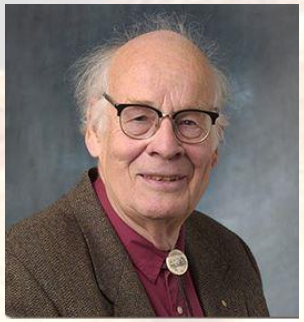

Transition theory &
application in New Zealand

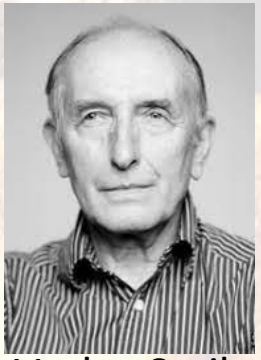
About the speaker

- Academic: BAgSci, MApplSci, PhD (vet epidemiology)
- Industry:
  - National tech transfer programme for deer industry
  - Farmers – veterinary sector – meat processing
- Transition theory – core physics


Al Bartlett


Charlie Hall


Dave Murphy


Vaclav Smil

Introduction

- Seemingly intractorble issues
- The big picture – humans, energy, transition
- Transition of agriculture in New Zealand
- Net Zero Transition for whole of New Zealand
- Suggestions for a success

Reducing emissions:

big picture

Core emissions issue

a tough chew

- Humans not cows
- Human population growth
- Growth in energy consumption
- Growth in emissions
- a key barrier to overcome
- Not popular

world population over the last 12.000 years
7.7 billion in 2019
billion in 2011
6 billion in 1999
5 billion in 1987
4 billion in 1975
3 billion in 1960
2 billion in 1928
5 billion in 1900
990 million in 1800
600 million in 1700
5 billion
4.5 billion
4 billion
3.5 billion
3 billion
2.5 billion
2 billion
1.5 billion
1 billion
0.5 billion
7x increase since 1800
4 million in 10,000 BCE
The average growth rate from 10,000 BCE to 1700 was just 0.04% per year
190 million in the year 0
Mid 14th century: The Black Death pandemic in Europe kills 200 million people.
10,000 BCE
8,000 BCE
6,000 BCE
4,000 BCE
2,000 BCE
0
2000
Based on estimates by the History Database of the Global Environment (HYDE) and the United Nations. On OurWorldInData.org you can download the annual data.
This is a visualization from OurWorldInData.org, where you find data and research on how the world is changing.
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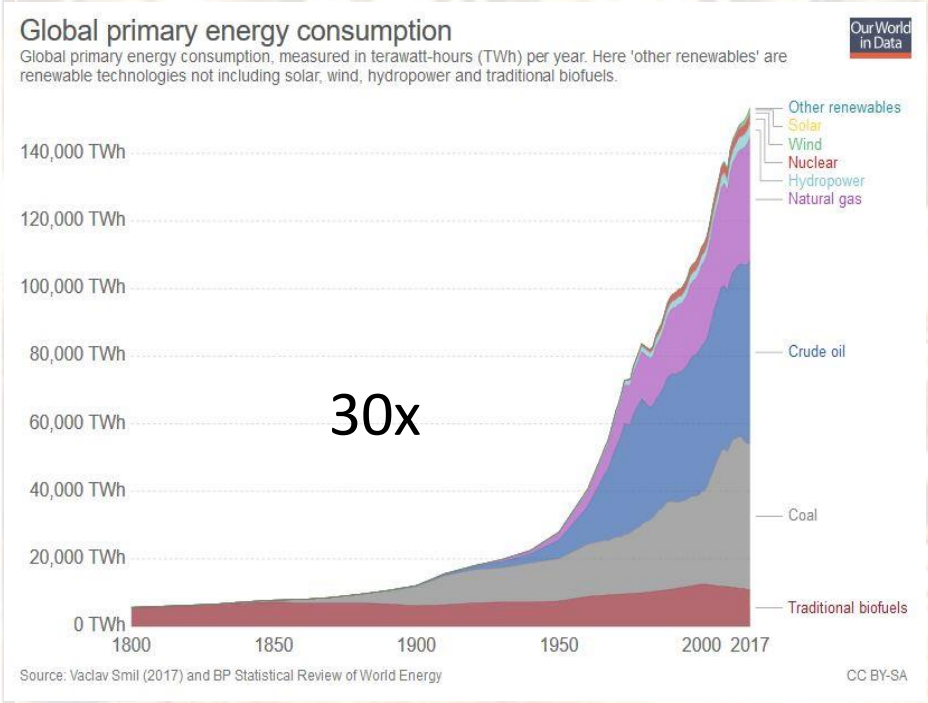
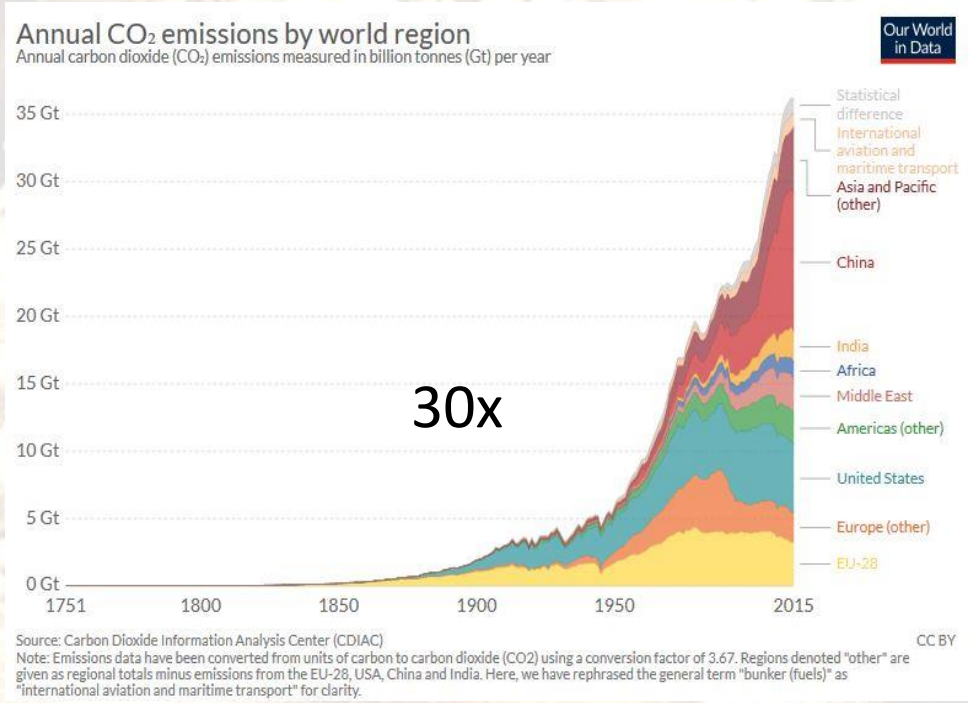
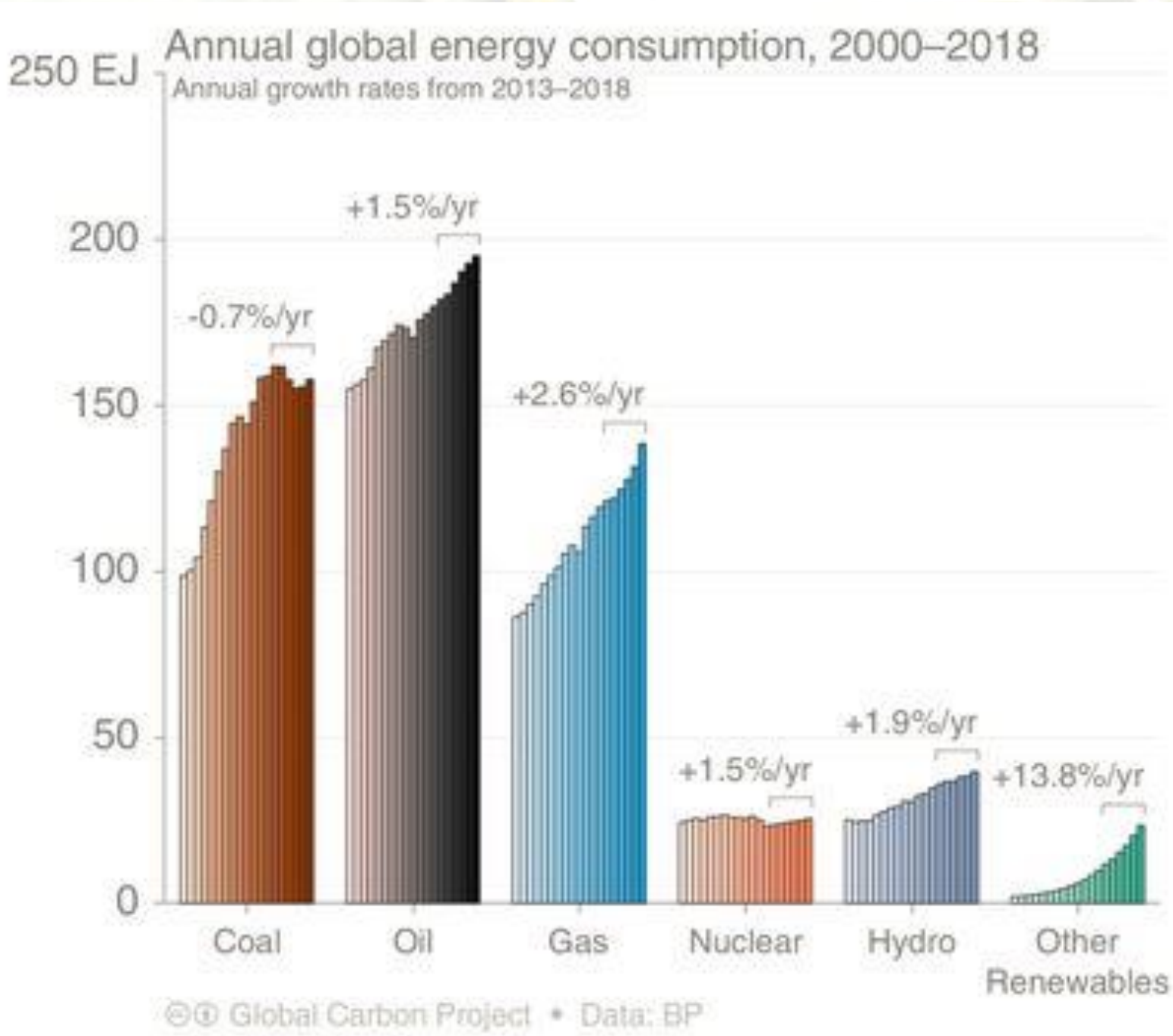
Emissions & resource consumption

