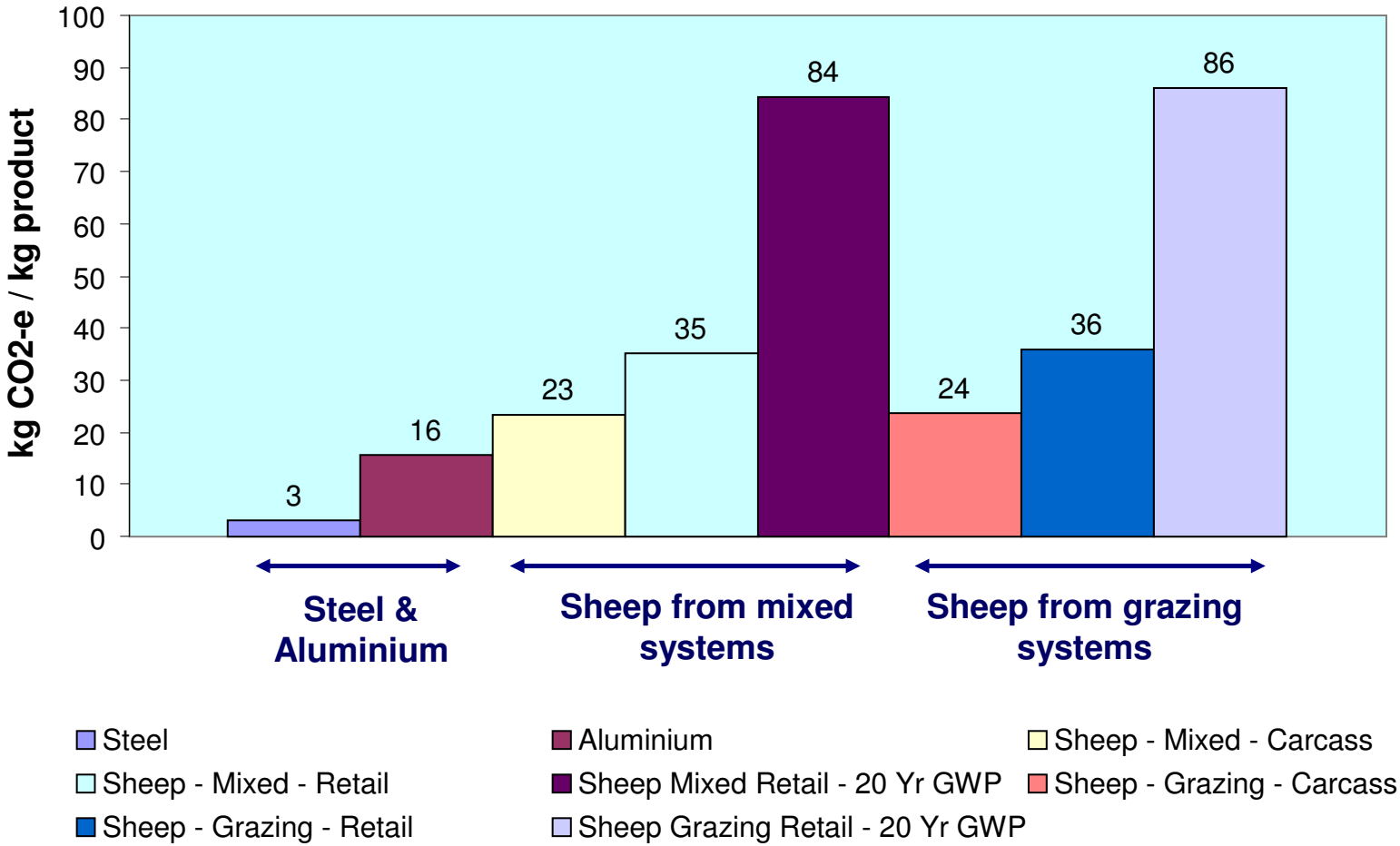


Some of the emissions from small ruminants are attributed to milk and fibre, reducing the meat figure



SOME FURTHER COMPARISONS

Let's see how the global emissions intensity of chicken and pig meat compares, based on retail weight and a 20-year GWP.

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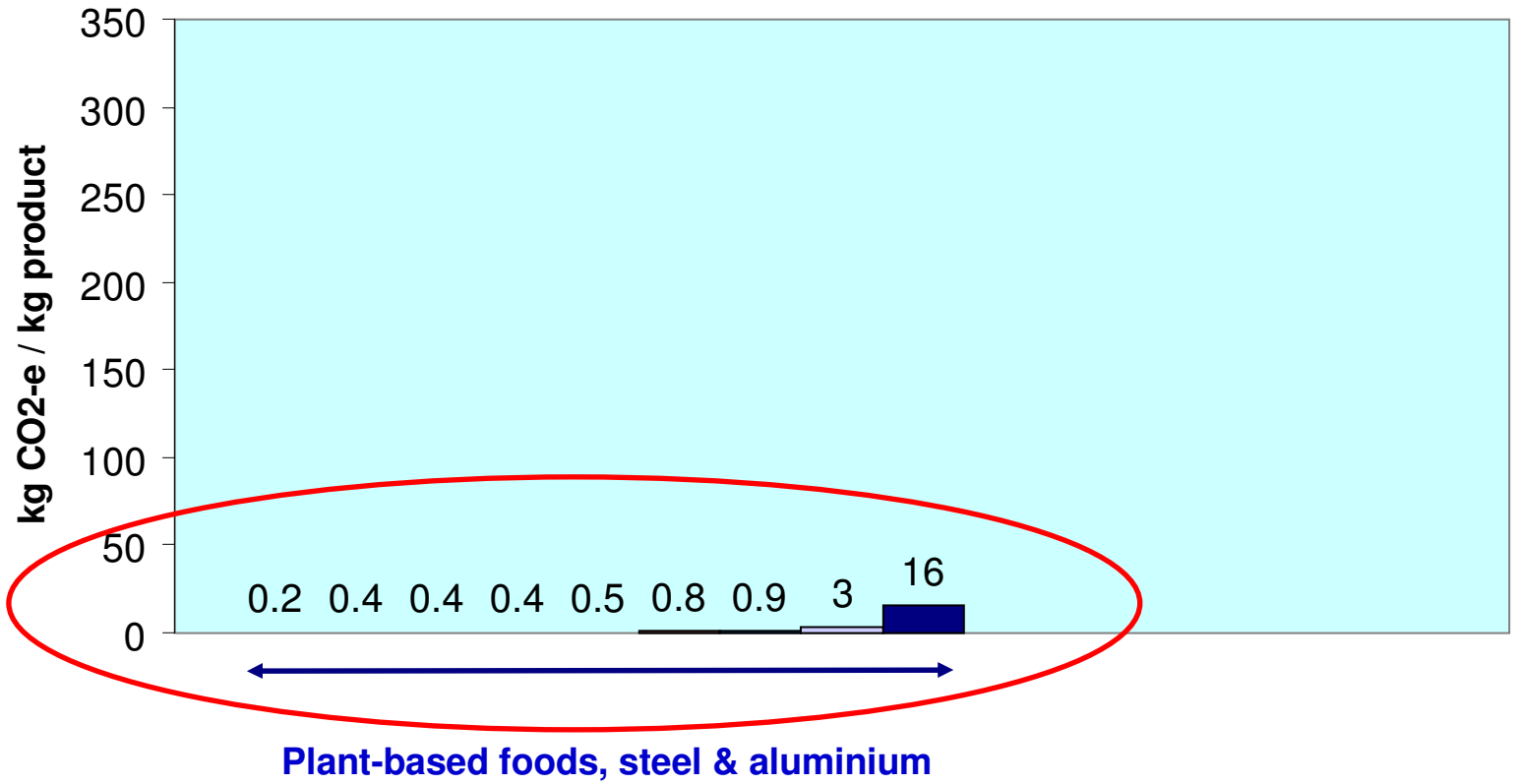
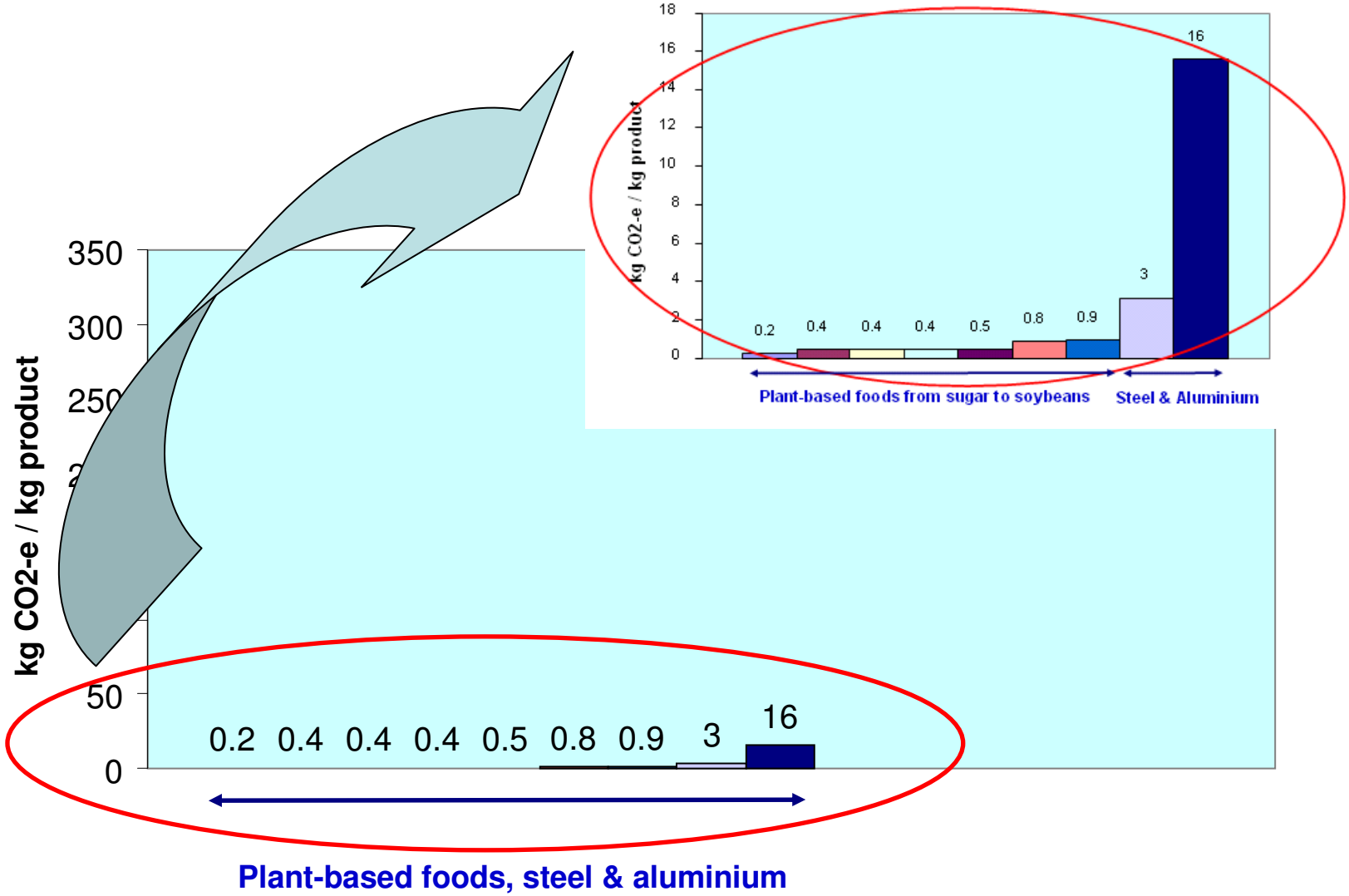
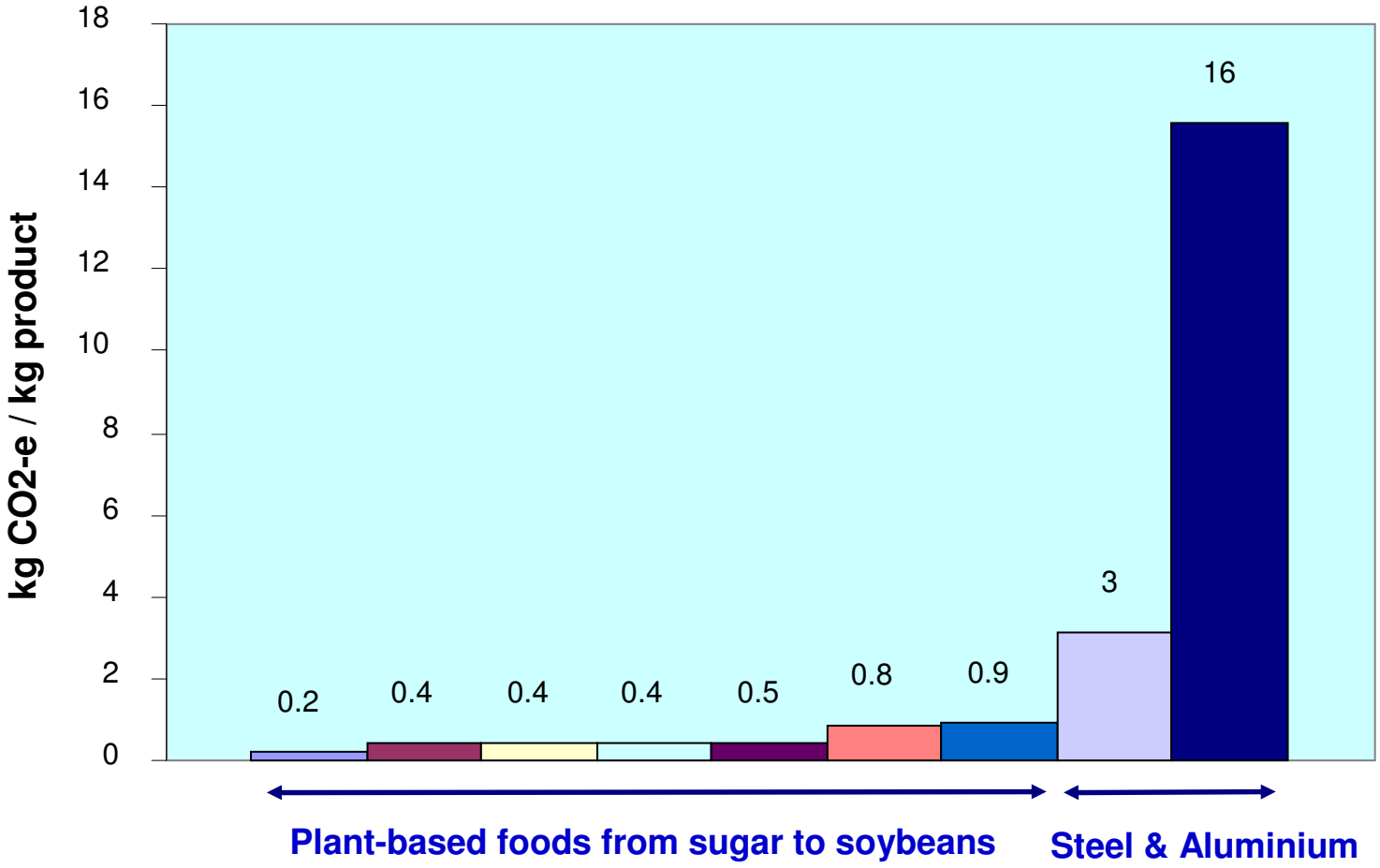
Firstly, we'll revert to the original scale on the chart.

