

EROI analysis of TIMES-NZ emissions reduction modelling

Solis Norton

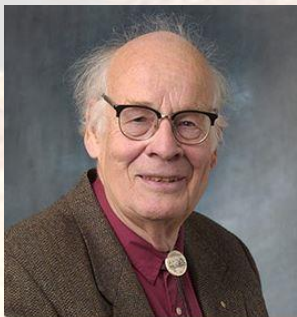


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Introduction

- Variety of model approaches essential to visualise transition
- Energy Return On (Energy) Investment counterpoint to economic approaches
- Economy within society within the wider environment
- Feedback included from ISBPE, New York, May 2021



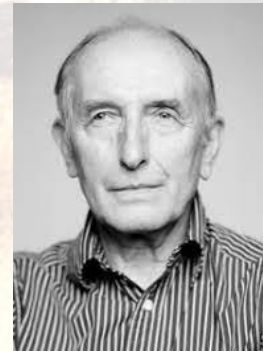
Al Bartlett



Charlie Hall



Dave Murphy



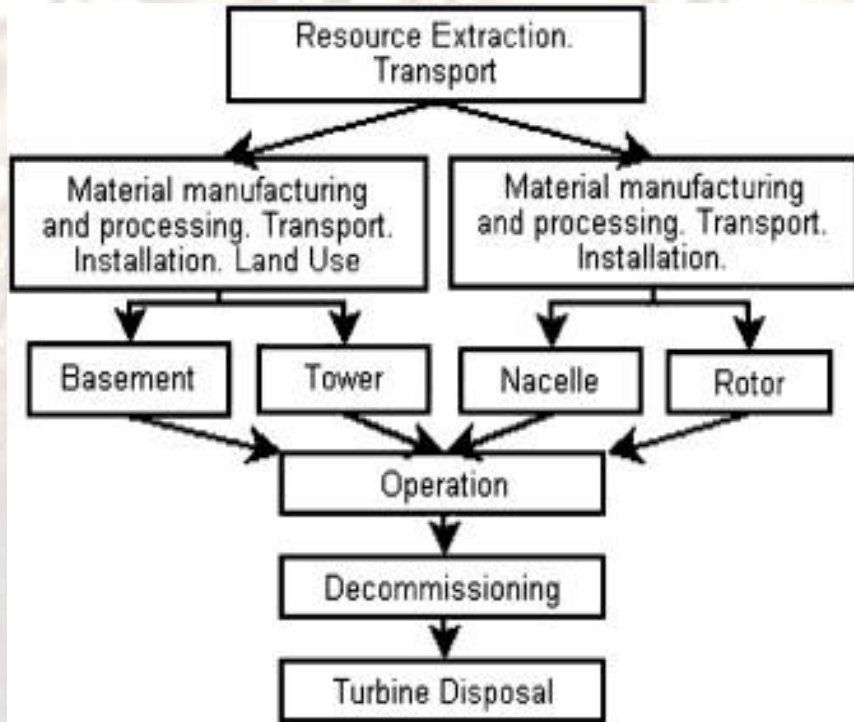
Vaclav Smil

Energy Return On (Energy) Investment

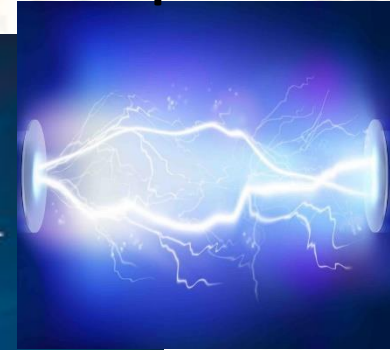
- Thermodynamics and biophysical economics
 - Measure outputs and inputs of an energy system
 - Joules (energy) rather than \$\$\$
 - Ratio of outputs to inputs is the **EROI**
- *Reflects energetic efficiency of an energy system*