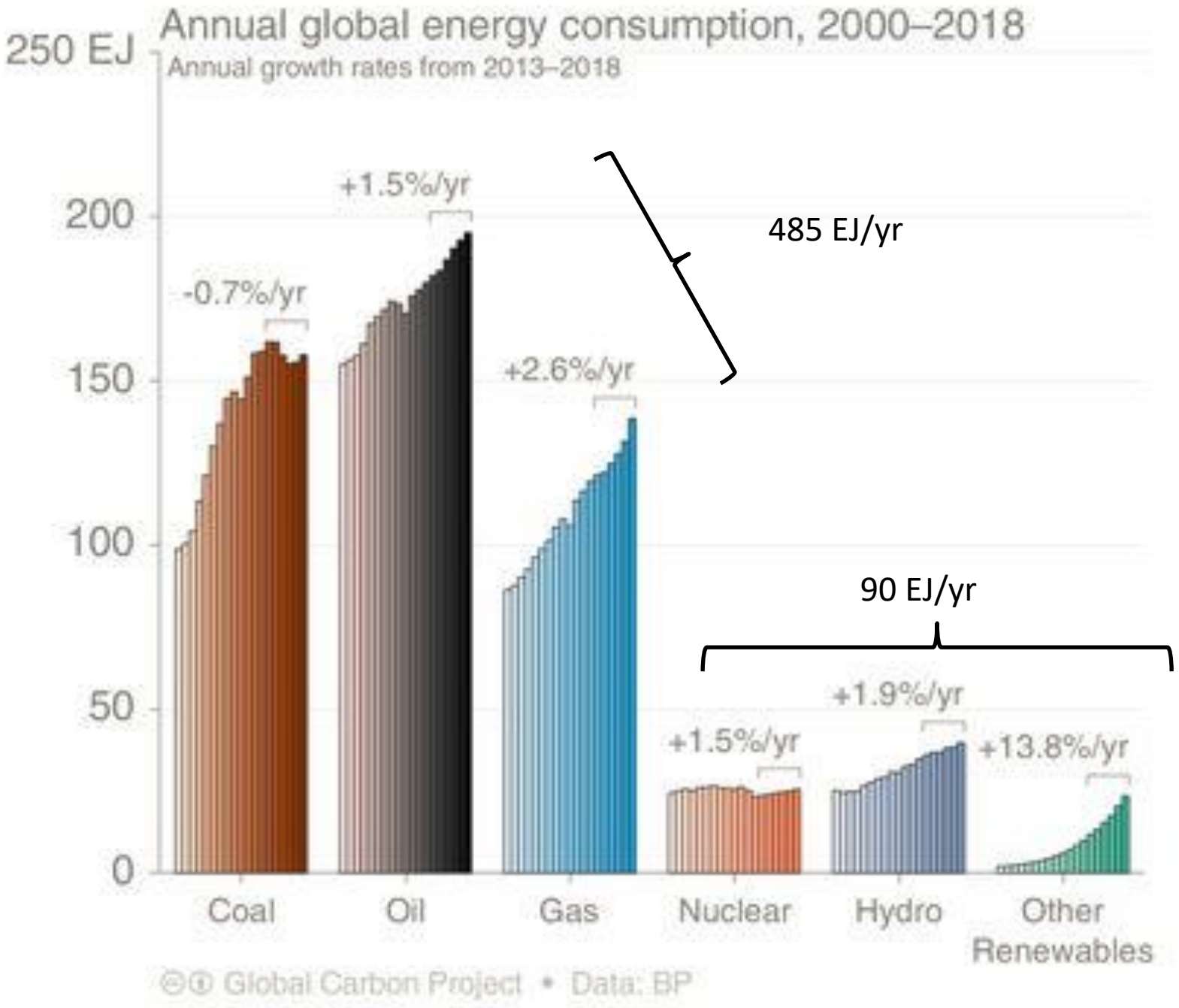




Decouple growth from energy use?

We have a problem….


Annual global energy consumption, 2000–2018
Annual growth rates from 2013–2018
250 EJ
200
150
100
50
0
-0.7%/yr
+1.5%/yr
+2.6%/yr
+1.5%/yr
+1.9%/yr
+13.8%/yr
Coal
Oil
Gas
Nuclear
Hydro
Other Renewables
Global Carbon Project • Data: BP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-0.7%/yr
+1.5%/yr
+2.6%/yr
+1.5%/yr
+1.9%/yr
+13.8%/yr
485 EJ/yr
90 EJ/yr
Coal
Oil
Gas
Nuclear
Hydro
Other Renewables
Global Carbon Project • Data: BP

Disconnection

- IPCC – “oil & gas prodn down ~20% by 2025”
- Oil industry plan multi trillion investment

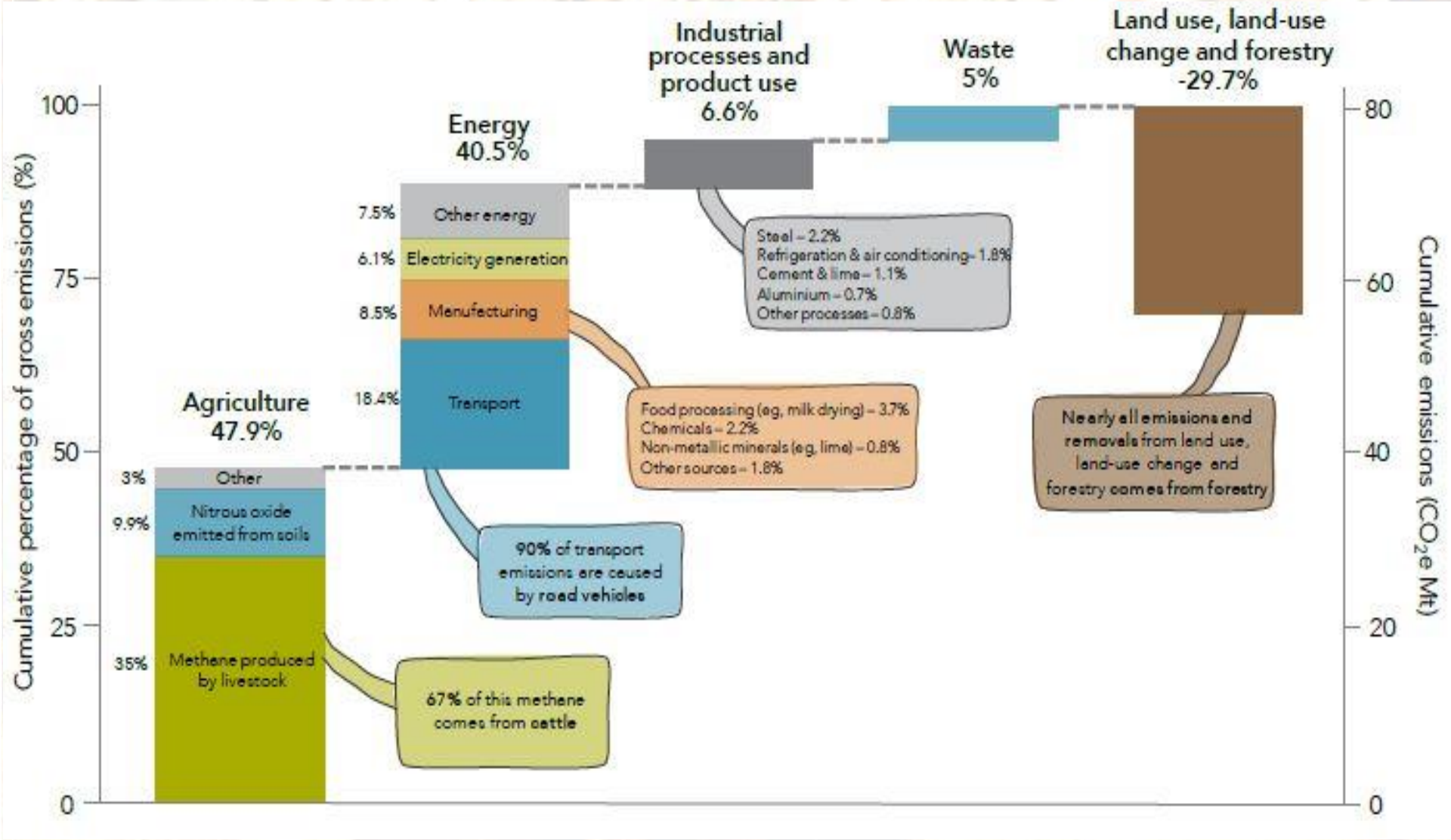
  Investment in renewables an order of magnitude less
- Exxonmobil > pump 25% more in 2025
- More than 40% difference
- Impact of divestment intensifying