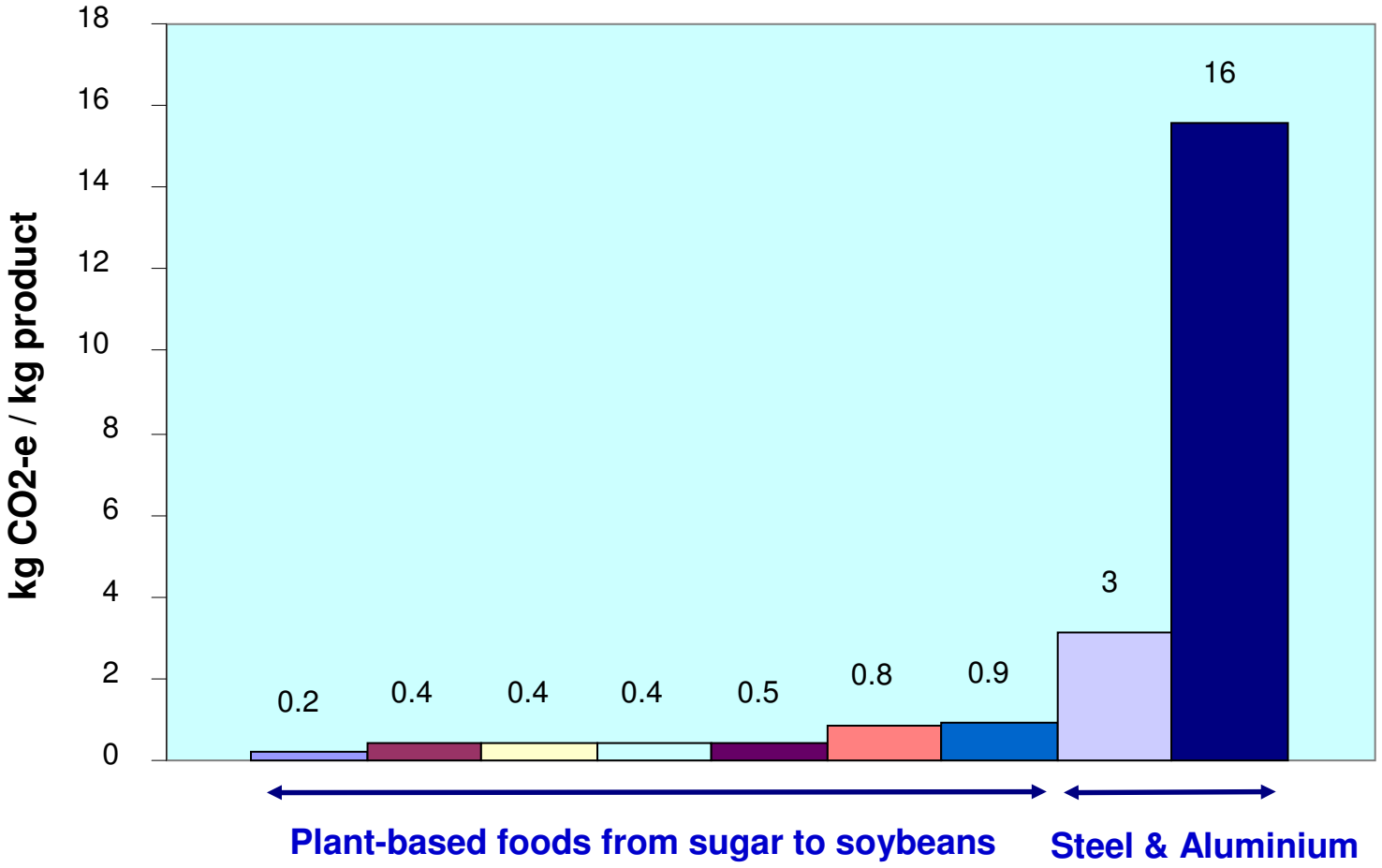


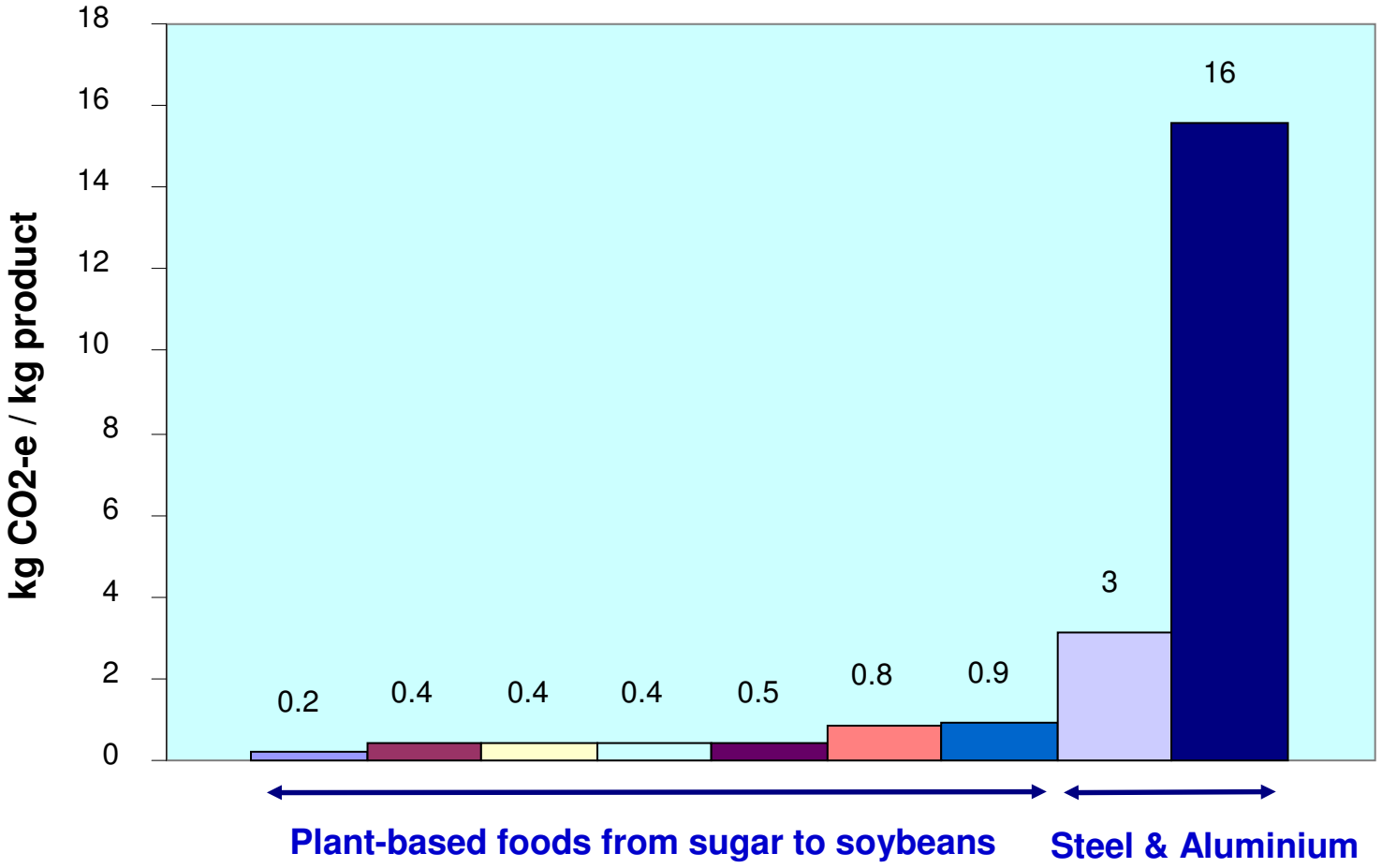


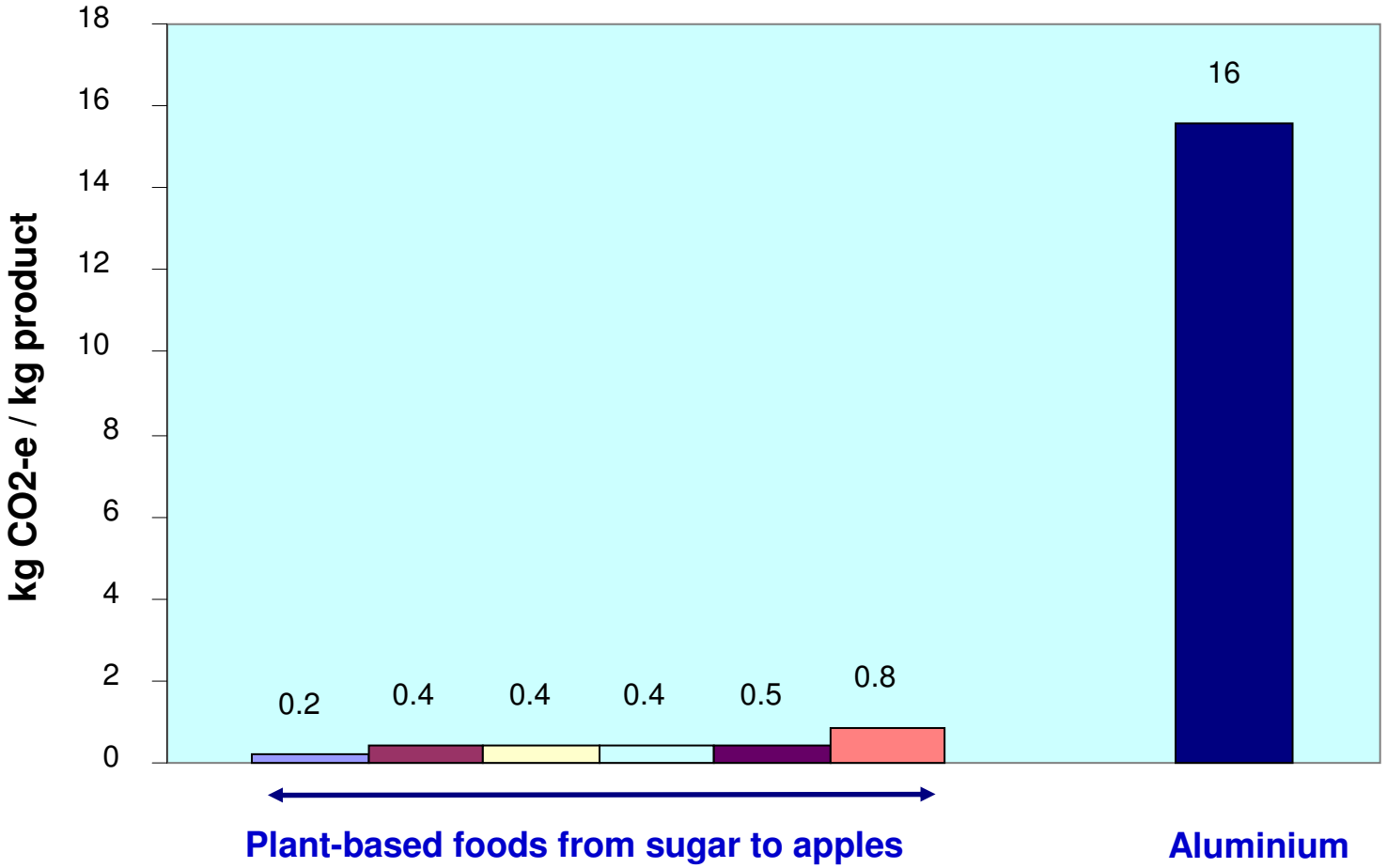
Emissions Intensity



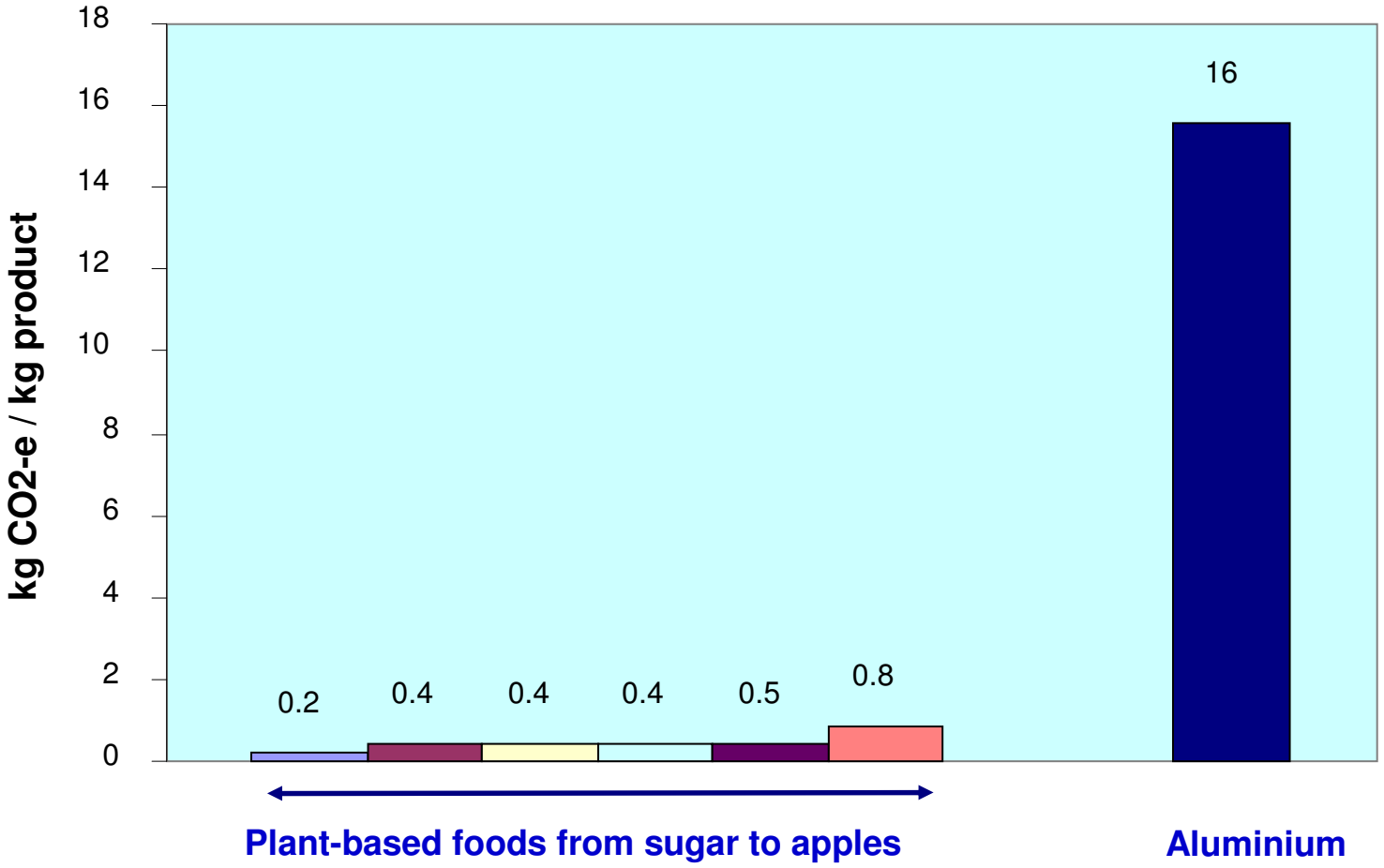
To make some room, we'll remove soy beans and steel