Example: EROI for wind power

Inputs



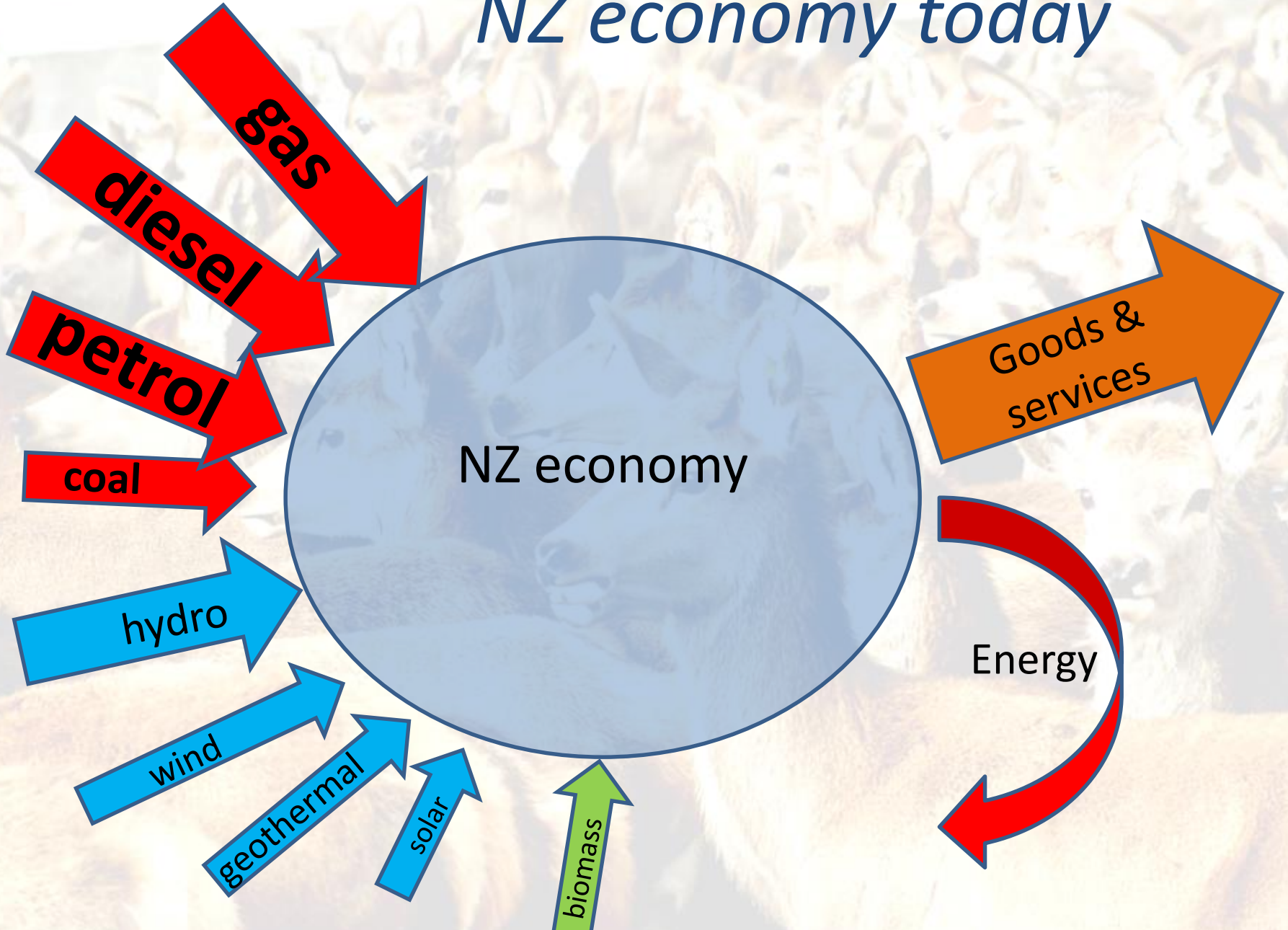
Outputs