Intractorble issue number 1

Reducing emissions:

NZ primary sector

NZ emissions profile



Up 20% since 1990

Zero Carbon Act

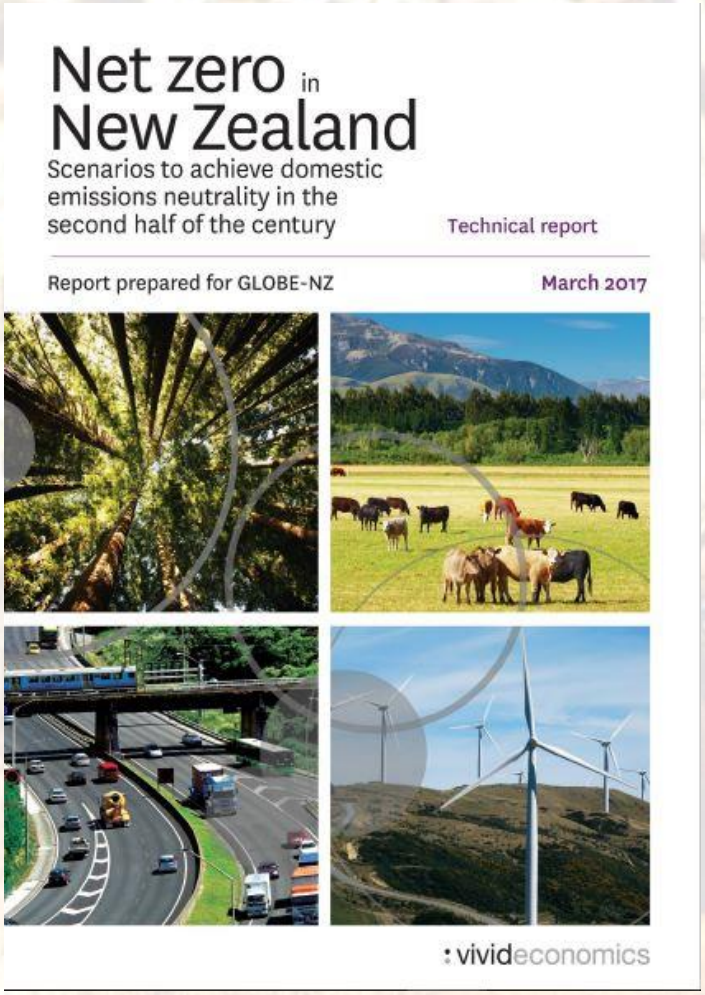
Reduce emissions ~75% by 2050

How:

- Plant trees (40-90,000 ha/yr)
- Electrify transport systems
- Change structure & method of agriculture

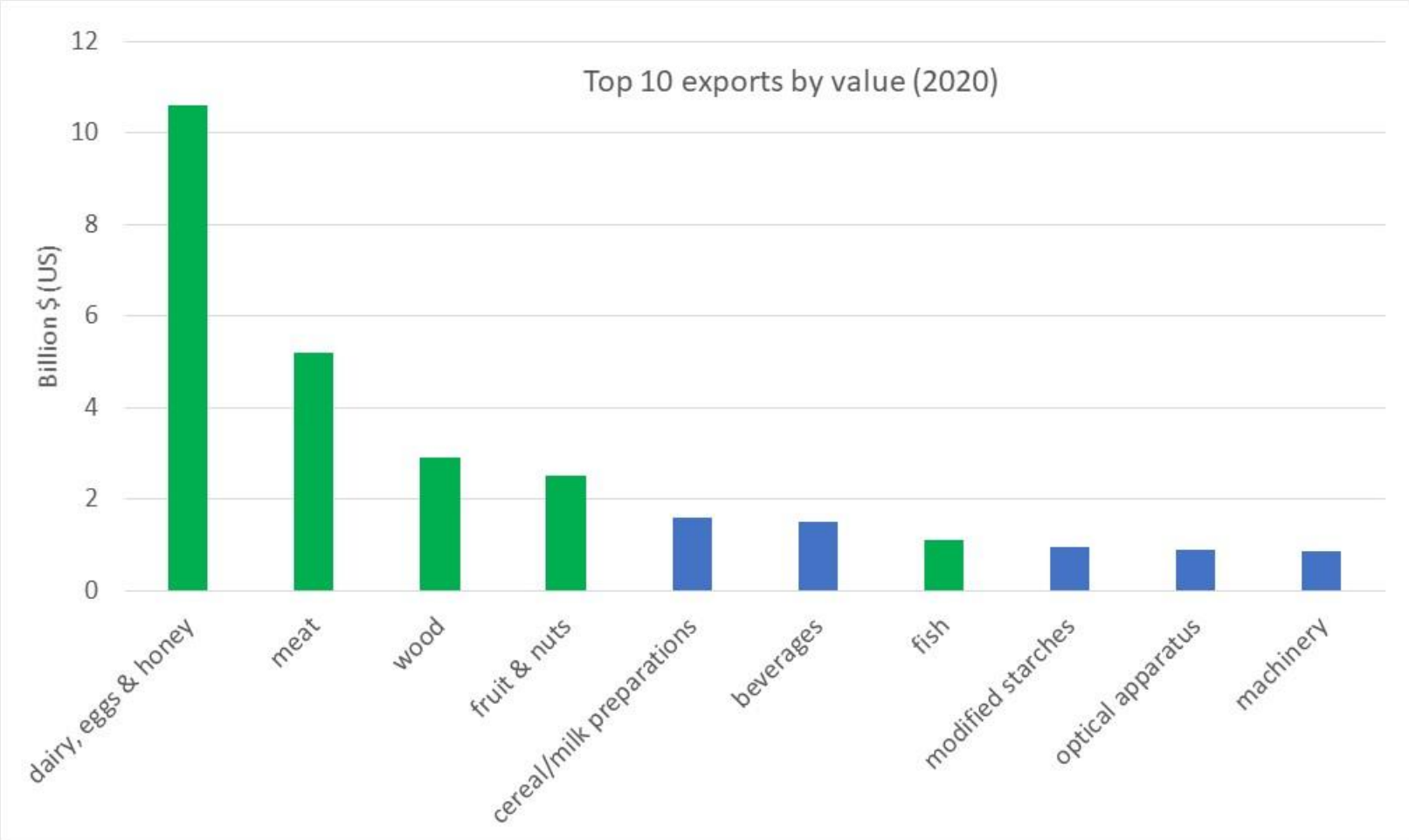
Emissions Trading Scheme
$50 - $200/tCO2 emitted

- Assume doubling of GDP concurrently

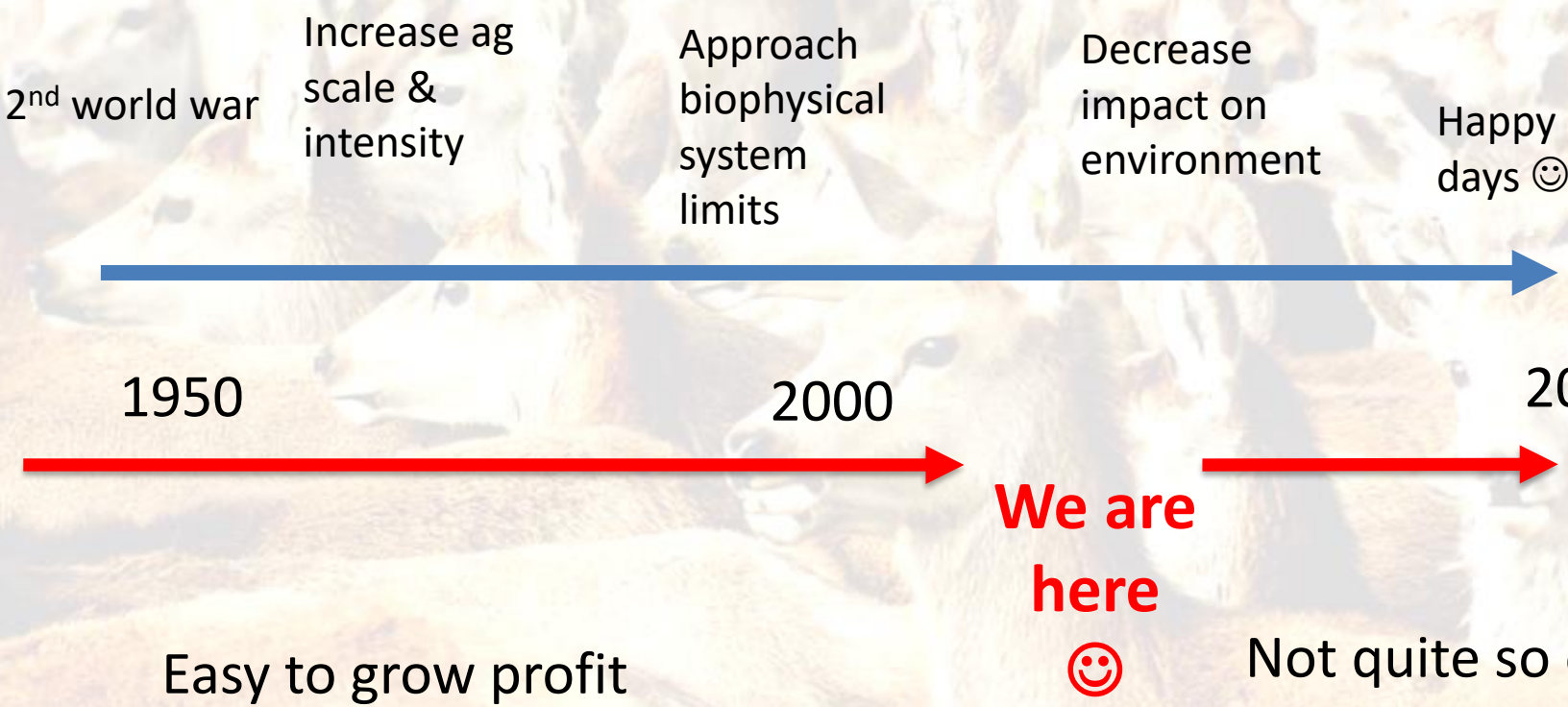


Primary sector in NZ economy

- Small contributor to GDP (~7%)
- Major contributor to export revenue (~70%)