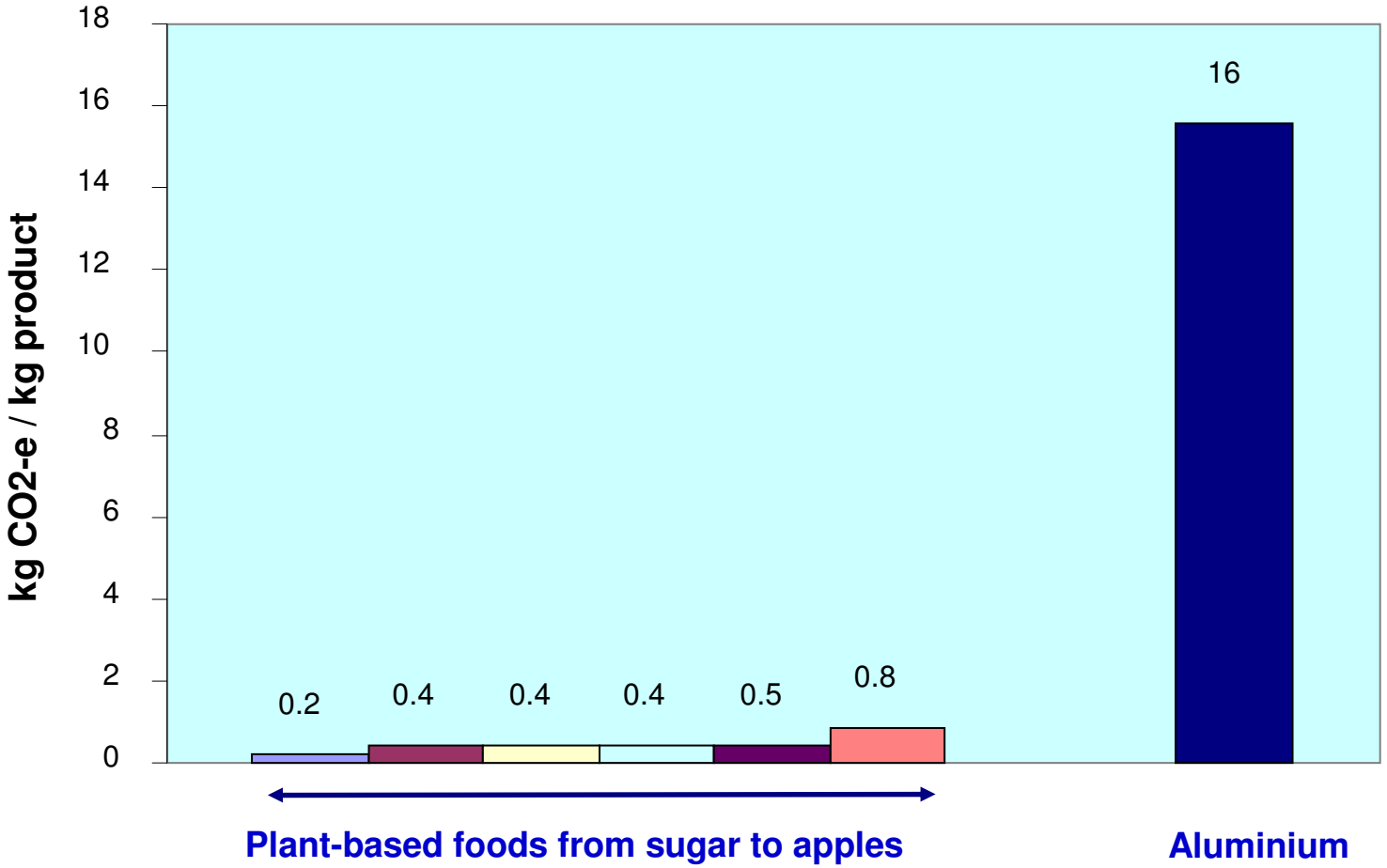


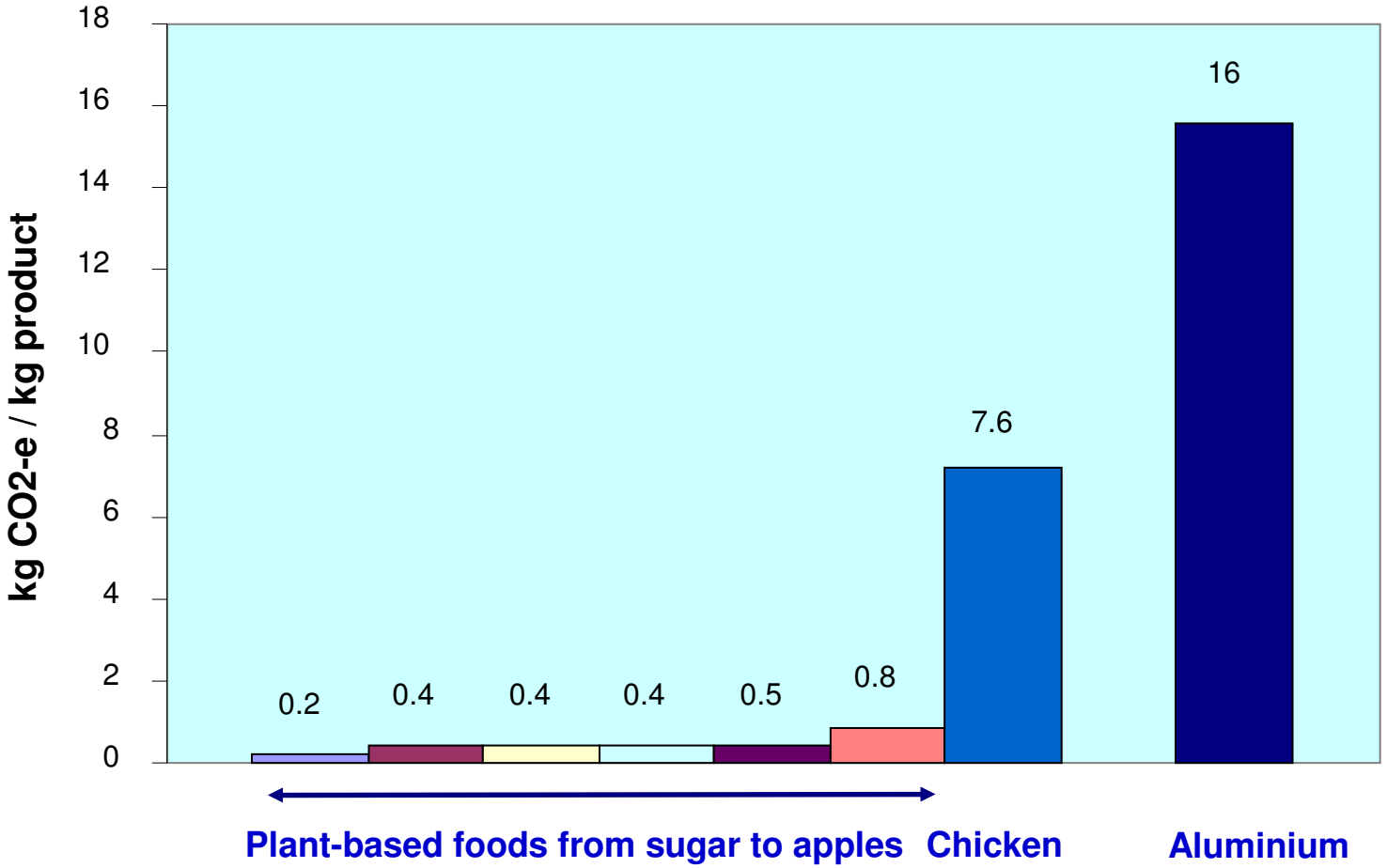


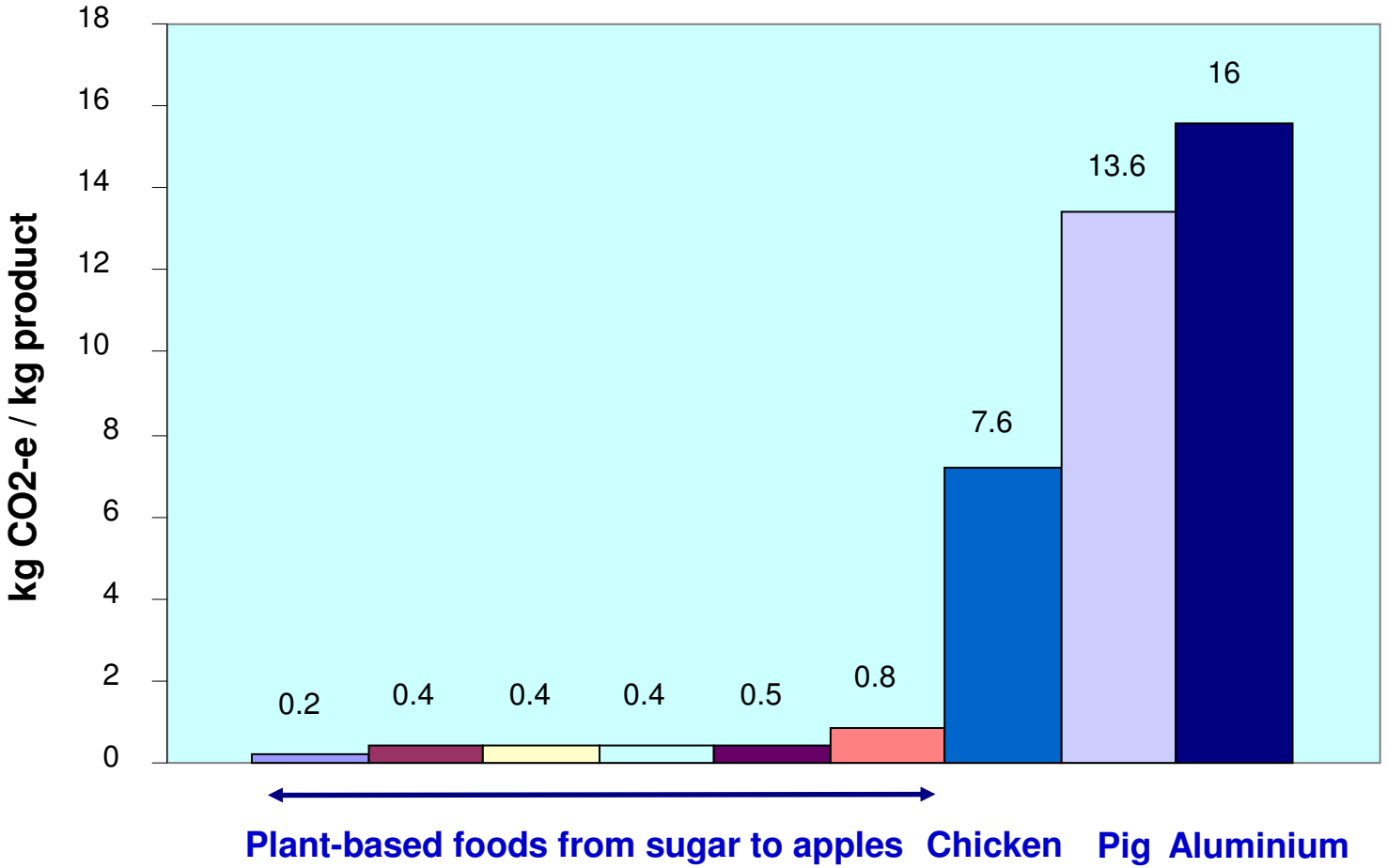


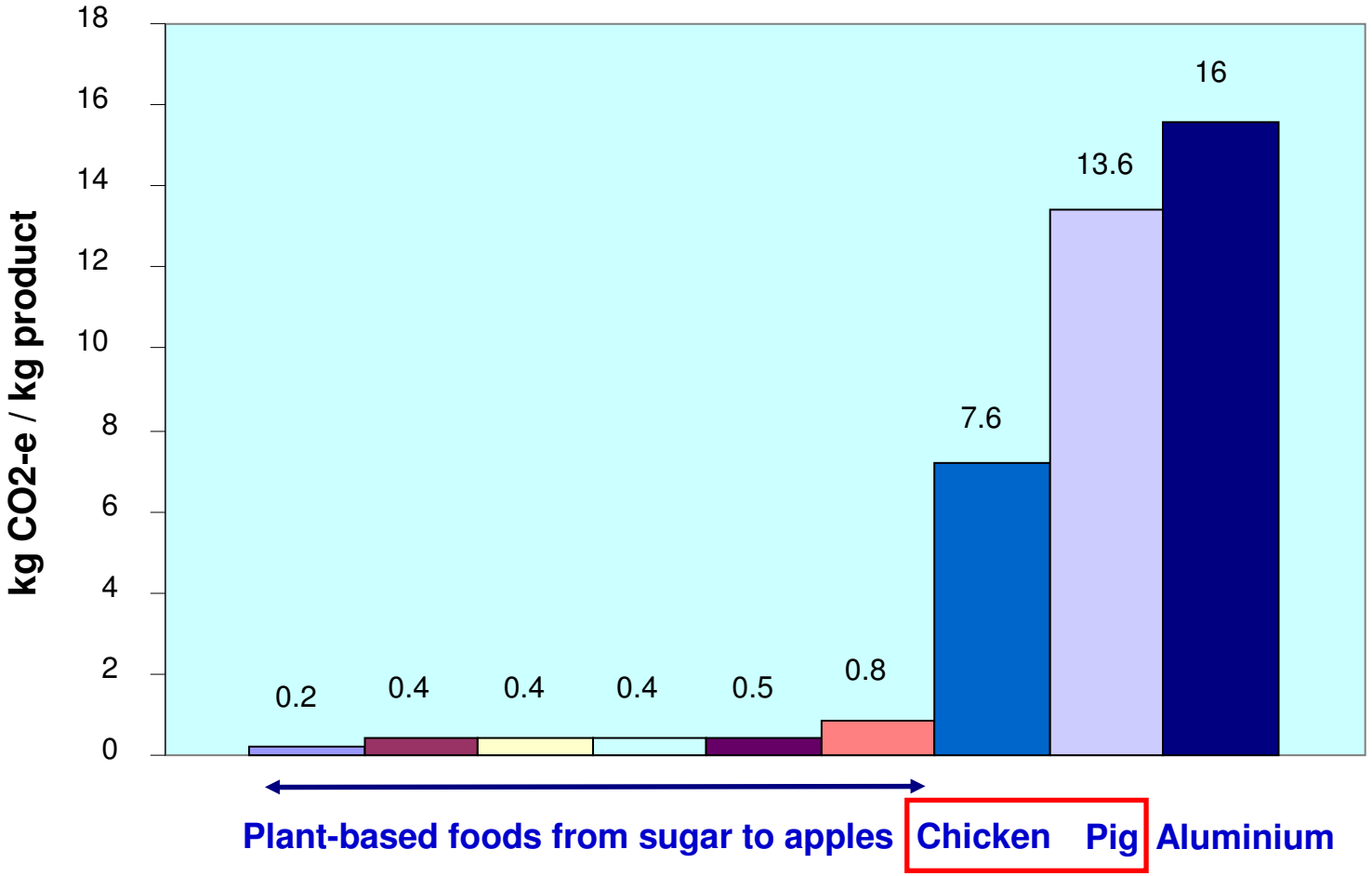
Now we'll add pig and chicken meat.



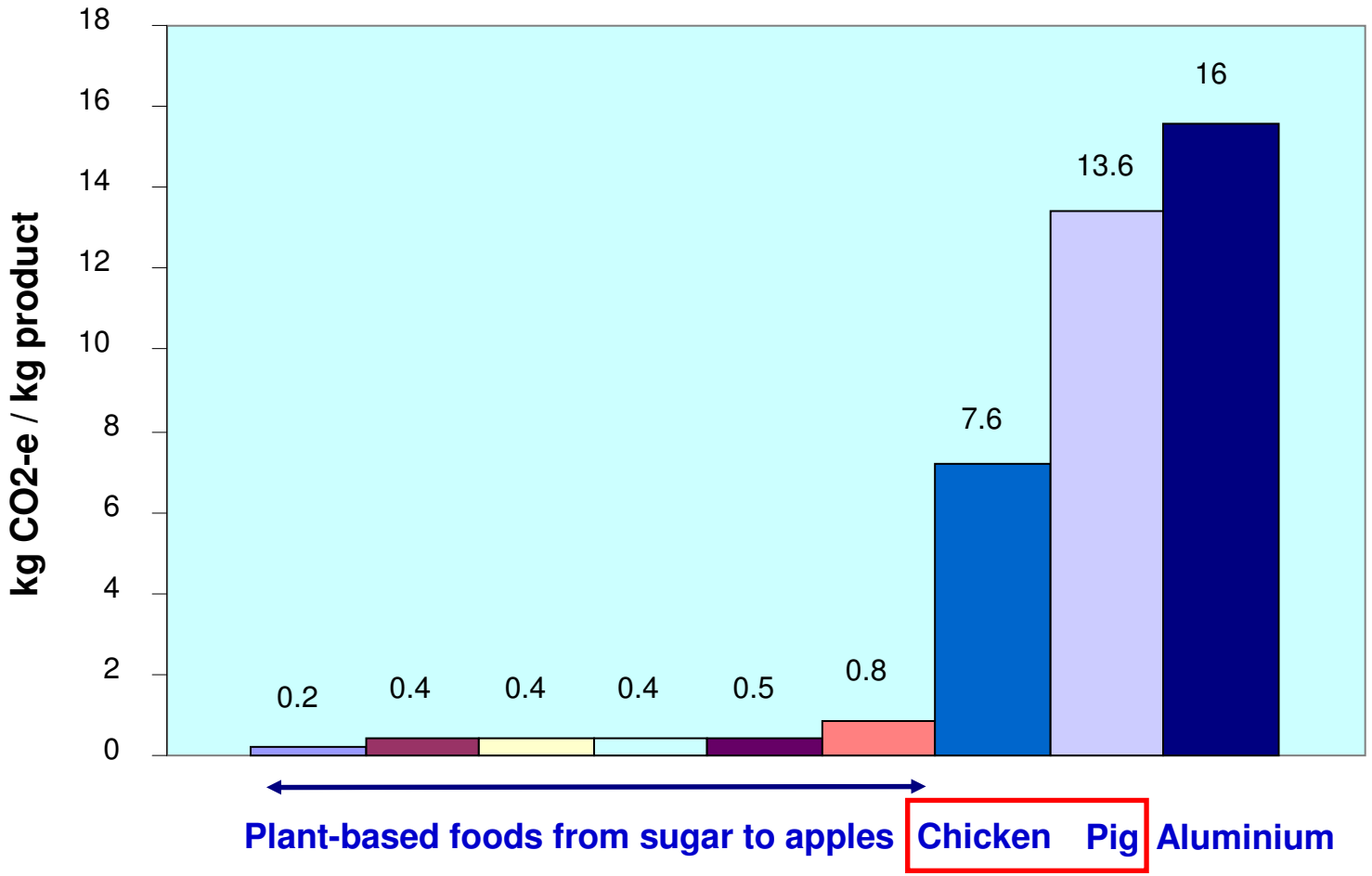








The emissions intensity of chicken and pig meat is very poor relative to plant-based alternatives.



The emissions intensity of Australian beef production is lower than the global average due primarily to higher productivity (more meat per cow), relatively high feed digestibility and a reduction in livestock-related land clearing since the end of 2006.

The land clearing may increase following the recent overturning by the current Queensland government of a ban imposed by the previous government on broad scale land clearing.

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The UNFAO has not produced emissions intensity figures for specialised beef in Australia.

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For our next comparison, we'll consider figures produced by Australia's Department of the Environment.

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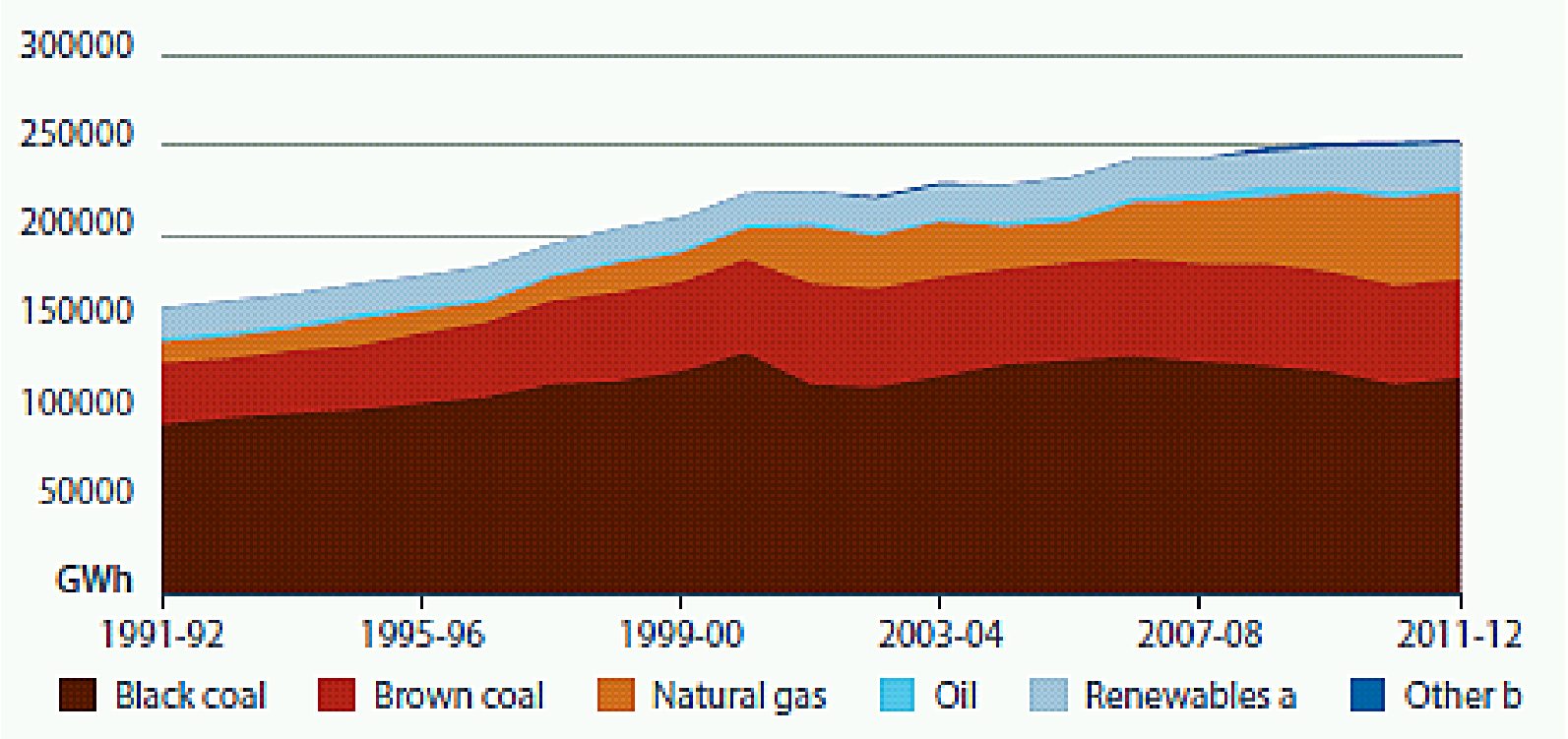
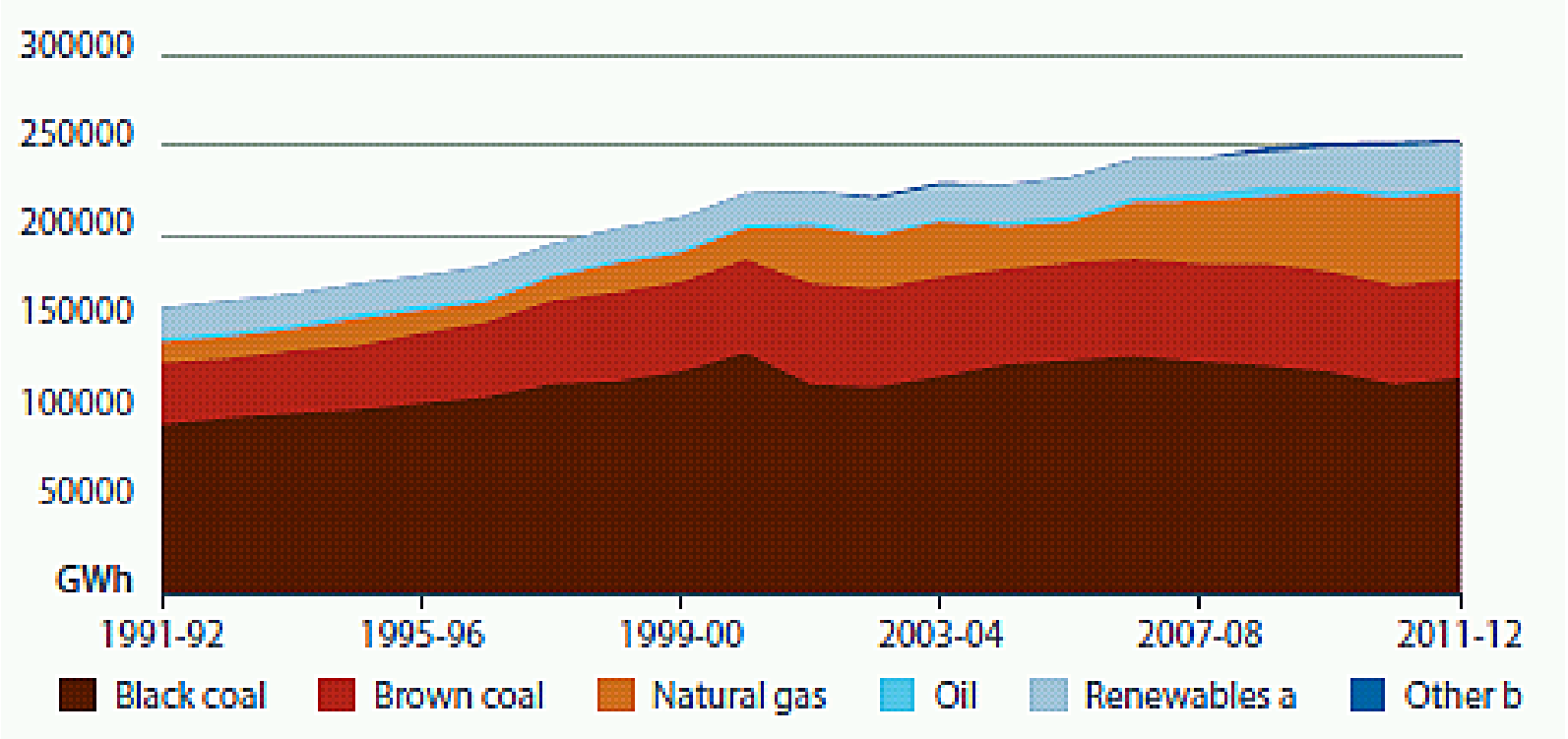
Let's see how the aggregate emissions of cows and other livestock animals compare to those of Australian electricity generation, taking into account only methane emissions in respect of the animals.