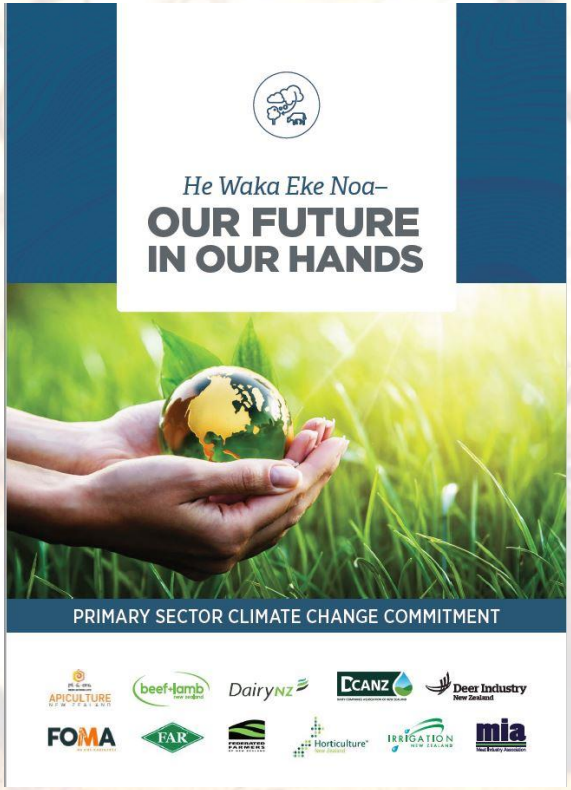


NZ Ag Timeline



Transition plan for primary sector

- All farmers know GHG number by 2022
- All farmers have mitigation ***plan*** by 2025
- 10% reduction in methane by 2030
- 24 – 47% reduction by 2040



Practical reality of emissions

- ~20g methane/kg feed eaten by ruminant
- Natural process, difficult to change

- Accounting for woody vegetation sequestering carbon
- Most farms already doing mostly the right thing

- Technological solutions
- Methane inhibitors, genetics, alternative feeds etc

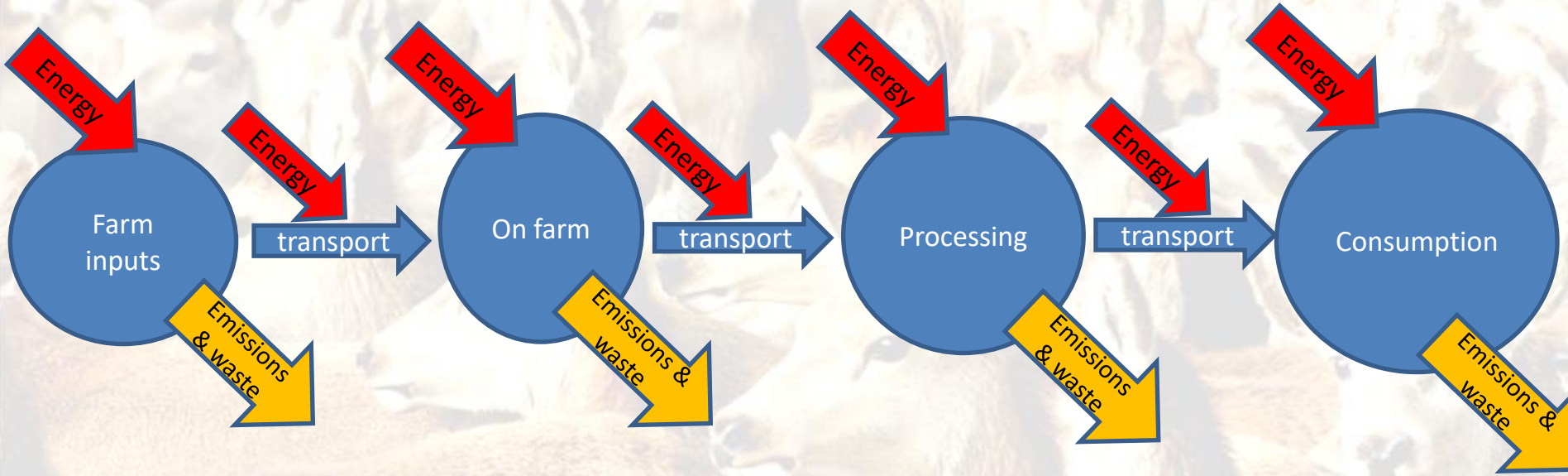
  No silver bullet any time soon

Administrative reality of transition

- Regulation growing rapidly
- Calculating the GHG number
- Expert advice on adaptation
- Integrated Farm Planning
  - Water quality
  - Emissions
  - Biodiversity

- Regulations vary by locality
- Creating, policing & auditing regulations resource intense

Beyond farm gate: the primary chain



- Systems understanding
- Low hanging fruit?
- Strong links, weak links,
- Overall chain feasibility

Situation today

- Confusion & frustration
- Groundswell – “Howl of protest”
- Loss of goodwill & constructive relationships

Intractorble issue number 2

Reducing emissions:

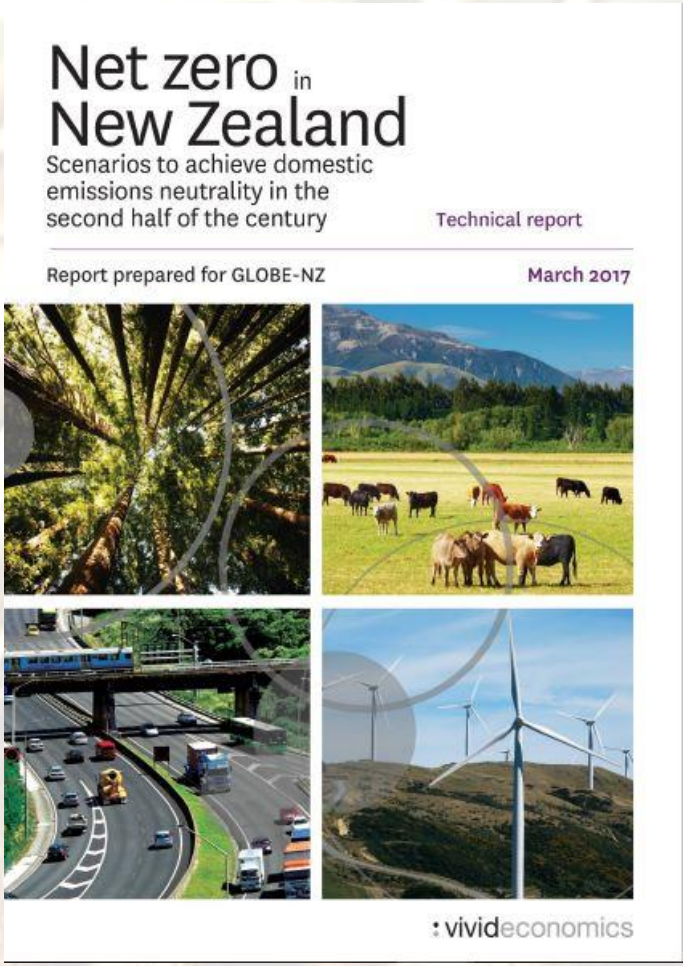
New Zealand economy

Plan: Net Zero in NZ

Economic model of transition pathways

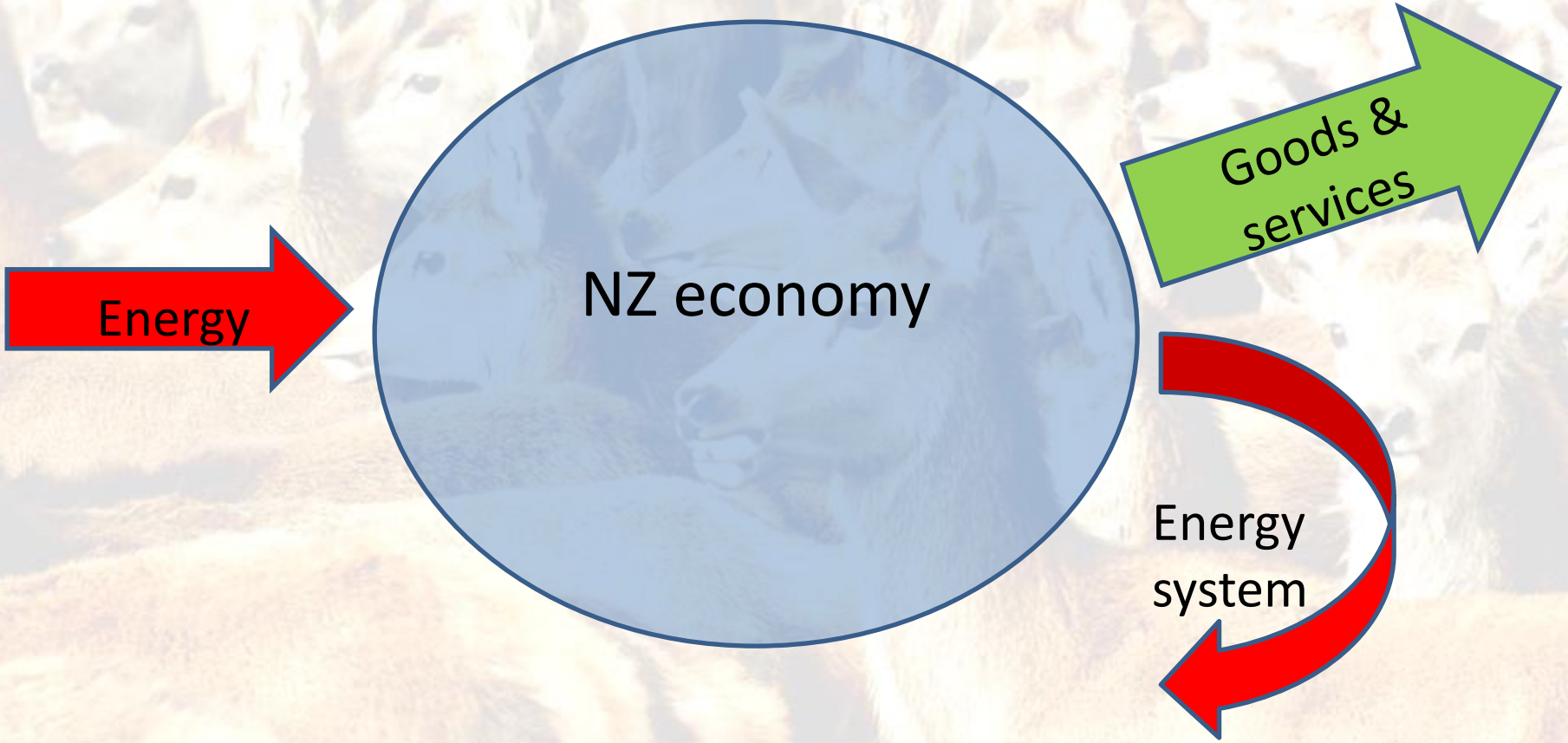
Apply Energy Return On Investment analysis