Background: Around 90 per cent of Australia's electricity is generated from traditional fossil fuels, with 69 per cent from coal and 19 per cent from natural gas.



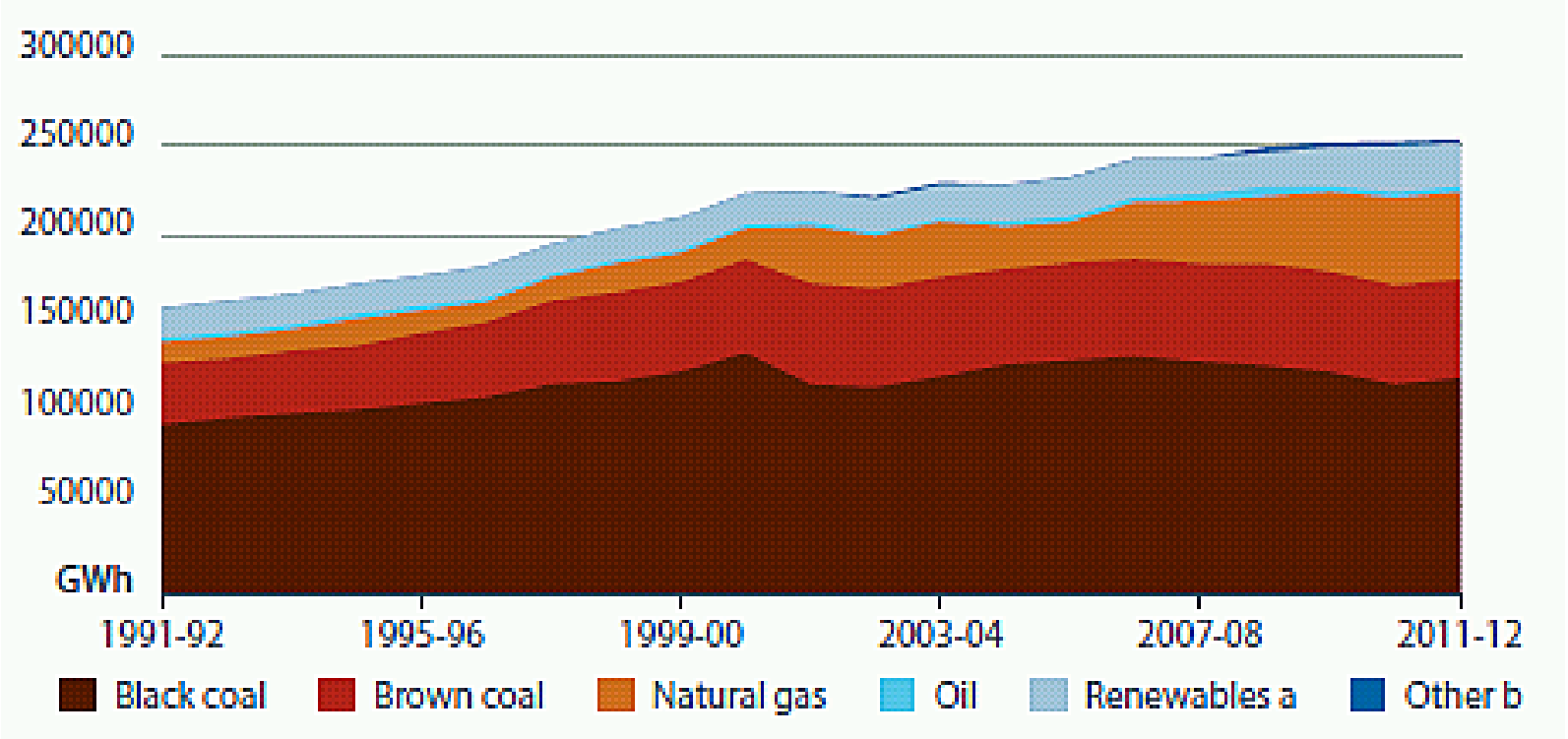
a includes wind, hydro, solar PV and bioenergy; b includes multi-fuel power plants

In terms of gross domestic product, Australia's economy was ranked number 12 of 214 nations by The World Bank as at 8th May, 2014.



a includes wind, hydro, solar PV and bioenergy; b includes multi-fuel power plants

Australia's per capita emissions are amongst the highest in the world.



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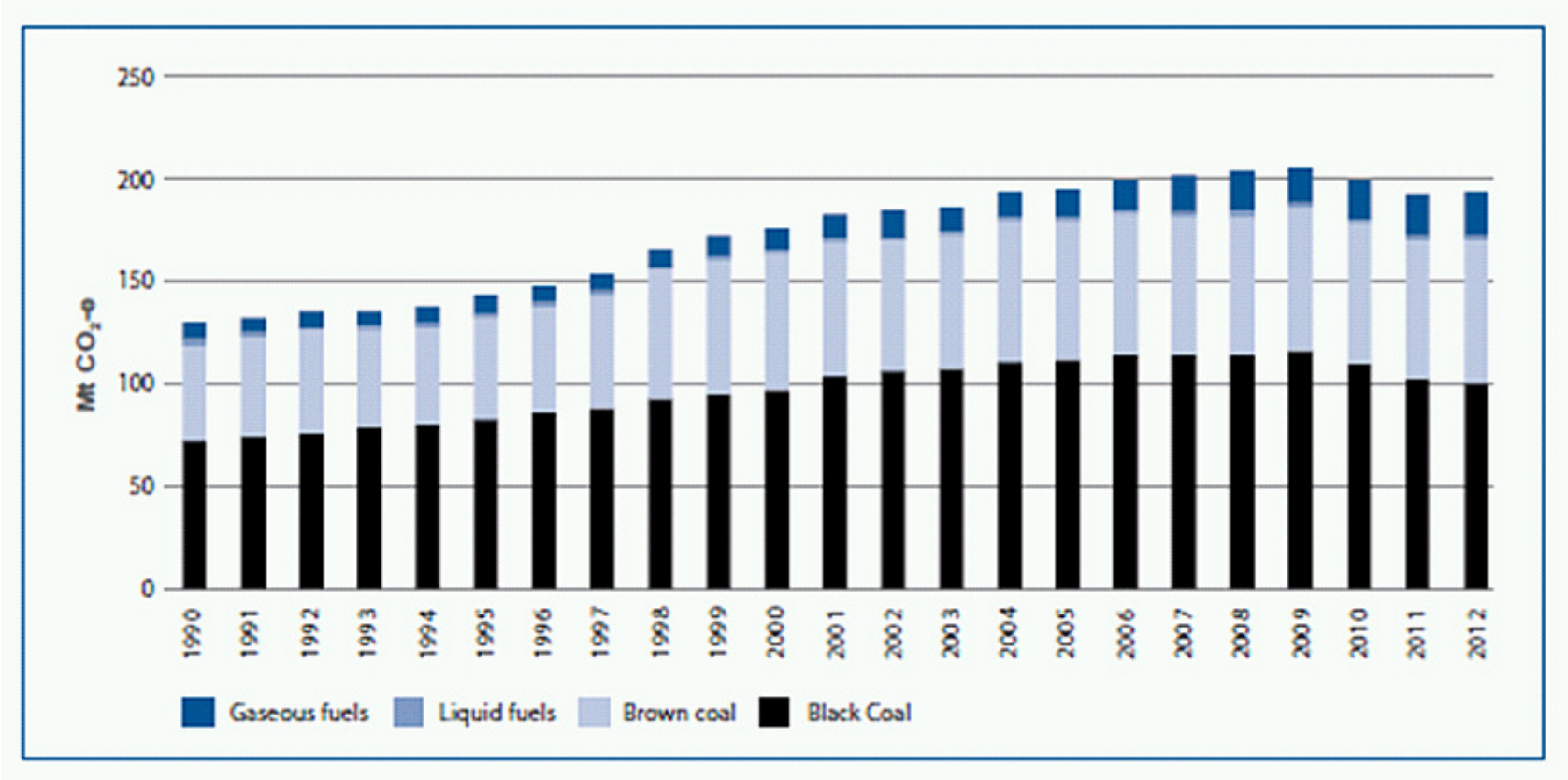
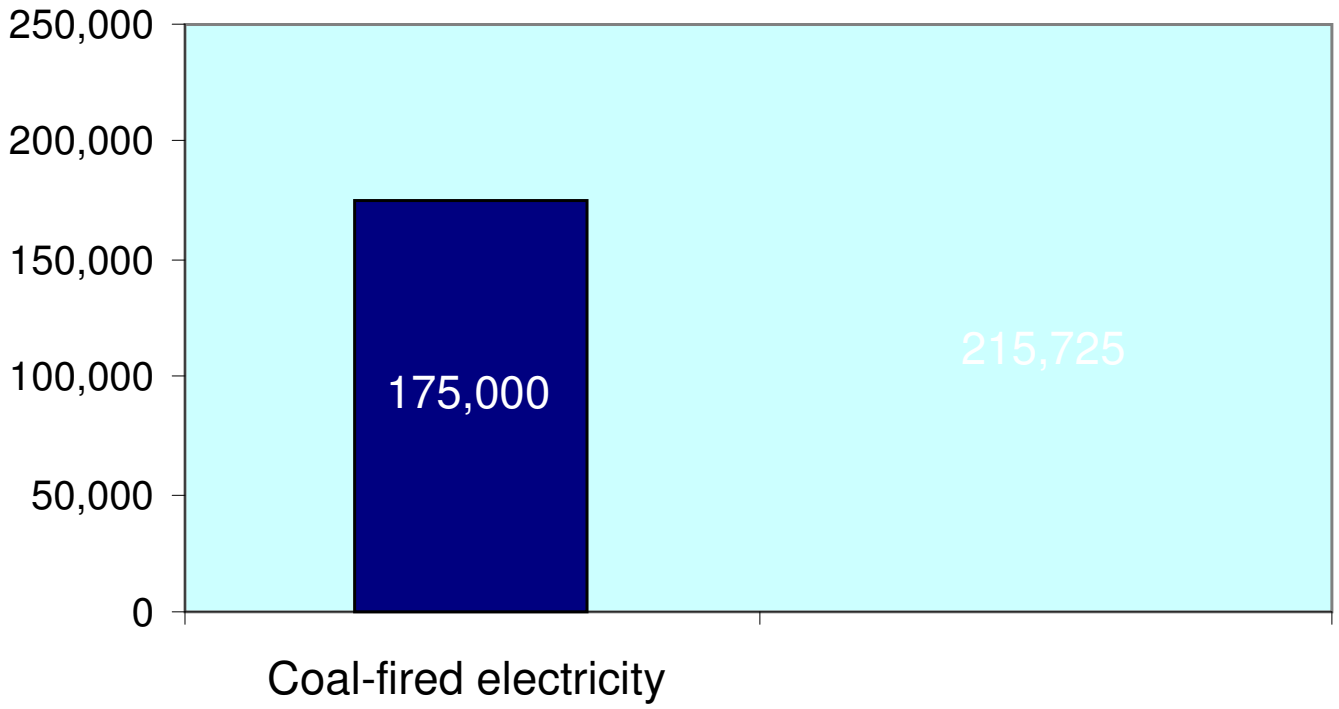
Around 90 percent of Australia's emissions from fossil fuel electricity generation come from black and brown coal.

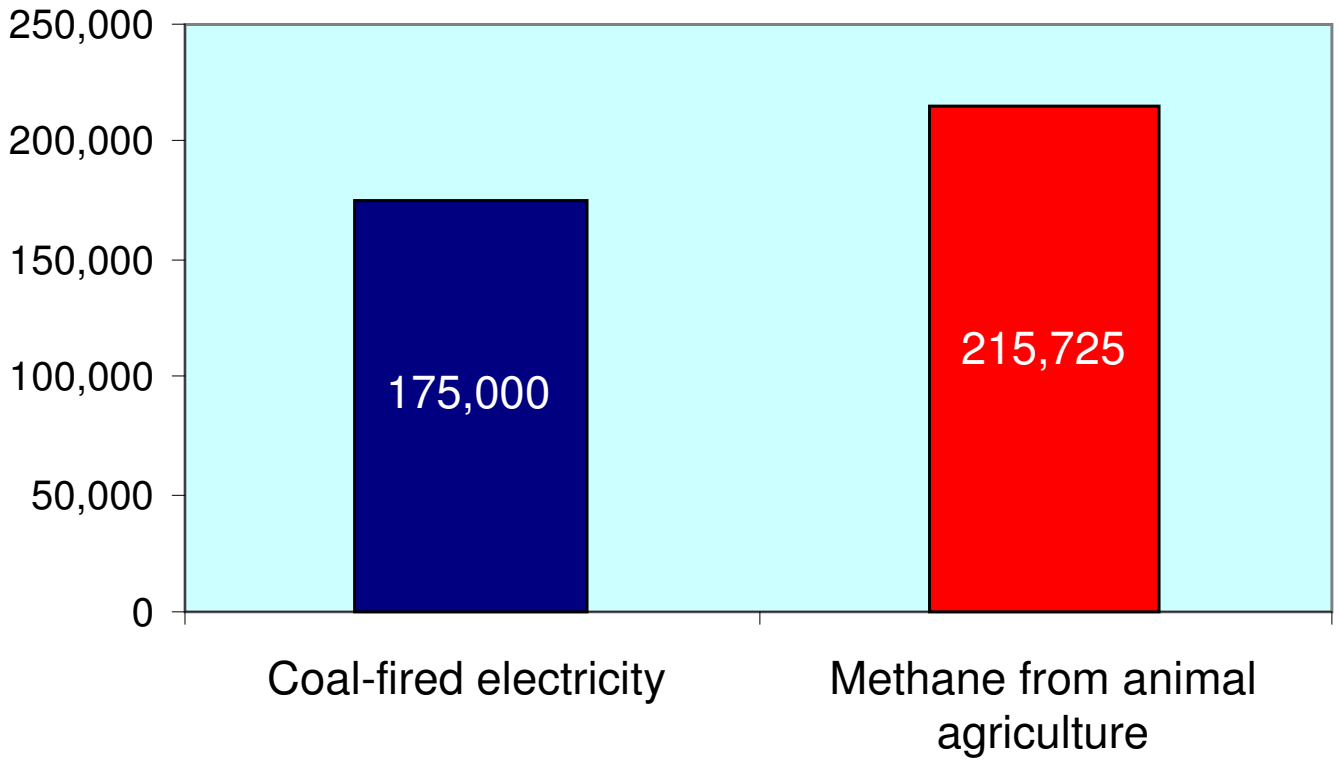


Electricity emissions: Australian Government, Dept of the Environment, "National Inventory Report 2012 Volume 1", Fig. 3.2 CO2-e emissions from electricity generation by fossil fuels, 1990-92, p. 50.

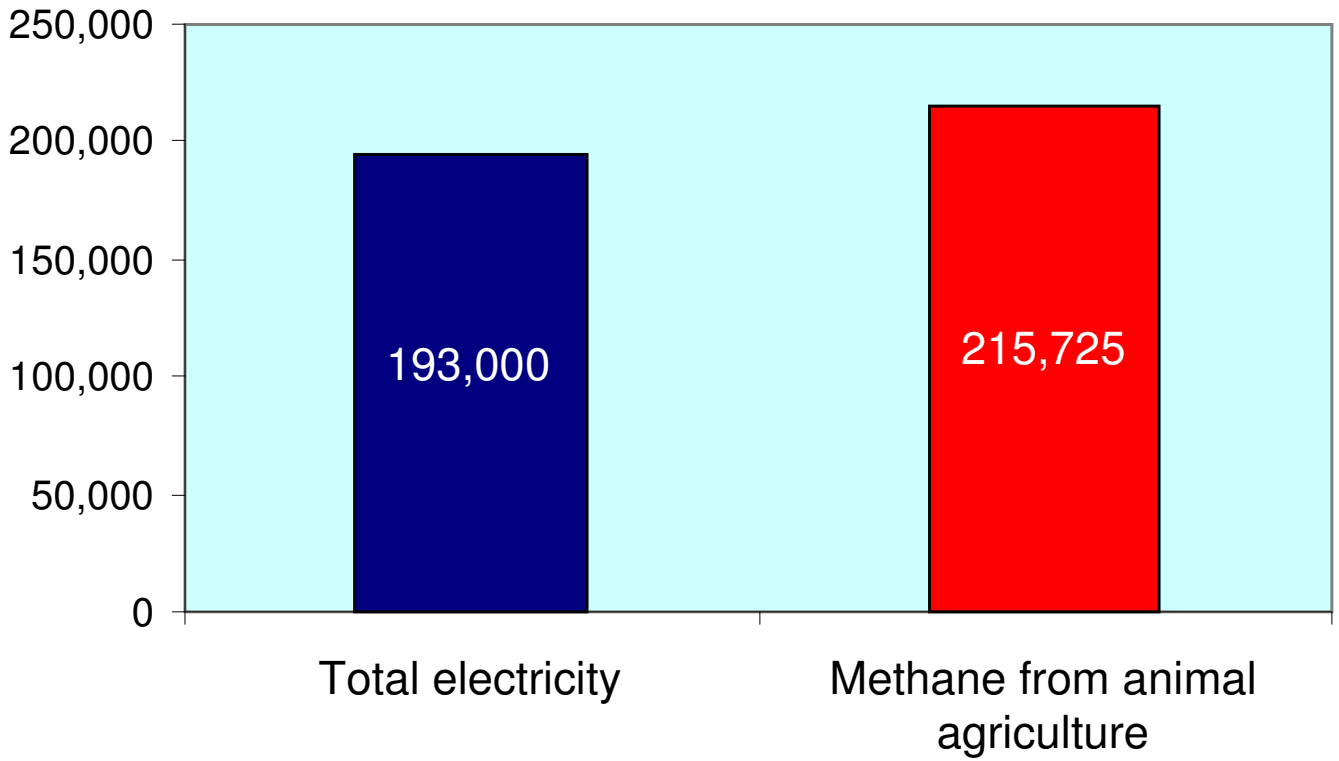
CO2-e emissions (Gg) 2012: Coal-fired electricity



CO2-e emissions (Gg) 2012: Coal-fired electricity and methane from animal agriculture based on 20-year GWP



CO2-e emissions (Gg) 2012: All electricity generation and methane from animal agriculture based on 20-year GWP



On this basis, if the newly developed electric cows, sheep, chickens, pigs and other livestock animals were to require the amount of electricity that would create their current level of greenhouse gas emissions, then we would not be generating enough for them to operate, even if all other activities using electricity ceased!

The reported methane emissions are from: enteric fermentation (released primarily through belching); manure management; and savanna burning.

There appears to be no allowance in Australia's livestock-related greenhouse gas inventory for the following non-methane factors that are considered by the FAO: manure applied to feed crops (N2O); Fertilizer and crop residues (N2O); feed (CO2); and land use change (pasture expansion) (CO2).

Australia's greenhouse gas inventory does include N_20 emissions from manure management and savanna burning.

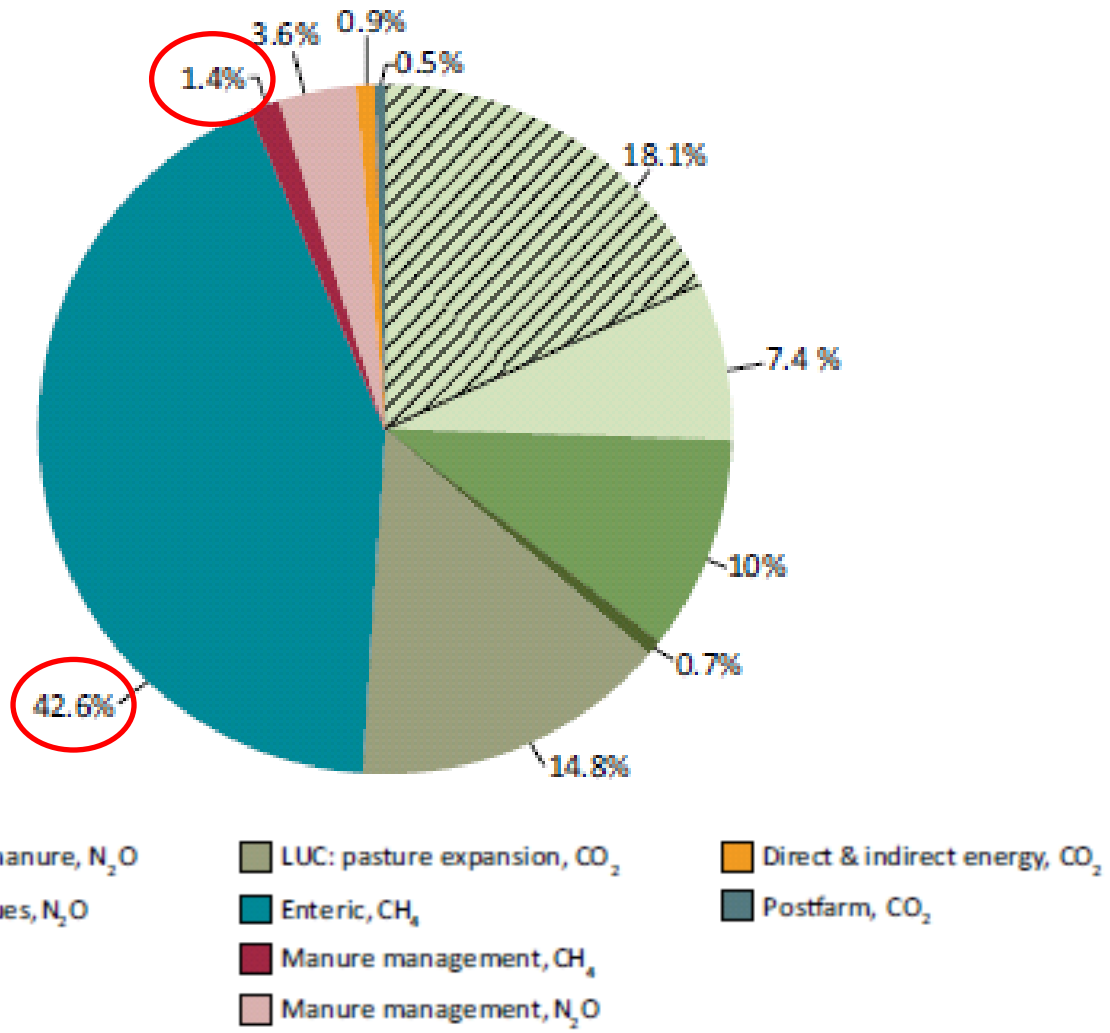
Notes:

- CO2 = carbon dioxide; CH4 = methane; N2O = nitrous oxide
- The UN FAO treats *"manure management"* and *"applied and deposited manure"* as separate categories. It appears the Australian figures included *"deposited manure"* in *"manure management"*.
- We have applied 57% of savanna burning to livestock production, in line with material commissioned by the former Australian Greenhouse Office.

Methane's share of beef's global average emissions is 44%

(Enteric fermentation 42.6% and manure management 1.4%)

Enteric	**42.6%**
Manure (3 categories)	**23.1%**
Feed & fertiliser	**17.4%**
LUC – Pasture	**14.8%**
Energy	**0.9%**
LUC – Soybean	**0.7%**
Postfarm	**0.5%**
Total	**100%**



Buying locally hardly helps

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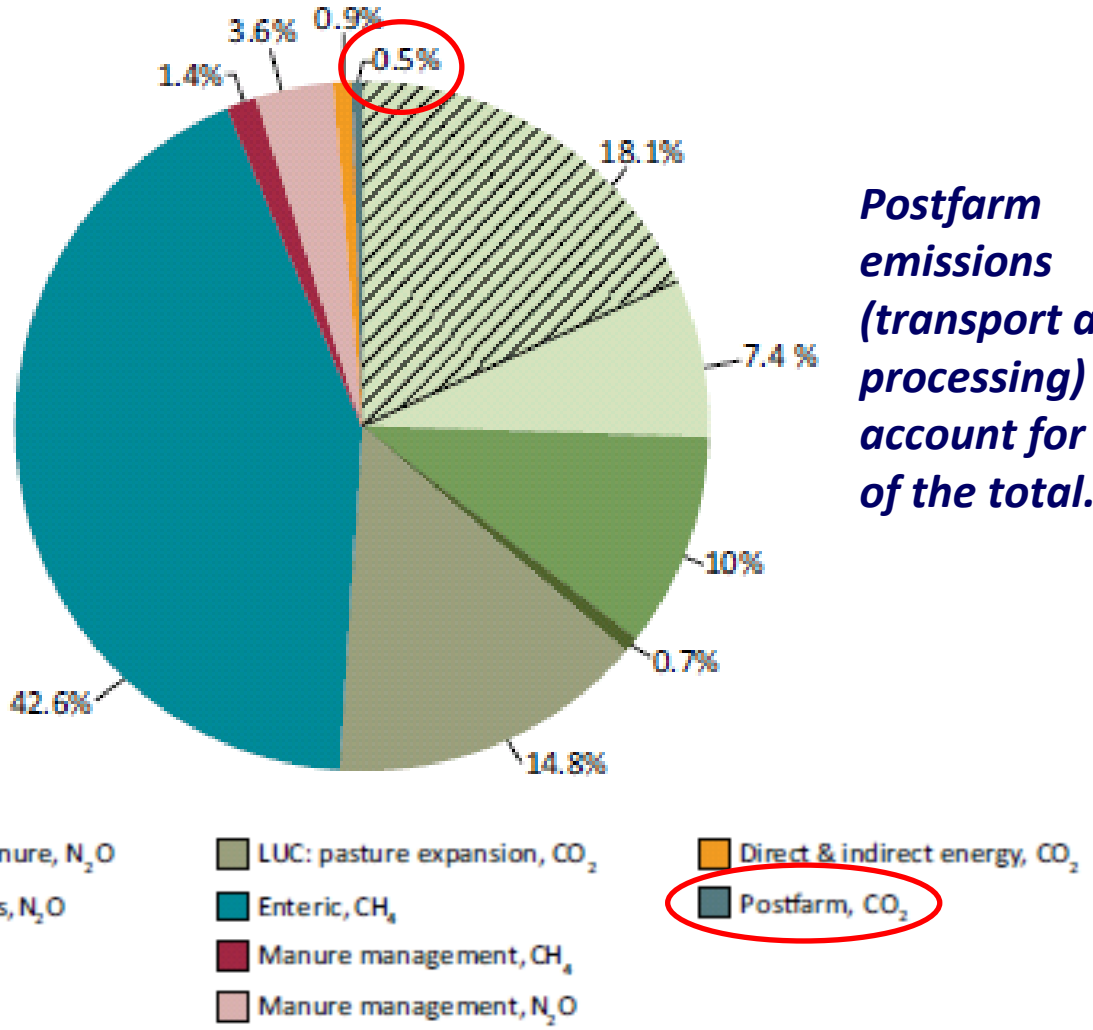
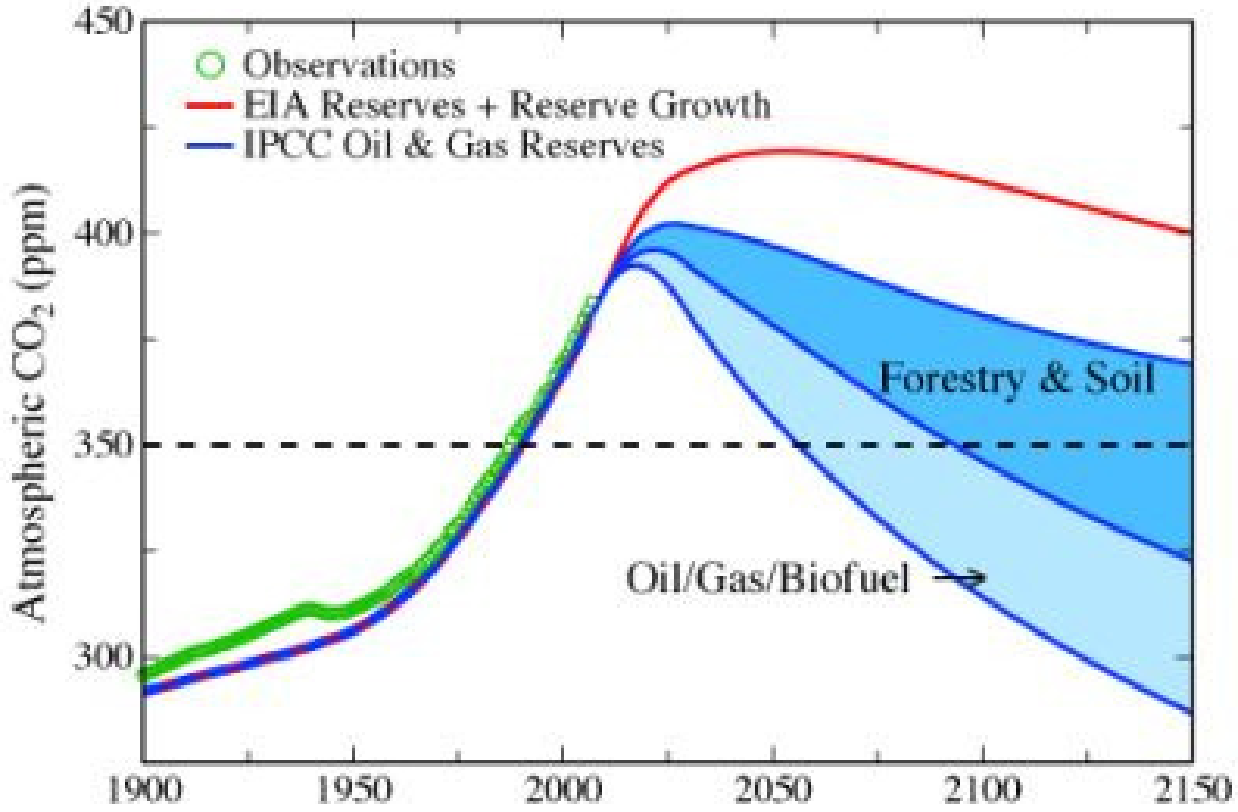


Postfarm emissions (transport and processing) only account for 0.5% of the total.

James Hansen – Essential Measures

CO_2 Emissions and Atmospheric Concentration with Coal Phaseout by 2030



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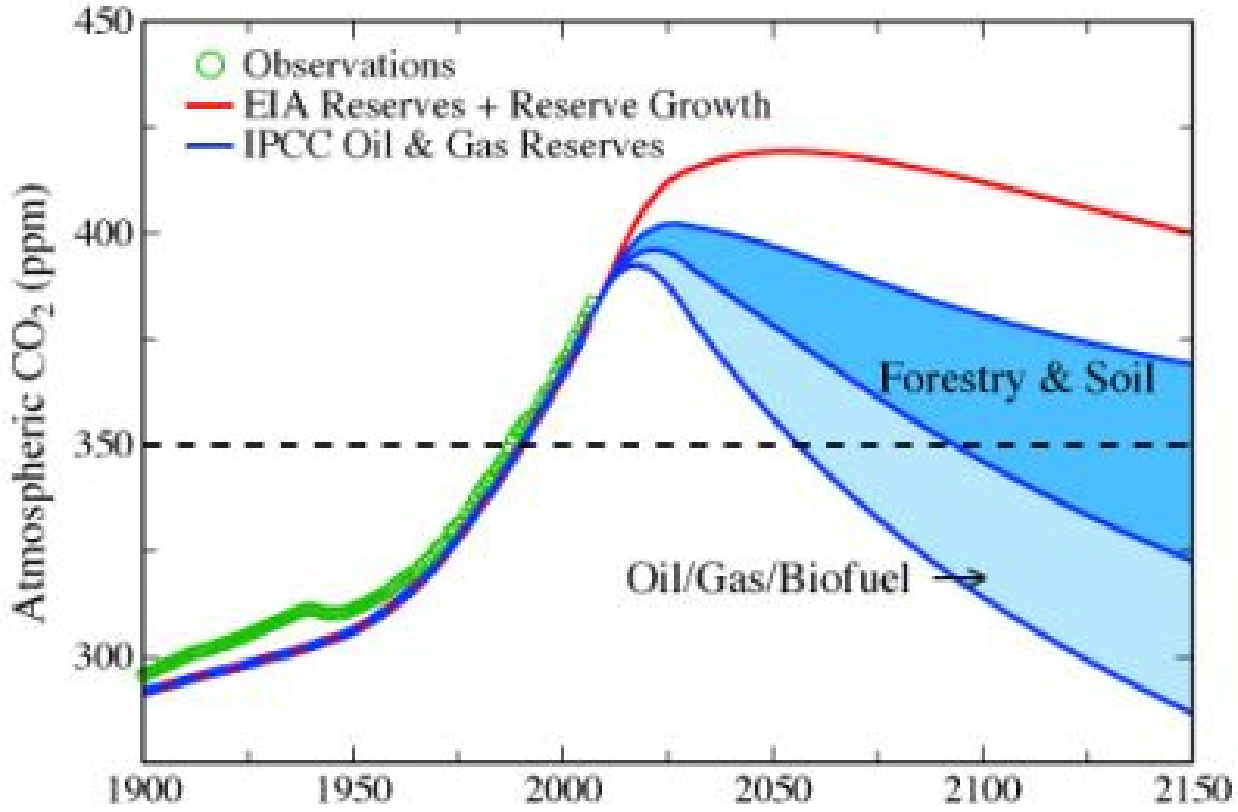

Massive reforestation and action on soil carbon will be critical

Alternative Diets (updated October 2014)

Beef grass fed 200g	Beef mixed 200g	Chicken 200g	Fish 200g	Tofu 100g
Broccoli 50g	Broccoli 50g	Broccoli 50g	Broccoli 50g	Soy Nuts 50g
Carrot 50g	Carrot 50g	Carrot 50g	Carrot 50g	Kidney Beans 50g
Potato 150g	Potato 150g	Potato 150g	Potato 150g	Broccoli 50g
Almonds 50g	Almonds 50g	Almonds 50g	Almonds 50g	Carrot 50g
Banana 150g	Banana 150g	Banana 150g	Banana 150g	Potato 150g
Orange 150g	Orange 150g	Orange 150g	Orange 150g	Almonds 50g
Oats 80g	Oats 80g	Oats 80g	Oats 80g	Banana 150g
Quinoa 100g	Quinoa 100g	Quinoa 100g	Quinoa 100g	Orange 150g
Spinach 100g	Spinach 100g	Spinach 100g	Spinach 100g	Oats 80g
Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Quinoa 100g
Avocado 50g	Avocado 50g	Avocado 50g	Avocado 50g	Spinach 100g
W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	Dried Apricots 65g
Cow’s milk 400g	Cow’s milk 400g	Cow’s milk 400g	Cow’s milk 400g	Avocado 50g
				W'meal Bread 130g
				Soymilk 400g

Plant foods’ emissions for this and subsequent slides are from an Oxford study released in June, 2014. Some are slightly higher than figures used in earlier slides but still significantly below the animal-based figures.