Contrast economics & resources



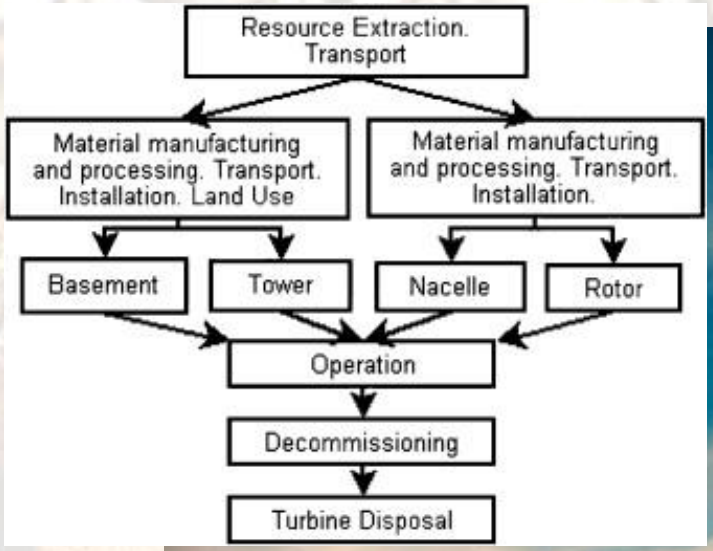
Energy Return On Investment

A ratio of energy outputs : energy inputs



Example: EROI for wind power

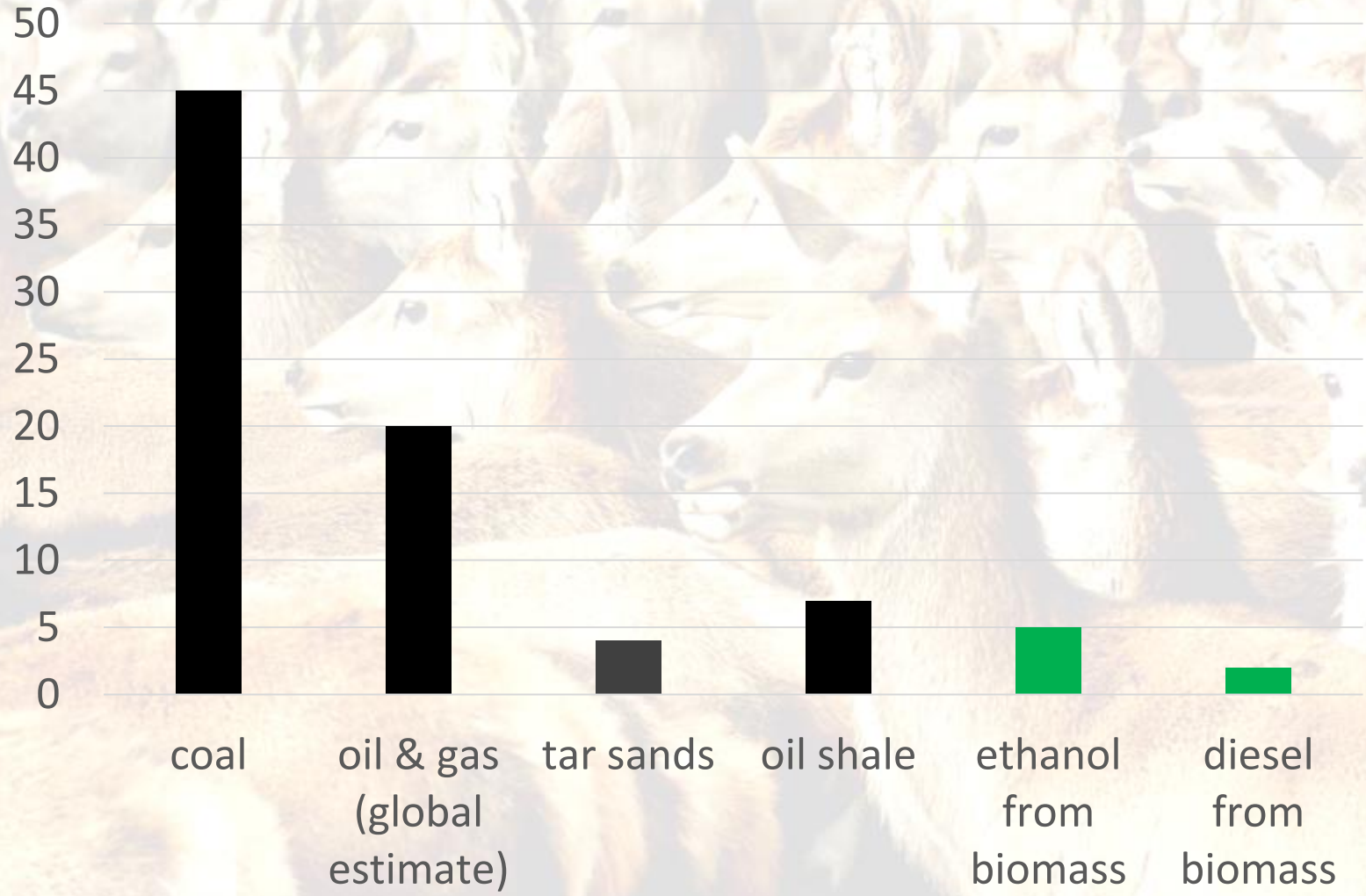
Inputs



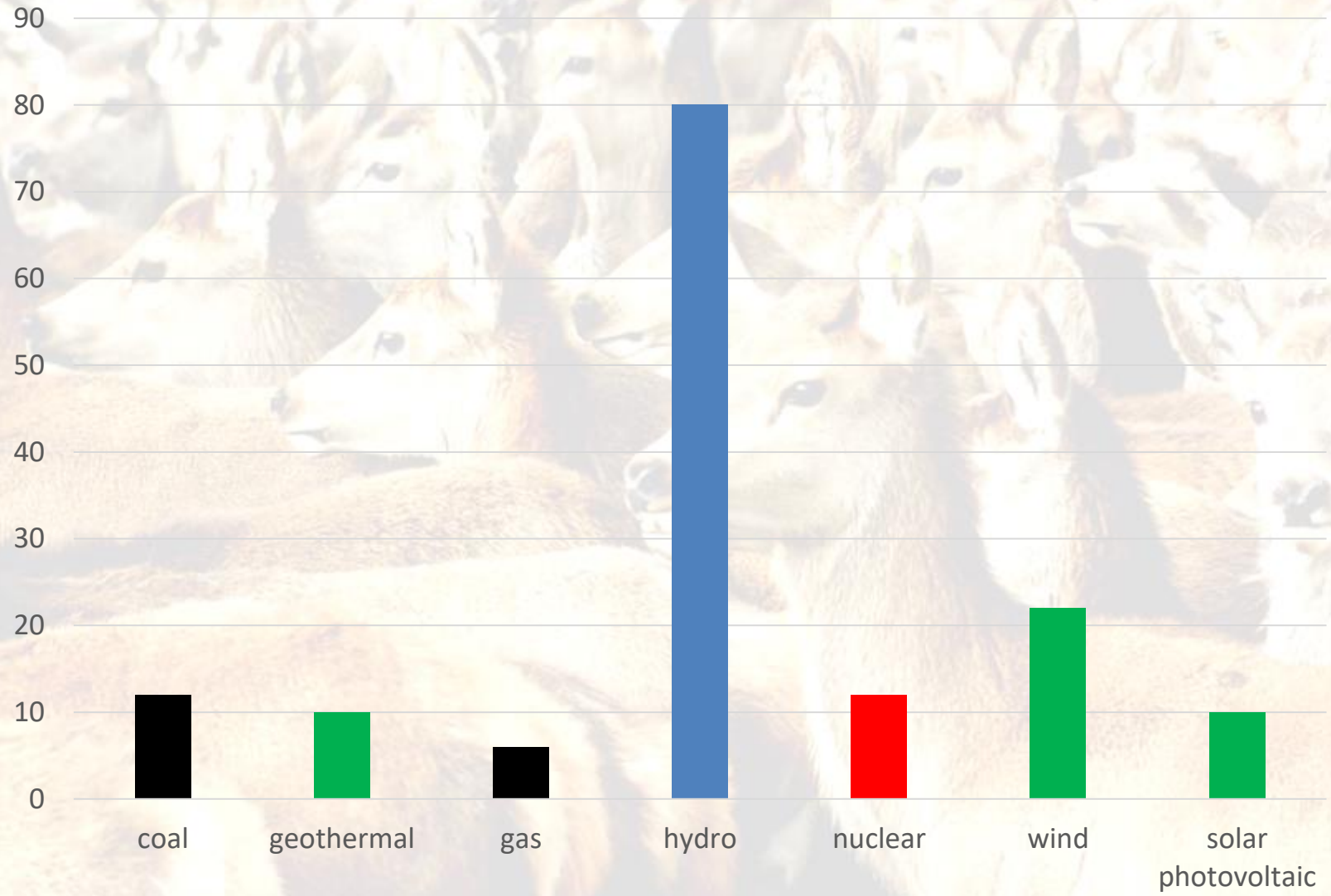
Outputs

Outputs: Inputs
20:1

EROI for fuel sources



EROI for electricity sources



EROI NZ economy today

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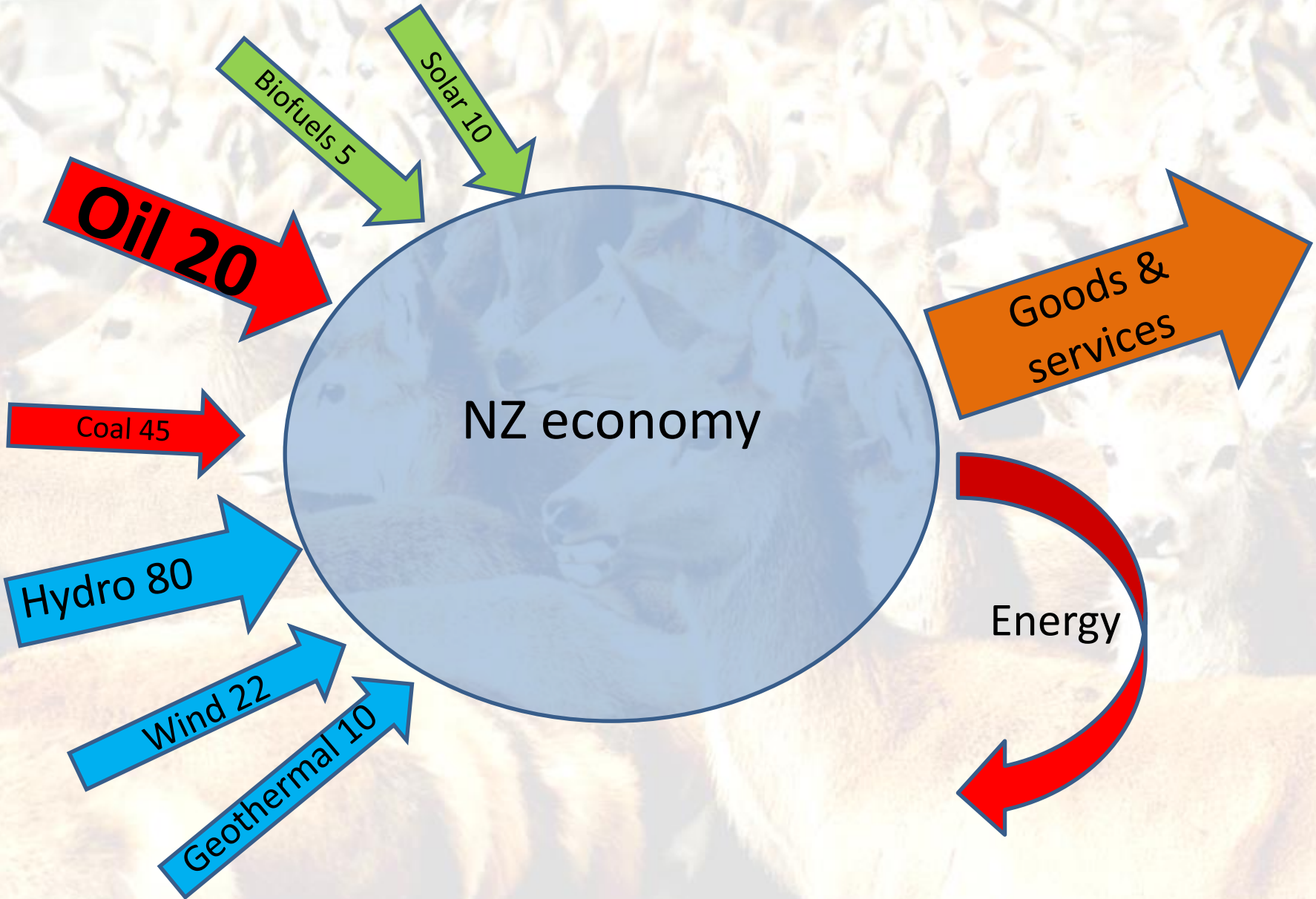