Alternative Diets (updated October 2014)

Beef grass fed 200g	Beef mixed 200g	Chicken 200g	Fish 200g	Tofu 100g Soy Nuts 50g Kidney Beans 50g
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Carrot 50g	Carrot 50g	Carrot 50g	Carrot 50g	Carrot 50g
Potato 150g	Potato 150g	Potato 150g	Potato 150g	Potato 150g
Almonds 50g	Almonds 50g	Almonds 50g	Almonds 50g	Almonds 50g
Banana 150g	Banana 150g	Banana 150g	Banana 150g	Banana 150g
Orange 150g	Orange 150g	Orange 150g	Orange 150g	Orange 150g
Oats 80g	Oats 80g	Oats 80g	Oats 80g	Oats 80g
Quinoa 100g	Quinoa 100g	Quinoa 100g	Quinoa 100g	Quinoa 100g
Spinach 100g	Spinach 100g	Spinach 100g	Spinach 100g	Spinach 100g
Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g
Avocado 50g	Avocado 50g	Avocado 50g	Avocado 50g	Avocado 50g
W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g
Cow's milk 400g	Cow's milk 400g	Cow's milk 400g	Cow's milk 400g	Soymilk 400g

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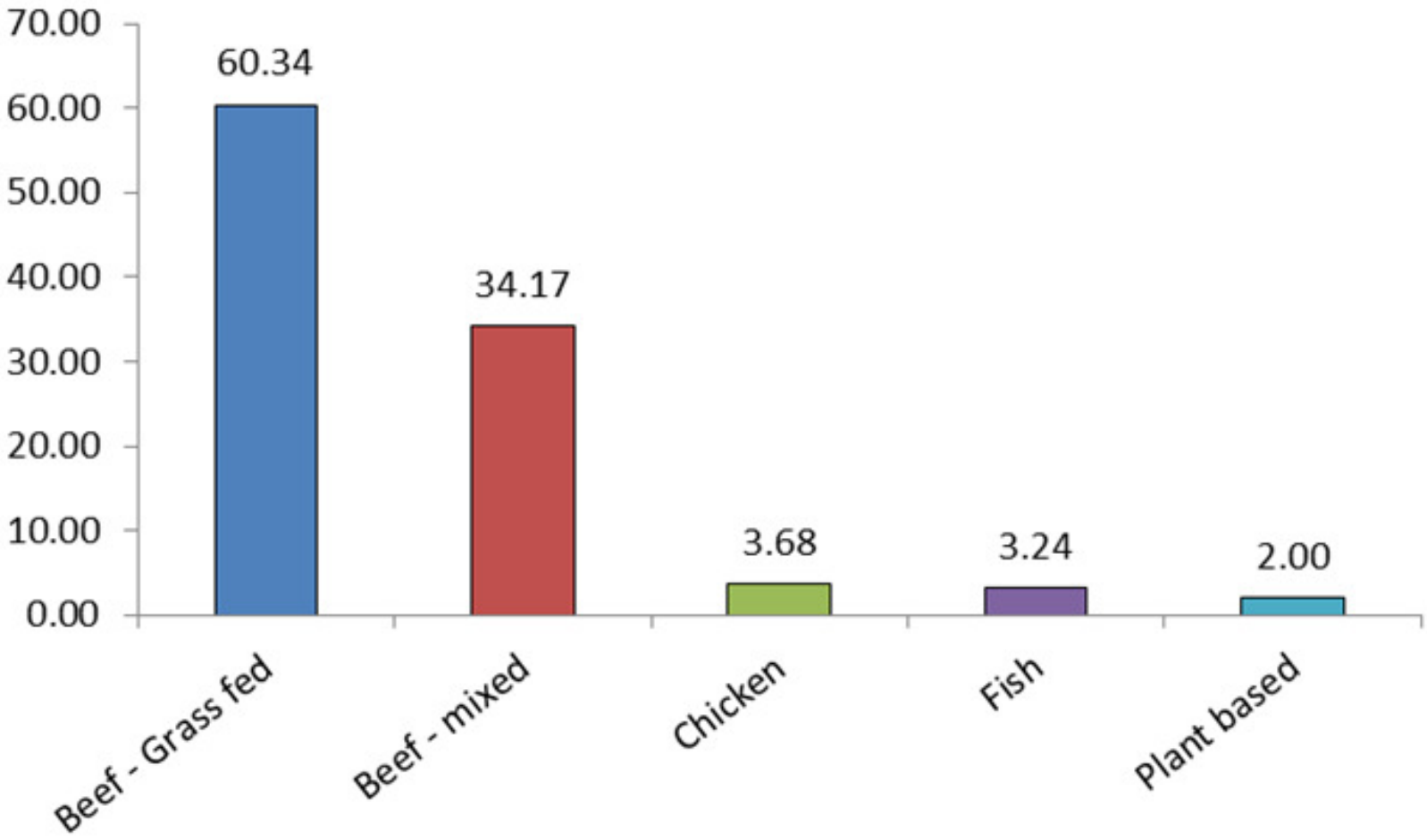
Beef grass fed 200g	Beef mixed 200g	Chicken 200g	Fish 200g	Tofu 100g Soy Nuts 50g Kidney Beans 50g
Broccoli 50g	Broccoli 50g	Broccoli 50g	Broccoli 50g	Broccoli 50g
Carrot 50g	Carrot 50g	Carrot 50g	Carrot 50g	Carrot 50g
Potato 150g	Potato 150g	Potato 150g	Potato 150g	Potato 150g
Almonds 50g	Almonds 50g	Almonds 50g	Almonds 50g	Almonds 50g
Banana 150g	Banana 150g	Banana 150g	Banana 150g	Banana 150g
Orange 150g	Orange 150g	Orange 150g	Orange 150g	Orange 150g
Oats 80g	Oats 80g	Oats 80g	Oats 80g	Oats 80g
Quinoa 100g	Quinoa 100g	Quinoa 100g	Quinoa 100g	Quinoa 100g
Spinach 100g	Spinach 100g	Spinach 100g	Spinach 100g	Spinach 100g
Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g	Dried Apricots 65g
Avocado 50g	Avocado 50g	Avocado 50g	Avocado 50g	Avocado 50g
W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g	W'meal Bread 130g
Cow's milk 400g	Cow's milk 400g	Cow's milk 400g	Cow's milk 400g	Soymilk 400g
Emissions: 60.34 kg	**Emissions:** 34.17 kg	**Emissions:** 3.68 kg	**Emissions:** 3.24 kg	**Emissions:** 2.00 kg

Plant foods' emissions for this and subsequent slides are from an Oxford study released in June, 2014. Some are slightly higher than figures used in earlier slides but still significantly below the animal-based figures.

Alternative Diets (updated October 2014)

Greenhouse gas emissions (kg per day)

Key distinguishing ingredients shown



Plant foods' emissions for this and subsequent slides are from an Oxford study released in June, 2014. Some are slightly higher than figures used in earlier slides but still significantly below the animal-based figures.

What about chickens and fish?

While emissions from diets featuring chicken and fish are comparable to the plant-based alternative, those two commodities in their own right are around three to four times as emissions intensive.

Fish photo© Furzyk73 | Dreamstime.com - Tinca Tinca, Doctor Fish, The Tench Photo; Chicken photo courtesy of aussiechickens.com.au

What about chickens and fish?

They also involve other massive environmental problems, including destruction of oceanic ecosystems and waste from around 60 billion chickens bred and slaughtered annually.

Some thoughts to conclude

Dr Andrew Glikson, earth and paleoclimate scientist at Australian National University

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"GOOD PLANETS ARE HARD TO COME BY!"

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References and supplementary slides follow

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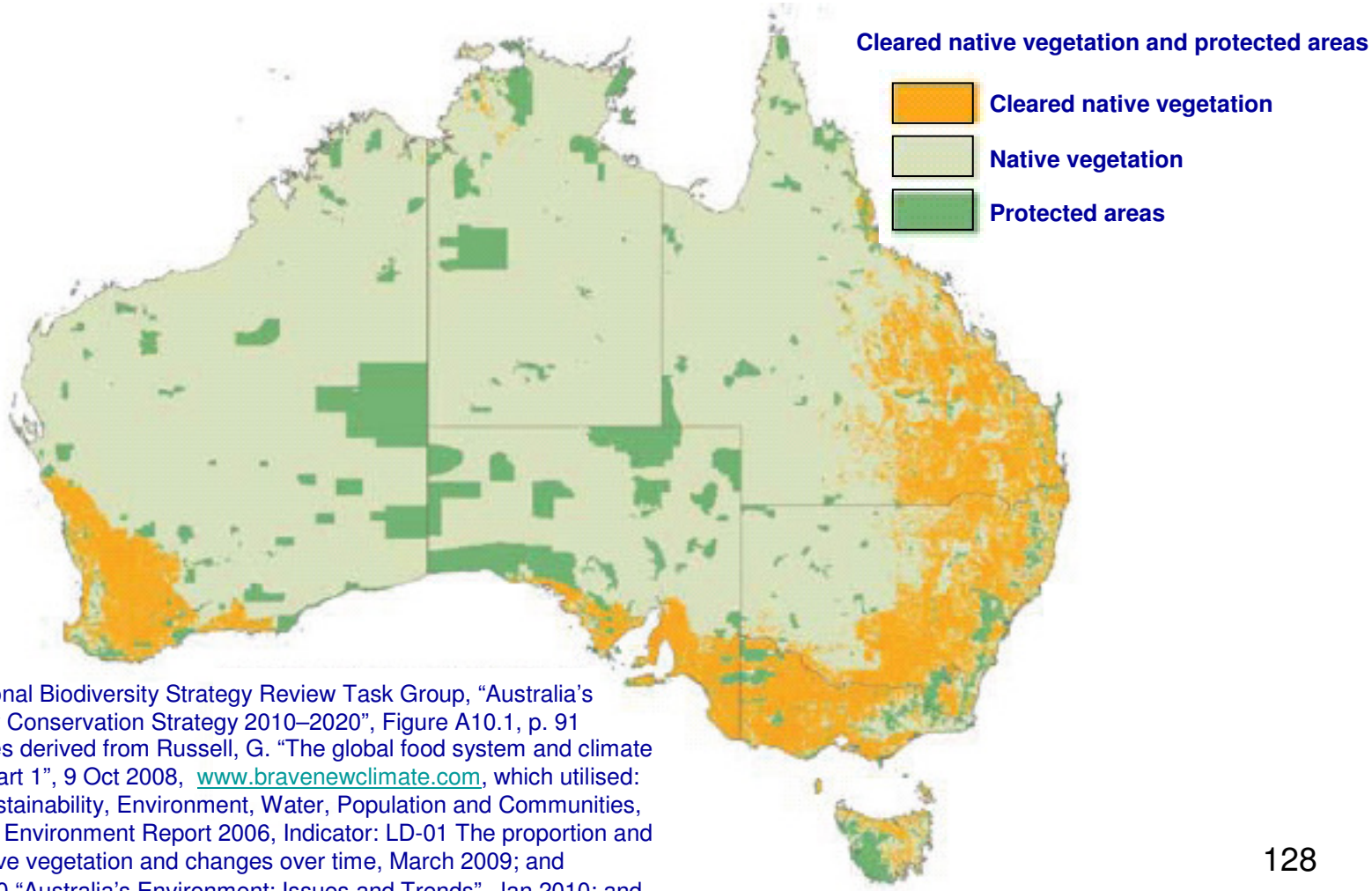
Supplementary slides
Land clearing
Nutrition

Land Clearing in Australia

Total area cleared since European settlement approx. 1 million sq. km.

Approx. 70% or 700,000 sq km (9% of Australia's land area) is due to livestock.



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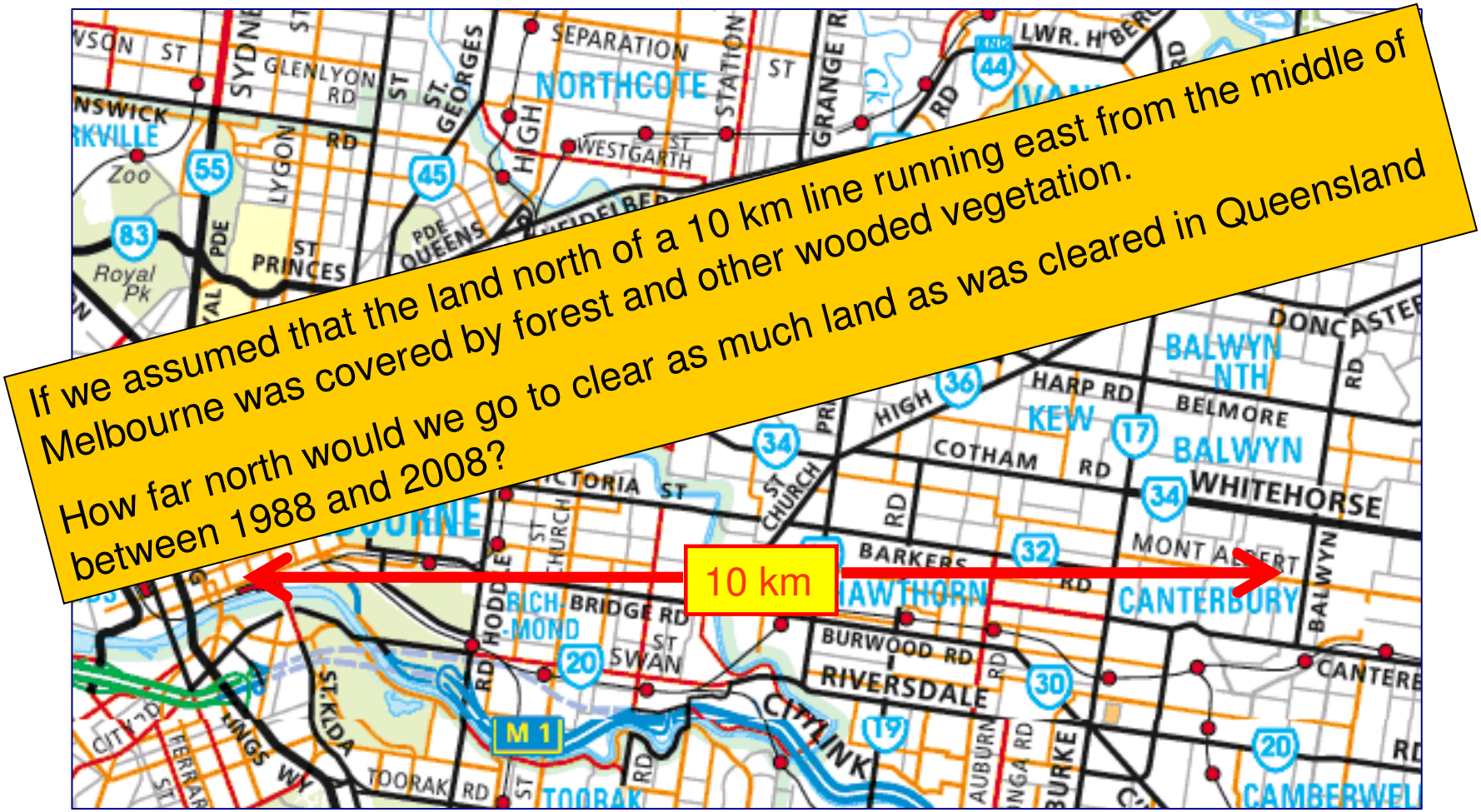
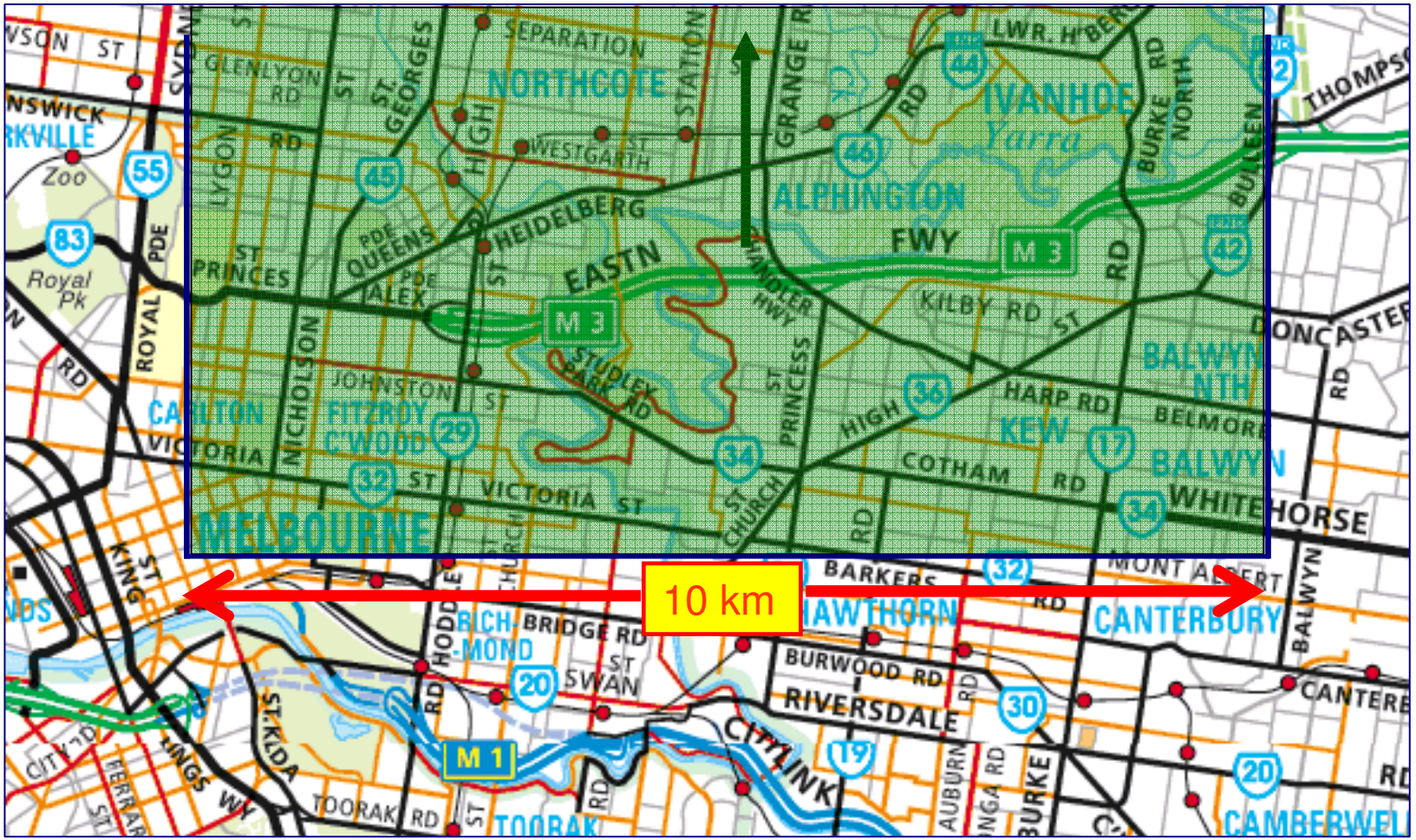
Land clearing in Australia



Land clearing in Australia



Land clearing in Australia – Queensland 1988 -2008
Approximately 78,000 square kilometres

Source:
Derived from Bisshop, G. & Pavlidis, L, "Deforestation and land degradation in Queensland - The culprit", Article 5, 16th Biennial Australian Association for Environmental Education Conference, Australian National University, Canberra,
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Original map: www.street-directory.com.au. Used with permission.
(Cairns inserted by this presenter.)

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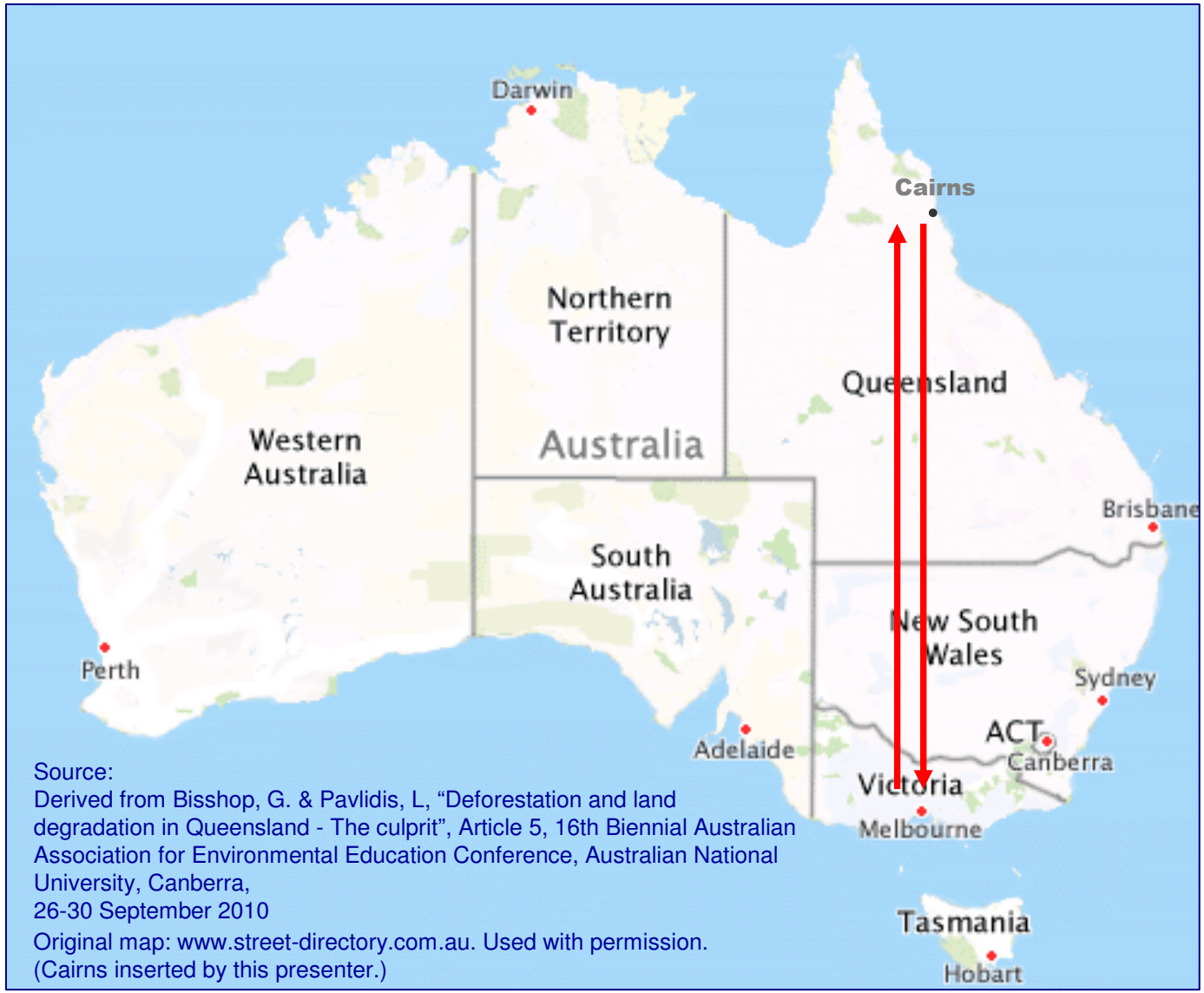

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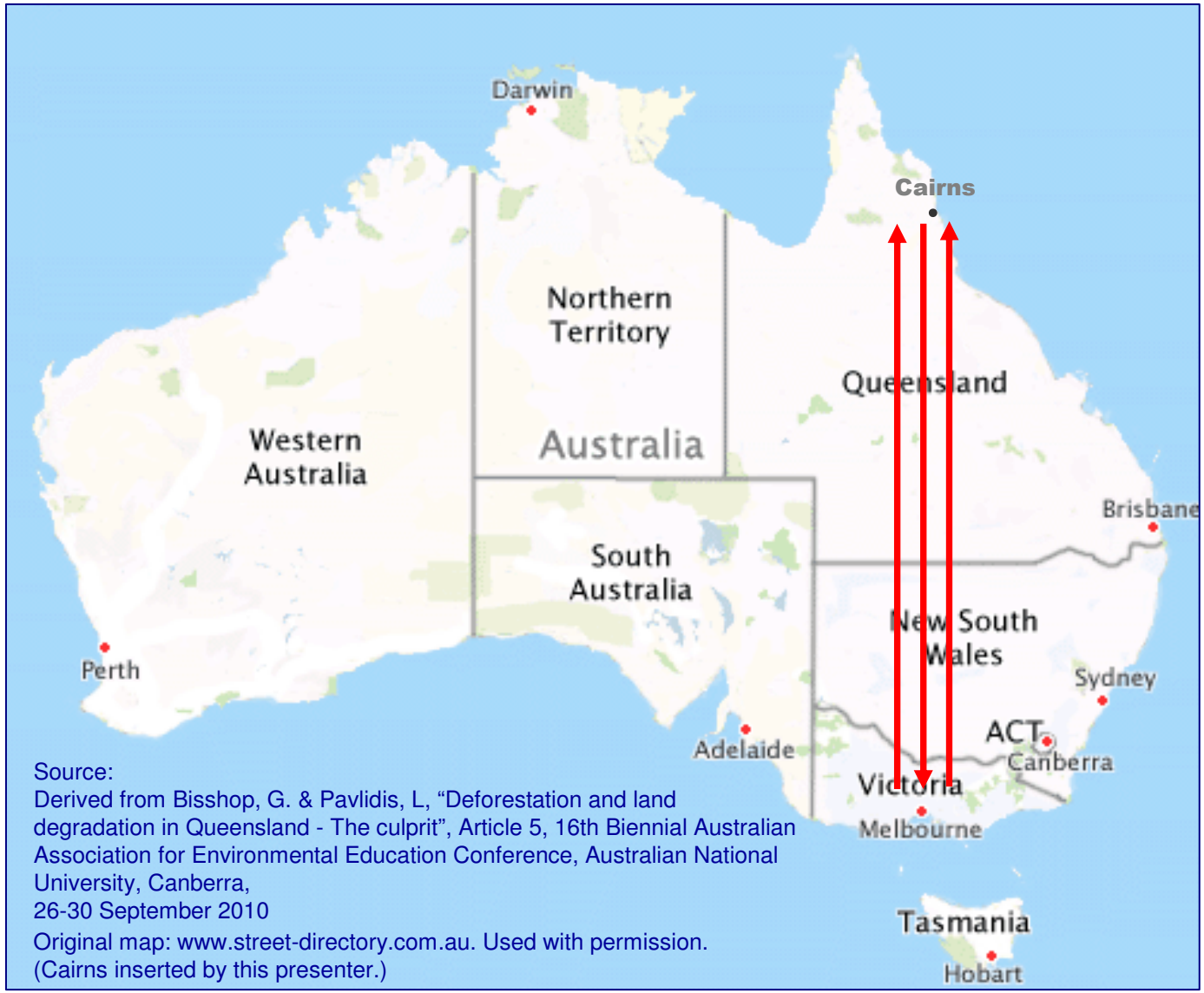

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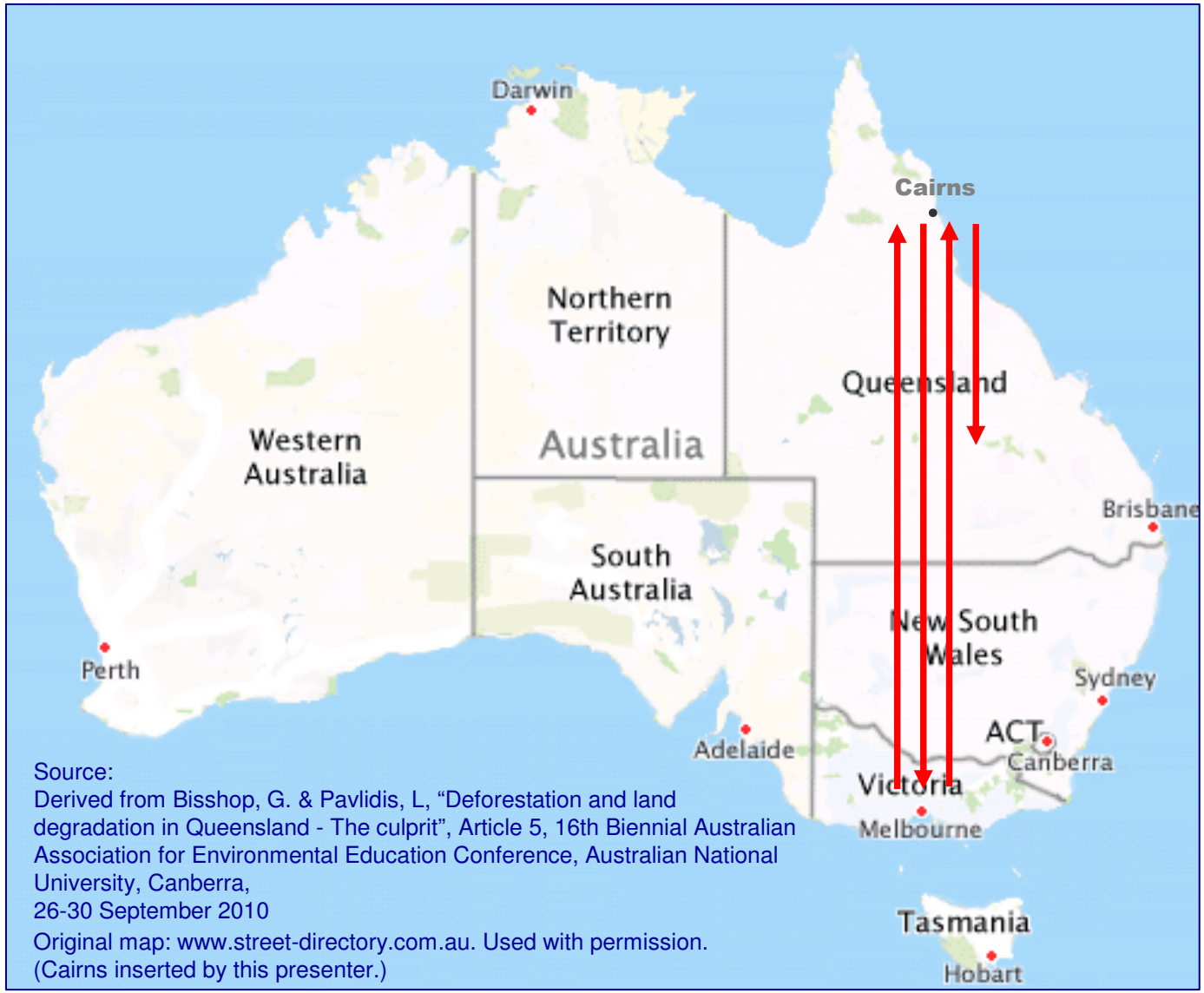

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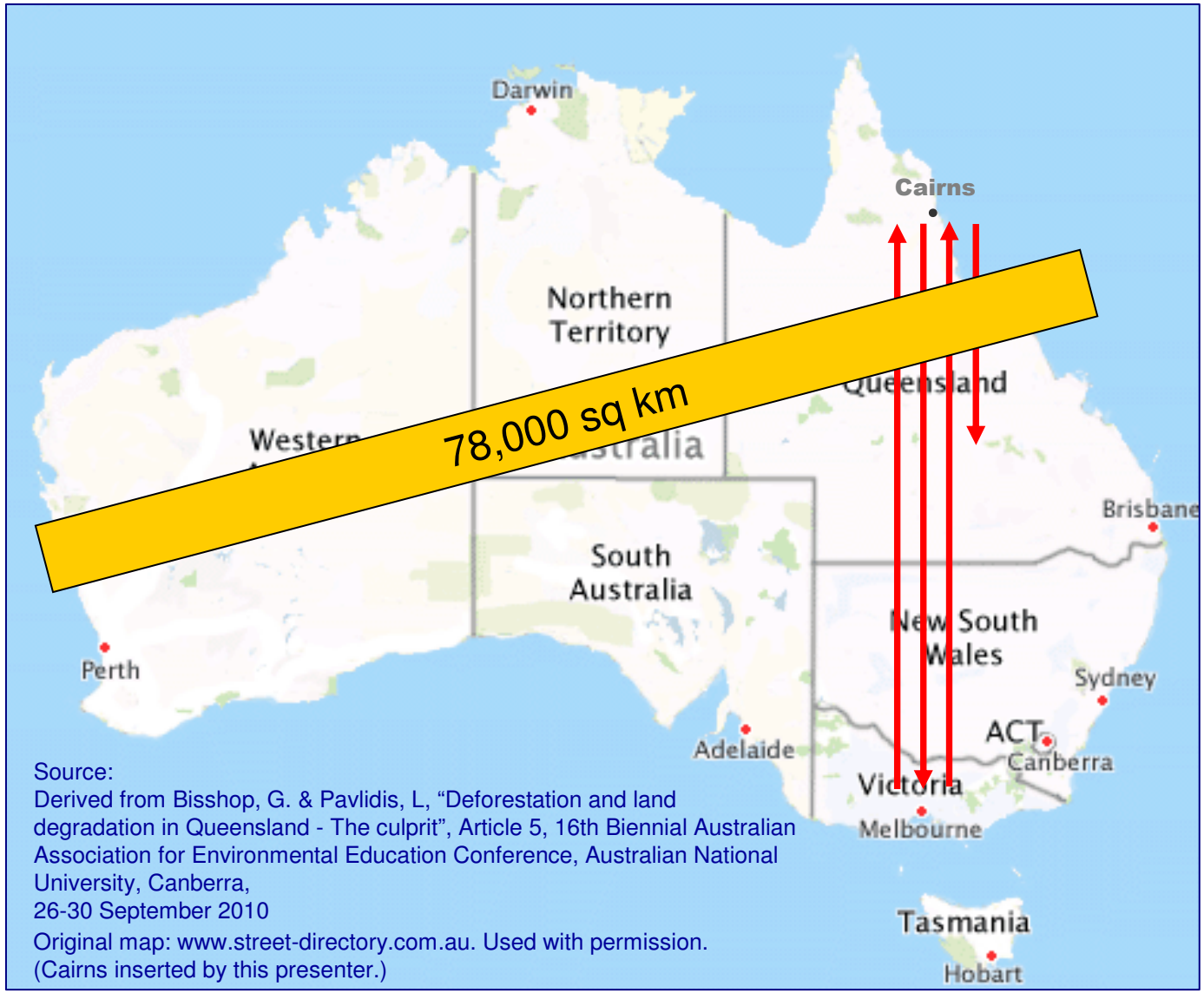

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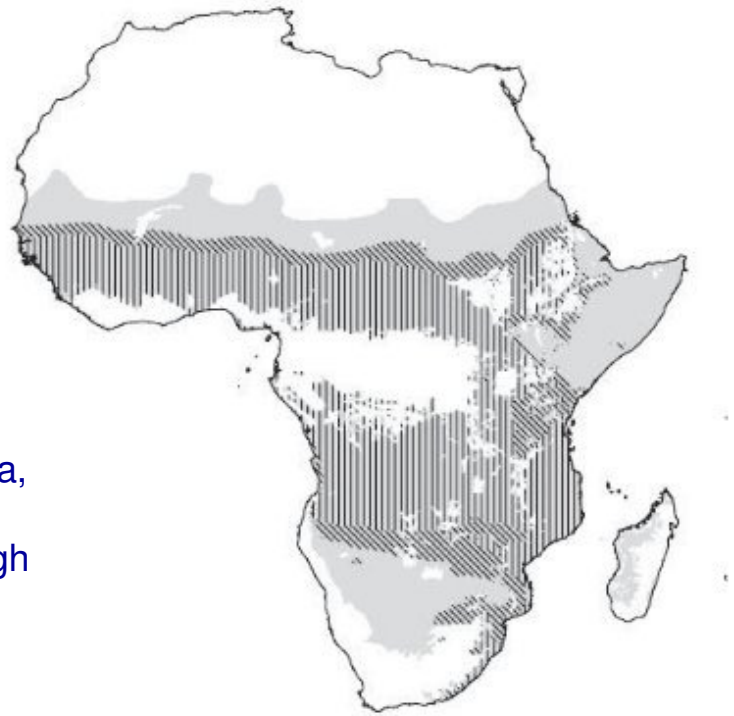
Rainforest destruction in Africa



The vertical lines primarily represent the Guinea Savanna, which was once forest and is maintained as savanna through regular burning, primarily to enable cattle grazing.