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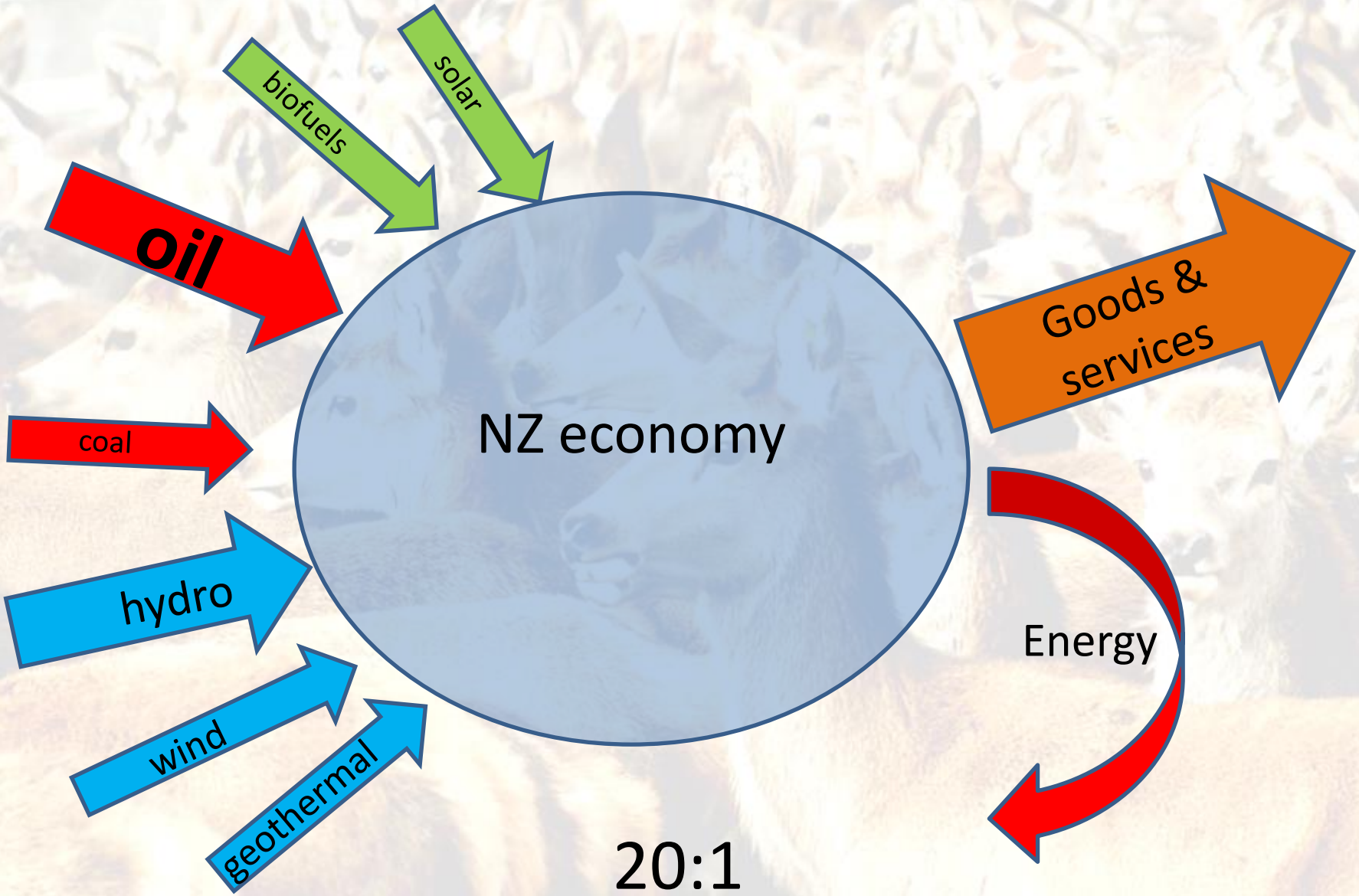
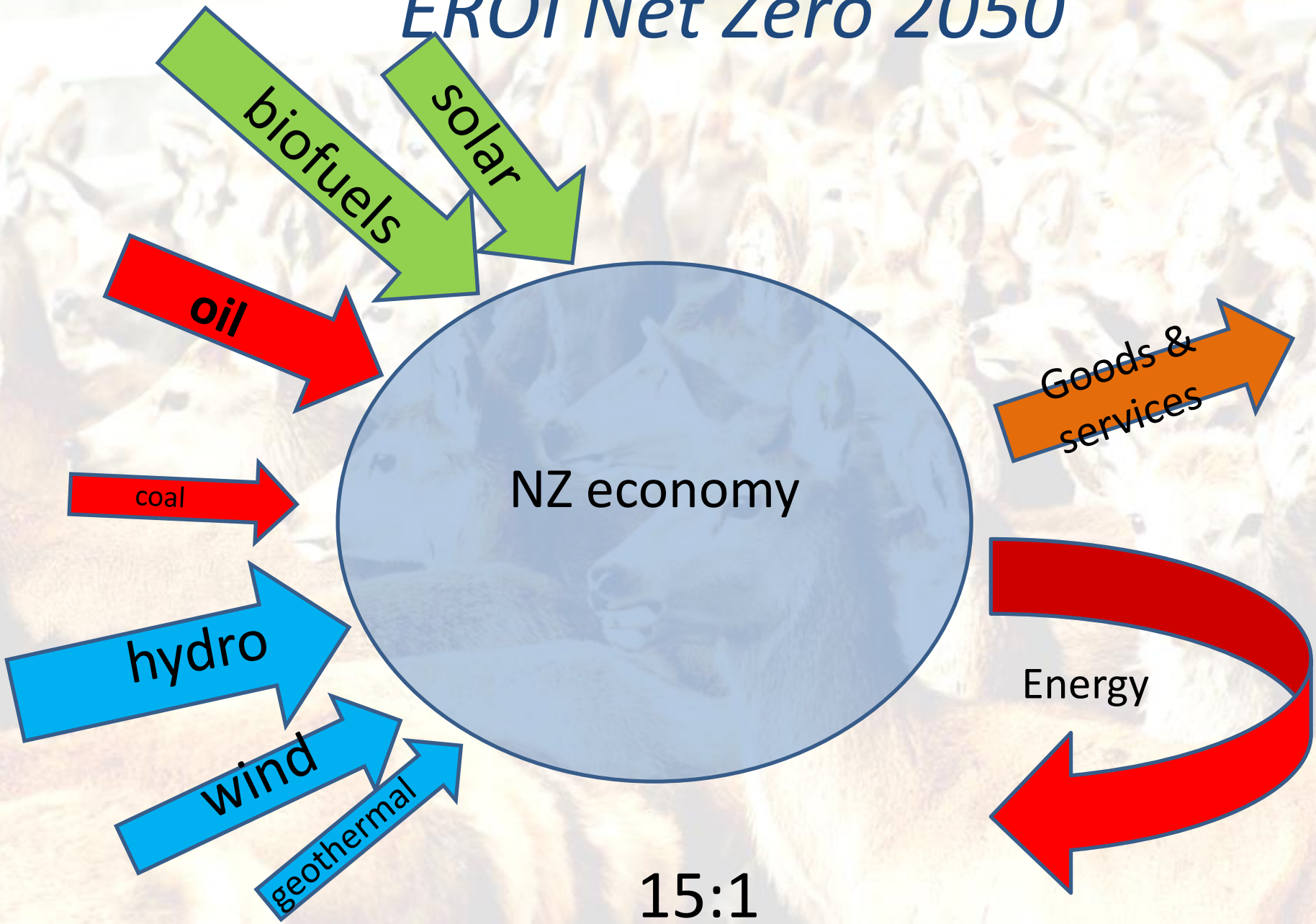


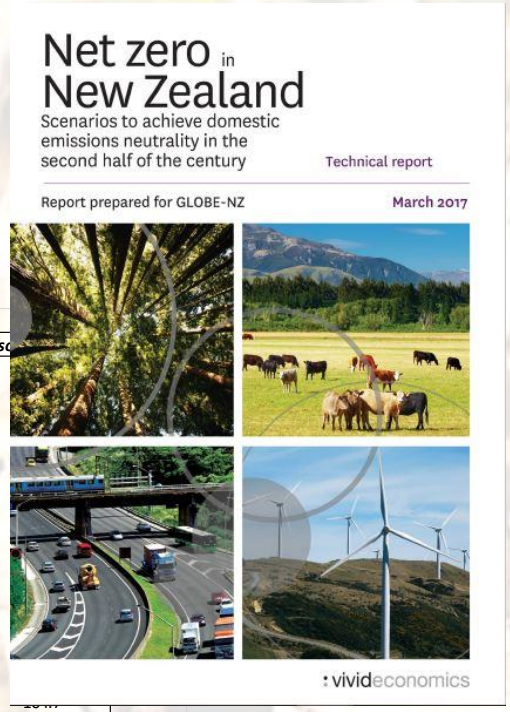
20:1

EROI Net Zero 2050



Net zero NZ

the numbers under the transition plan



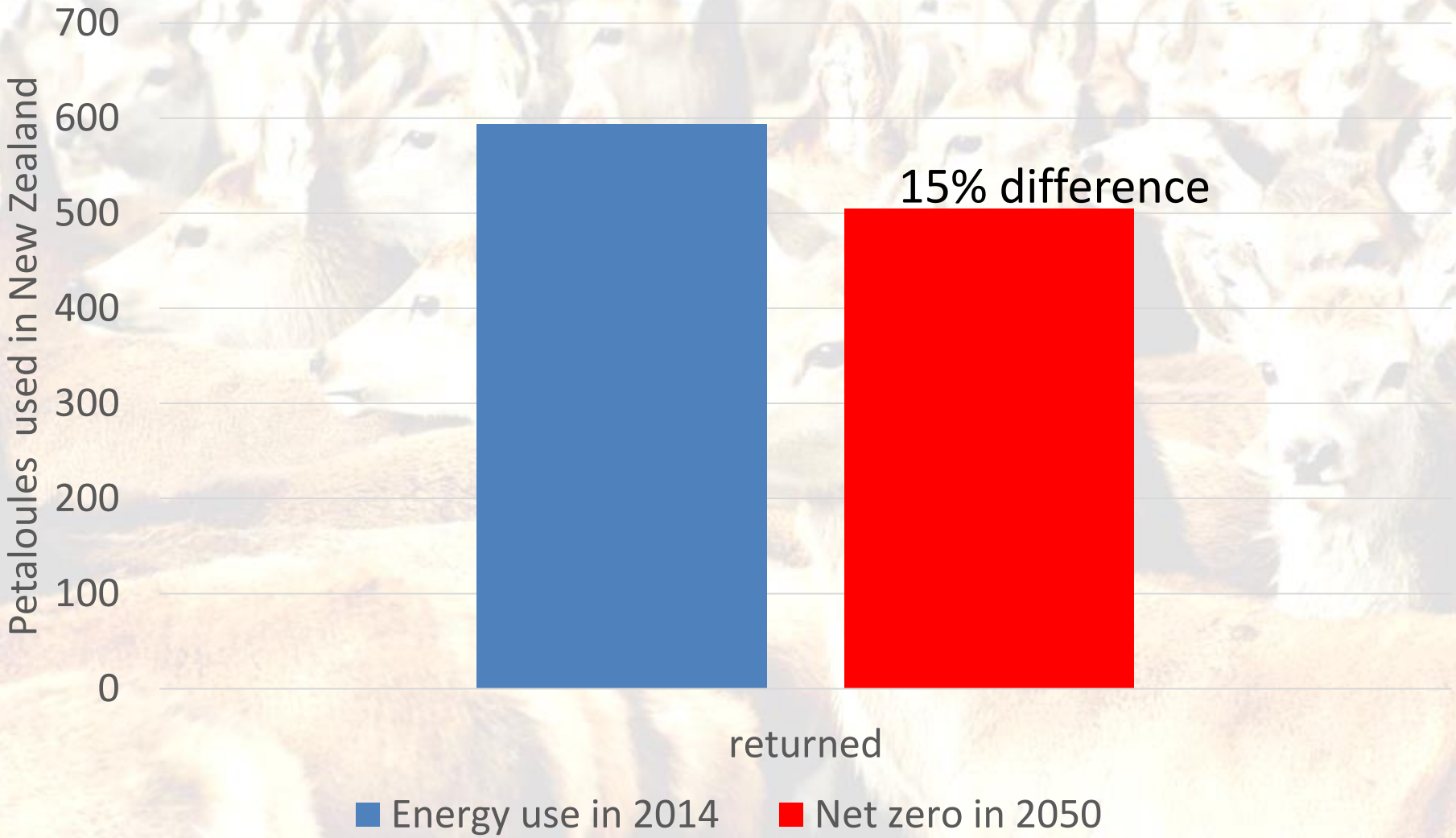
Vivid economics net zero technical report (2017), pg 8

	2014	Off track 2050	Innovative 2050	Resourceful 2050
Energy delivered (GWh)	164892	150259	140288	153592
Electricity (total)	39,206	70,926	83,414	71,347
Heat and direct energy	107866	120103	116106	123436
Electricity	39,148	61,668	72,784	62,089
Direct fuels	68718	58434	43318	61347
Transport	57,026	30,156	24,185	30,156
Electricity	58	9528	10630	9258
Direct fuels	56,968	20,898	13,555	20,898
Electricity generation (GWh)	42,193	76,330	89,769	76,782
Coal	1,831	736	0	741
Gas	6,567	6,132	1,795	6,168
Hydro	24,076	29,076	29,076	29,076
Geothermal	6,871	17,089	17,954	17,190
Solar	17	1,996	3,591	2,007
Wind	2,192	20,226	36,456	
Biofuels	585	1,007	898	

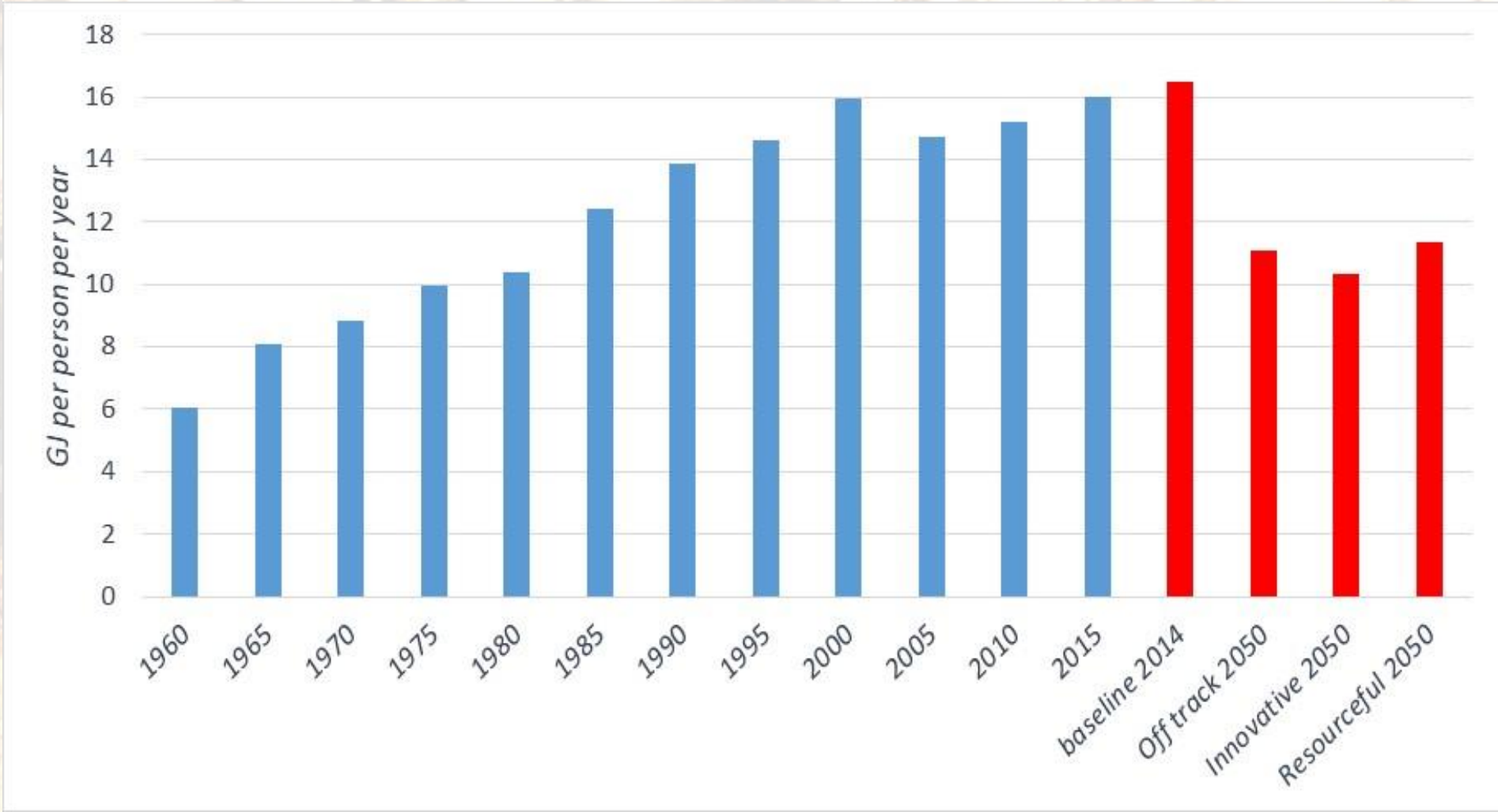
Converted to PJ	2014	Off track 2050	Innovative 2050	Resourceful 2050
Energy delivered	593.6	540.9	505.0	
Electricity (total)	141.1	255.3	300.3	
Heat and direct energy	388.3	432.4	418.0	
Electricity	140.9	222.0	262.0	
Direct fuels	247.4	210.4	155.9	
Transport	205.3	108.6	87.1	
Electricity	0.2	34.3	38.3	
Direct fuels	205.1	75.2	48.8	
Electricity generation	151.9	274.8	323.2	
Coal	6.6	2.6	0.0	
Gas	23.6	22.1	6.5	
Hydro	86.7	104.7	104.7	
Geothermal	24.7	61.5	64.6	61.9
Solar	0.1	7.2	12.9	7.2

EROI	Petajoules	2014 Primary	2014 invested	2014 returned	Off track 2050 Primary	Off track 2050 invested	Off track 2050 returned	Innovative 2050 Primary	Innovative 2050 invested	Innovative 2050 returned	Resourceful 2050 Primary	Resourceful 2050 invested	Resourceful 2050 returned
	Energy delivered	**623**	**29**	**594**	**580**	**38**	**542**	**556**	**51**	**505**	**592**	**39**	**553**
	Heat and direct energy	***406.2***	***17.9***	***388.3***	***462.6***	***30.2***	***432.4***	***460.3***	***42.4***	***418.0***	***475.5***	***31.2***	***444.4***
* scenario value	Electricity	148.9	7.96	140.9	234.7	12.66	222.0	291.4	29.37	262.0	236.3	12.76	223.5
25 12	Direct fuels	257.3	9.90	247.4	227.9	17.53	210.4	168.9	13.00	155.9	239.3	18.40	220.8
	Transport	***216.7***	***11.4***	***205.3***	***117.8***	***8.2***	***109.5***	***95.4***	***8.4***	***87.1***	***116.7***	***8.2***	***108.6***
* scenario value	Electricity	0.2	0.01	0.2	36.3	1.96	34.3	42.6	4.29	38.3	35.2	1.90	33.3
18 12	Direct fuels	216.5	11.39	205.1	81.5	6.27	75.2	52.9	4.07	48.8	81.5	6.27	75.2
	Electricity generation	***160.5***	***8.6***	***151.9***	***290.5***	***15.7***	***274.8***	***339.5***	***34.2***	***305.3***	***292.2***	***15.8***	***276.4***
12	Coal	7.1	0.55	6.6	2.9	0.22	2.6	0.0	0.00	0.0	2.9	0.22	2.7
6	Gas	27.6	3.94	23.6	25.8	3.68	22.1	7.5	0.31	7.2	25.9	3.70	22.2
80	Hydro	87.8	1.08	86.7	106.0	1.31	104.7	106.0	1.21	104.8	106.0	1.31	104.7
10	Geothermal	27.2	2.47	24.7	67.7	6.15	61.5	71.1	2.76	68.3	68.1	6.19	61.9
10	Solar	0.1	0.01	0.1	7.9	0.72	7.2	14.2	13.40	0.8	7.9	0.72	7.2
22	Wind	8.2	0.36	7.9	76.1	3.31	72.8	137.2	15.43	121.8	77.2	3.36	73.9
14	Biofuels	2.3	0.15	2.1	3.9	0.26	3.6	3.5	1.12	2.3	3.9	0.26	3.6
10	Other	0.2	0.02	0.2	0.3	0.02	0.2	0.0	0.00	0.0	0.3	0.02	0.2
total			8.58	151.89		15.67	274.8		34.22	305.3		15.79	276.4
Avg EROI (electricity)				***17.7***			***17.5***			***8.9***			***17.5***
Avg EROI (transport energy)				***18.0***			***13.3***			***10.4***			***13.3***
Avg EROI (heat & direct energy)				***21.7***			***14.3***			***9.9***			***14.3***
Avg EROI (overall energy delivered)				***20.3***			***14.1***			***10.0***			***14.1***

Total energy use

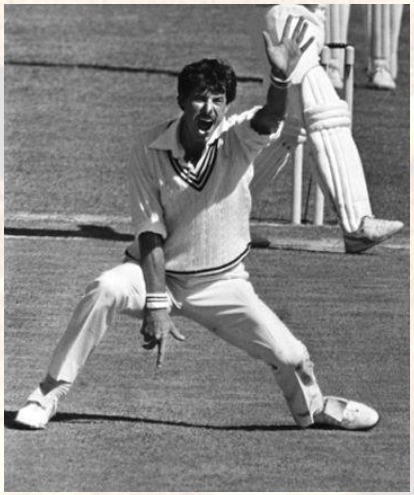


Energy use per capita in 2050



Double NZ GDP (2020)?

On-farm 1980



Intractorble issue number 3

What to do (fundamentally)

- EROI for TIMES-NZ energy system model
- Educate about resources as well as economics
- Consumption vs core systems
- Decompress & revitalise ag under strain
- Grow & strengthen ecological economics networks
- Stay positive ☺

Transition summary

- Global energy consumption challenging
- Budgeting with resources as well as economics is critical
- Net Zero NZ has a substantial, unbudgeted energy cost
- Vibrant, resilient healthy food systems please…at cost
- Stay positive ☺

Thank you, happy tractoring

NUFFIELD
NEW ZEALAND

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Thank you Wise Response!