Sources: Mahesh Sankaran, et al, “Determinants of woody cover in African savannas”, *Nature* 438, 846-849 (8 December 2005), cited in Russell, G. “Burning the biosphere, boverty blues (Part 2)”, www.bravenewclimate.com

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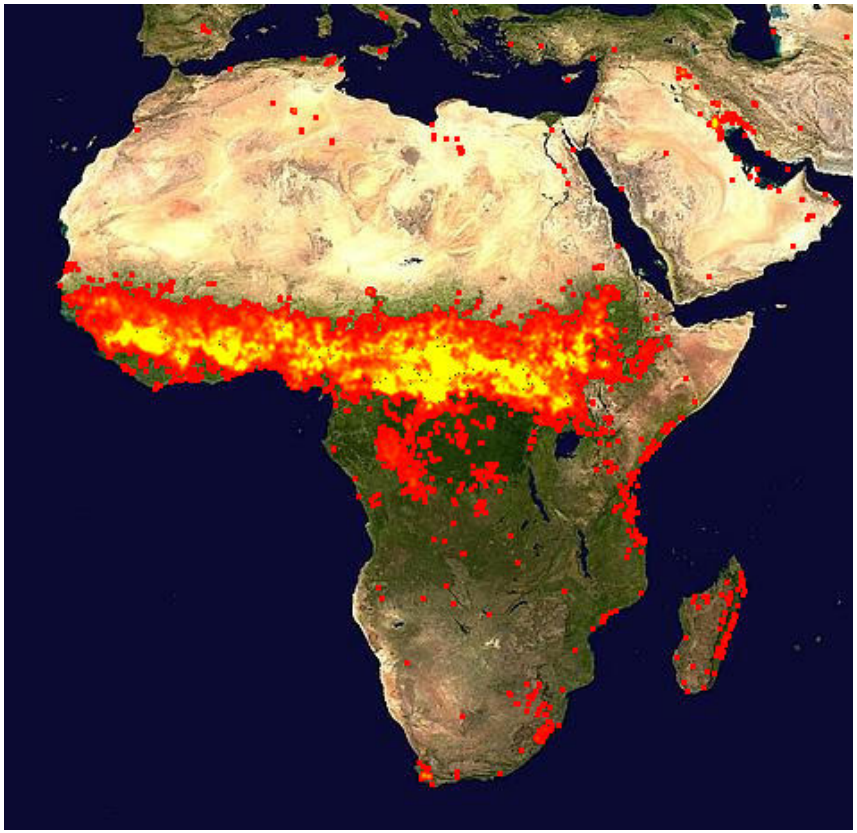

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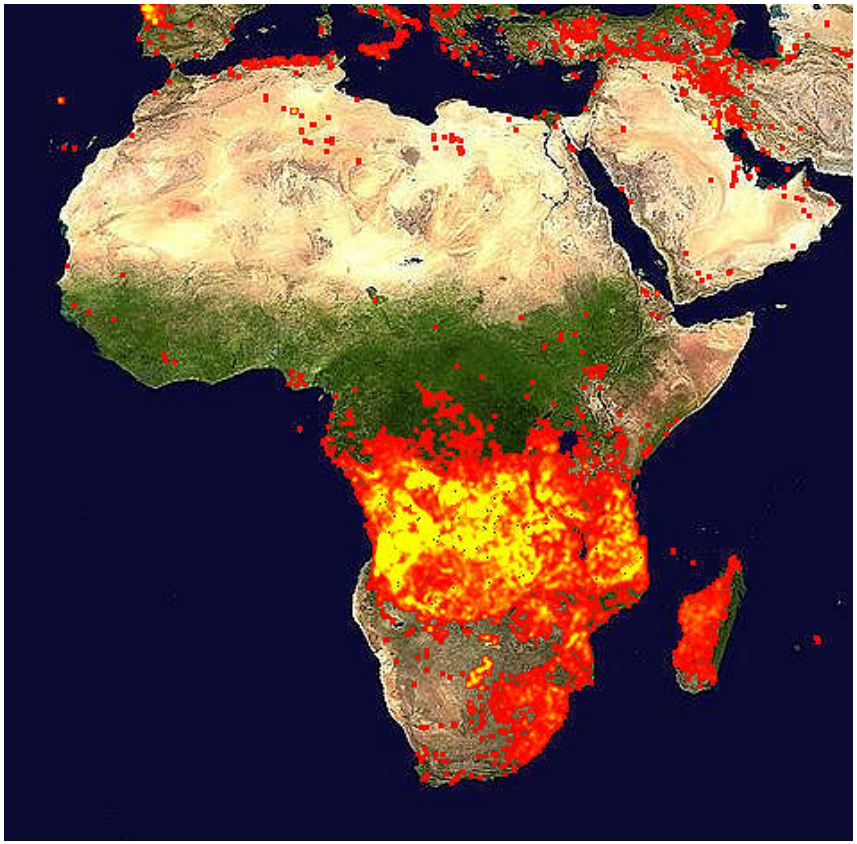

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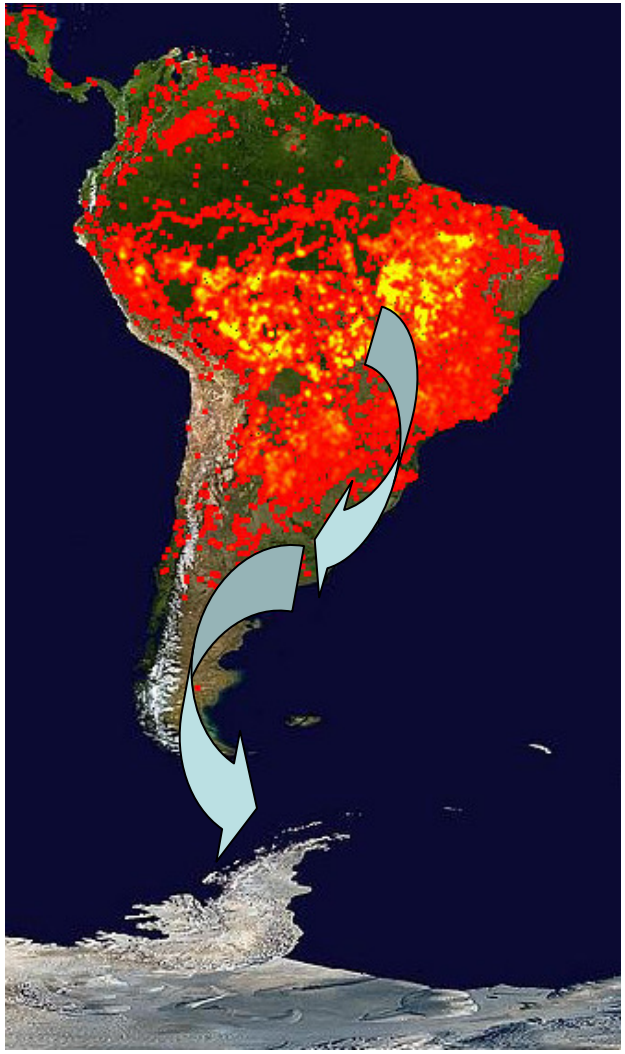
Rainforest destruction in South America

Winds transport black carbon from the Amazon to the Antarctic Peninsula.

47% to 61% of black carbon in Antarctica comes from pasture management in the Amazon and Africa.

Black carbon melts ice rapidly by absorbing heat from sunlight.



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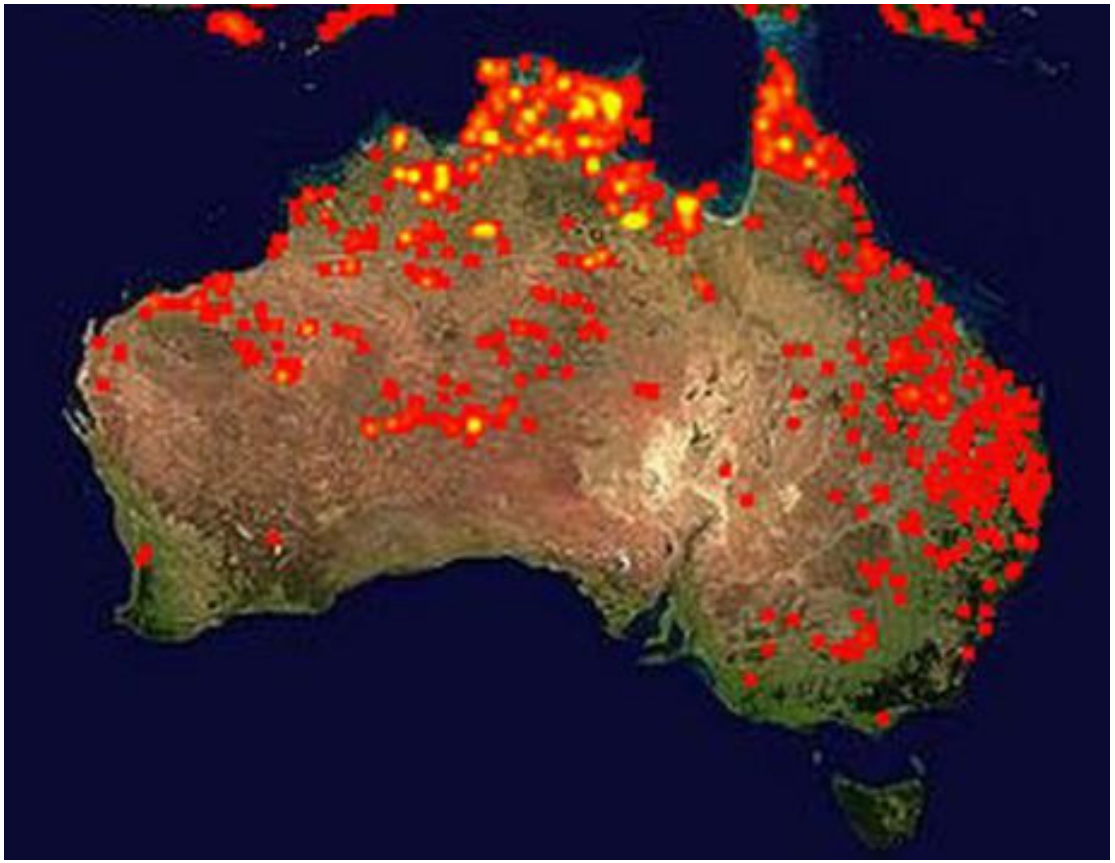
Burning in Australia



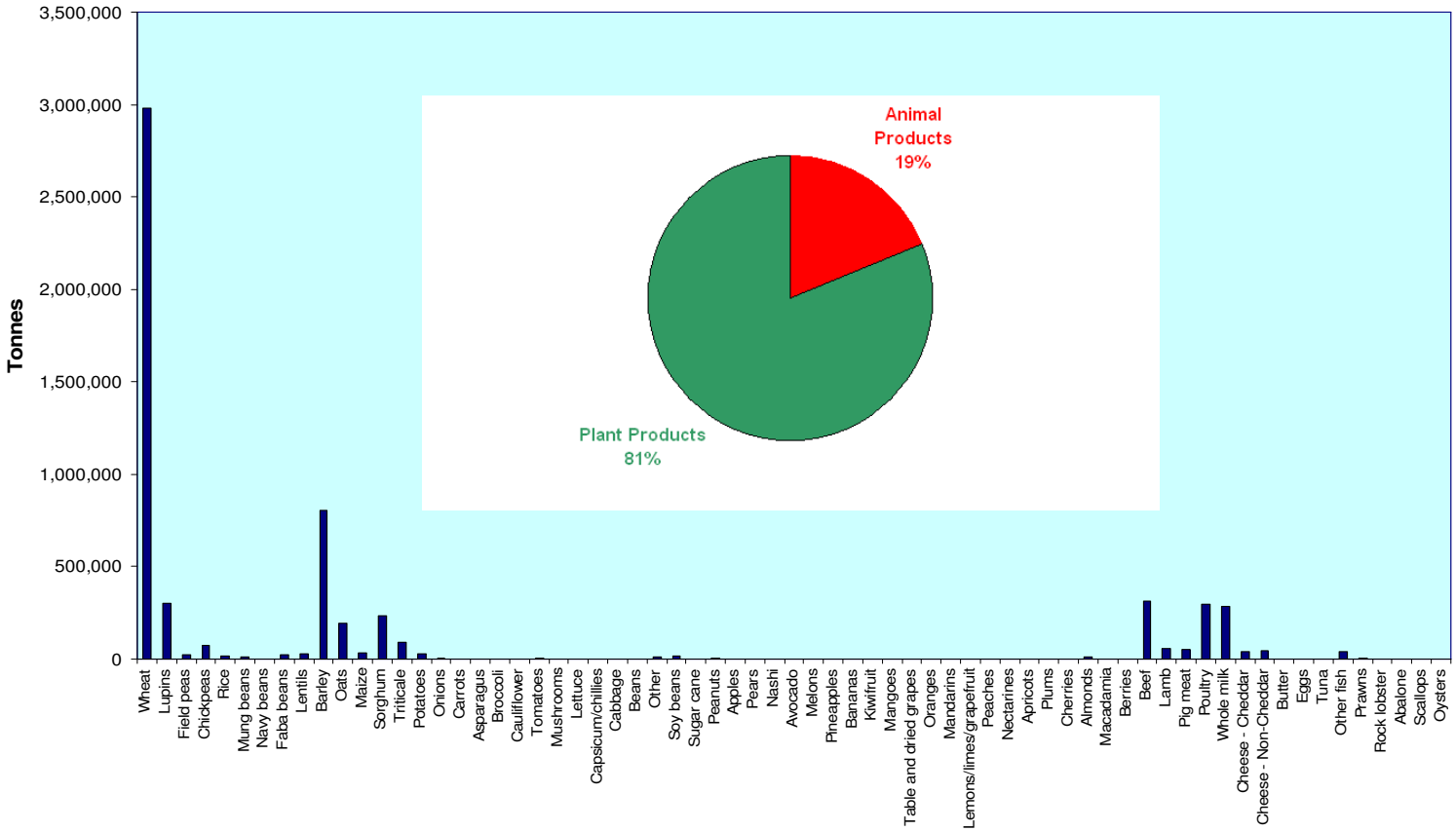
To put Australian savanna burning into context, the 2009 Black Saturday bushfires in the state of Victoria burnt around 4,500 hectares. In comparison, each year in northern Australia where 70% of our cattle graze, we burn 100 times that area across the tropical savanna.

Source: Modis fire map, NASA

Protein

Bull elephant © William Manning | Dreamstime.com

Protein Content

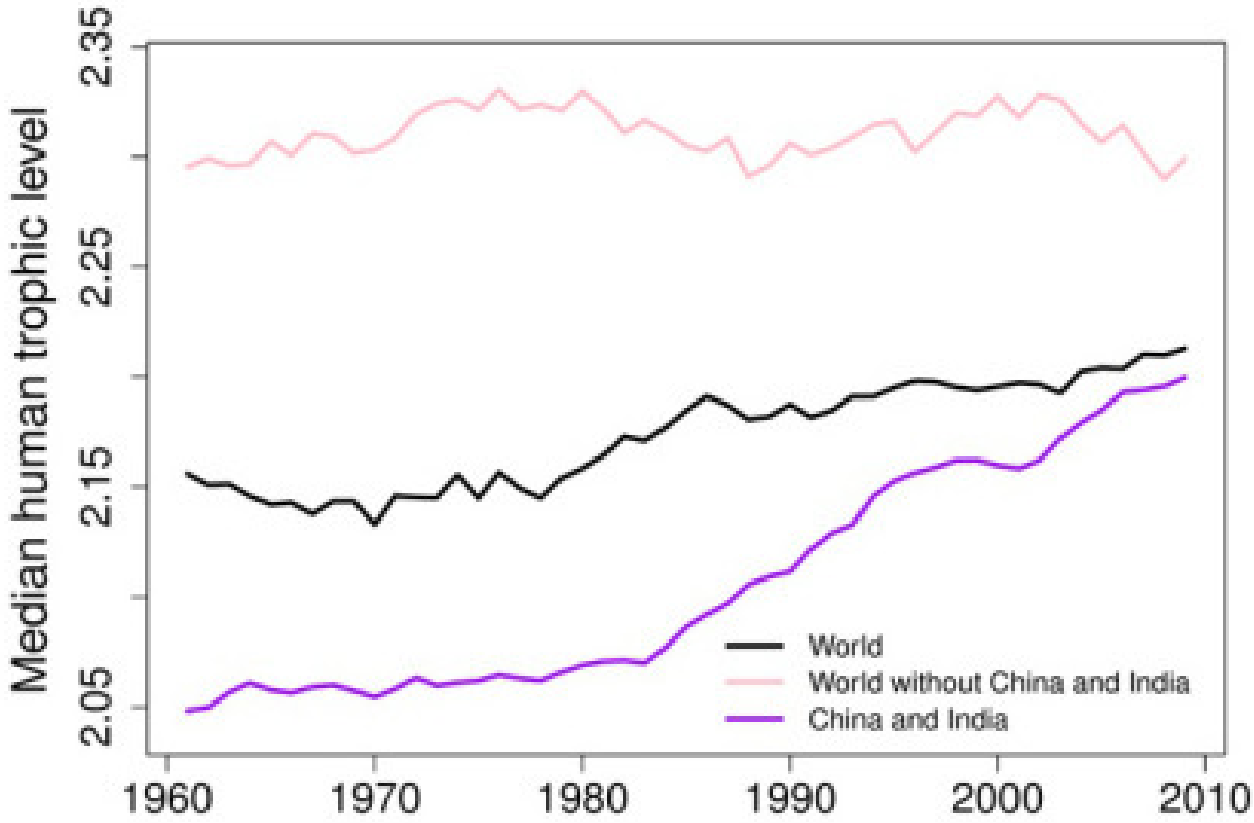


Protein

Product	Protein (grams) per kilo
Soy beans	396
Lupins	362
Poultry	282
Beef	270
Pig meat	266
Peanuts	258
Lamb	255
Cheese	249
Mung beans	239
Tuna	233
Navy beans	223
Almonds	212
Prawns	203
Chickpeas	193
Rock lobster	188
Oats	169
Scallops	168
Eggs	126
Wheat	107
Barley	99
Maize	94
Lentils	90

Trophic levels: a worrying trend

Trophic levels *"represent a synthetic metric of species' diet, which describe the composition of food consumed and enables comparisons of diets between species".*



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