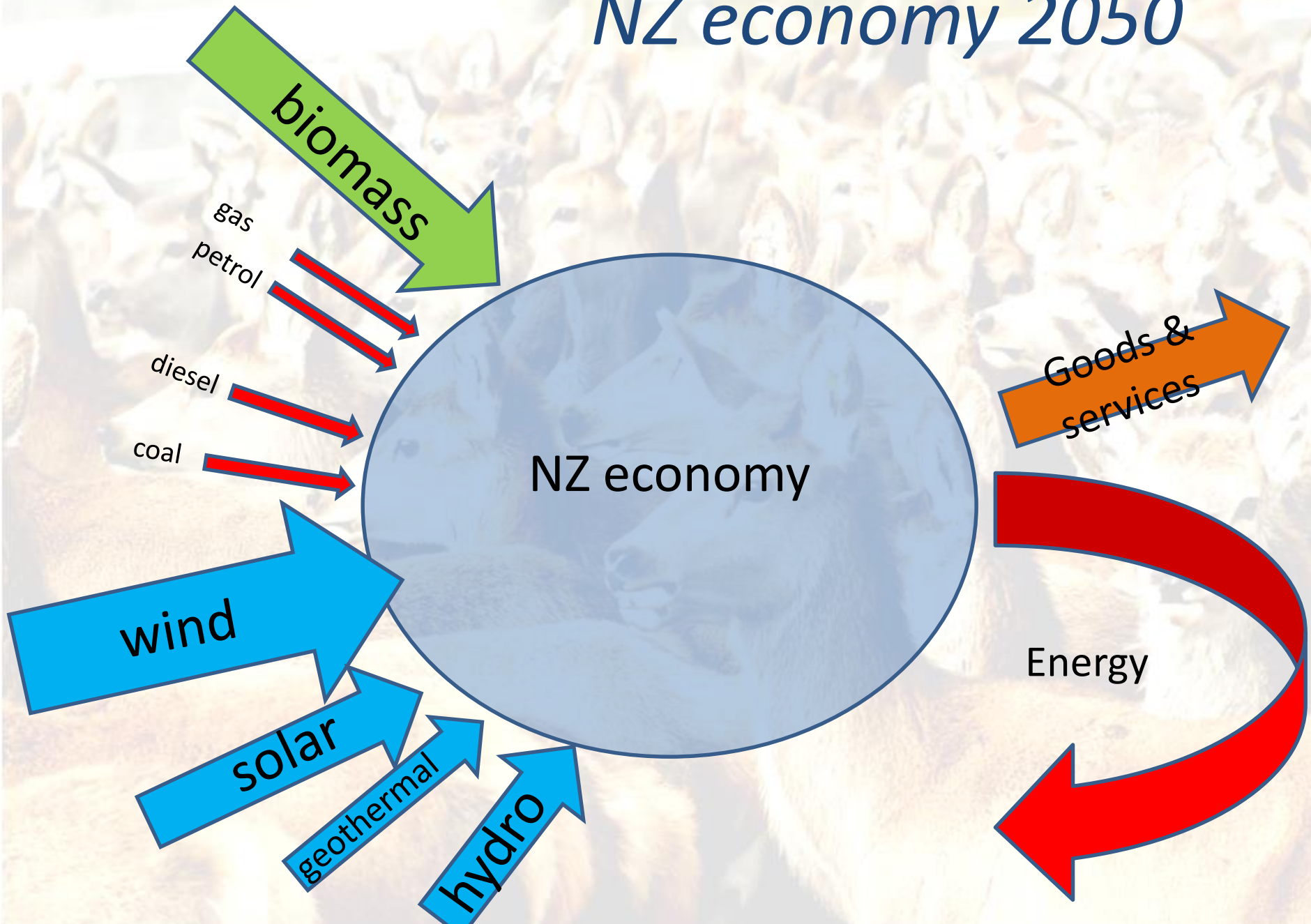
Literature on outputs: Inputs

20:1

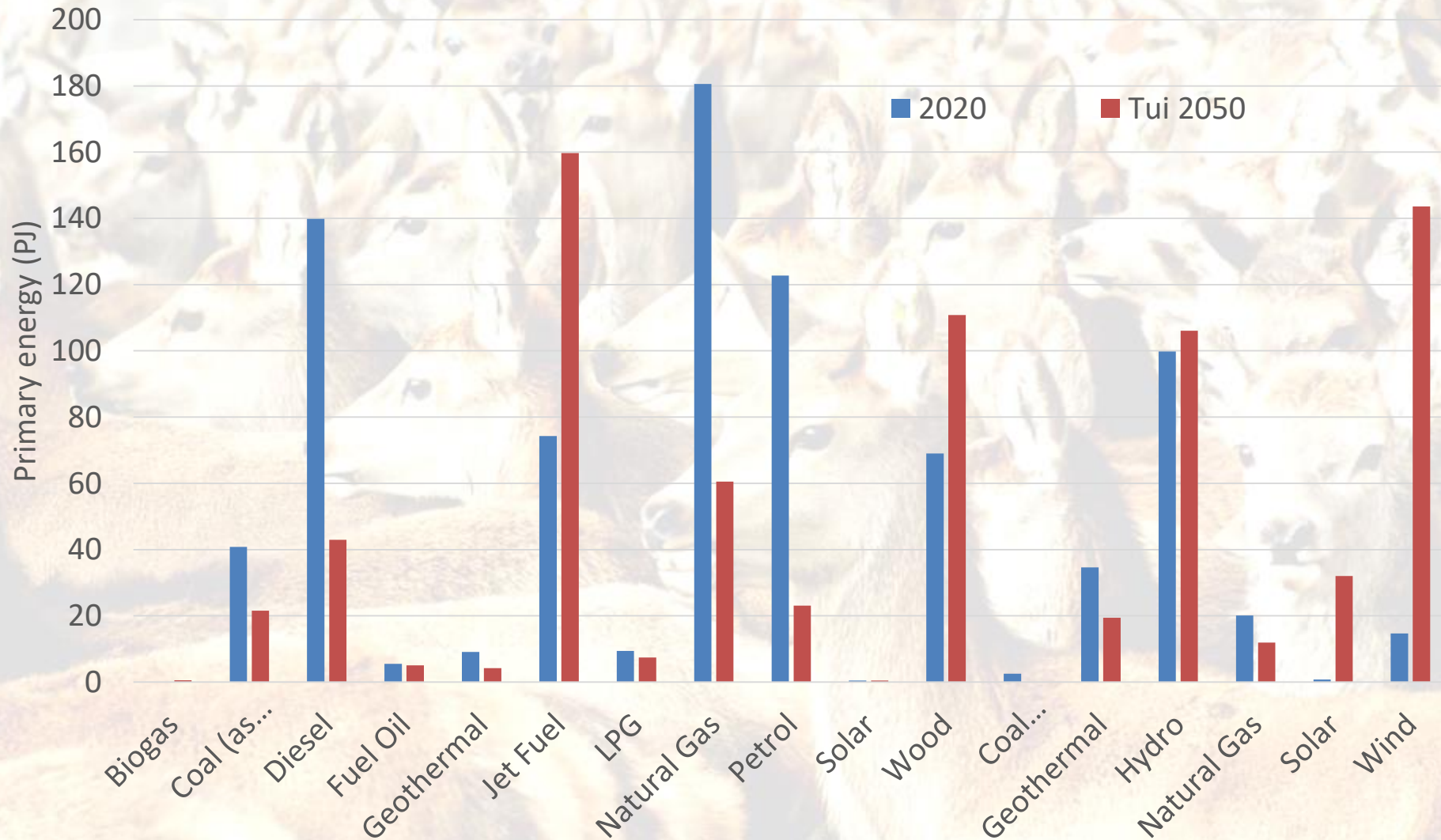
NZ economy today



NZ economy 2050



Tui energy transition scenario (2050)



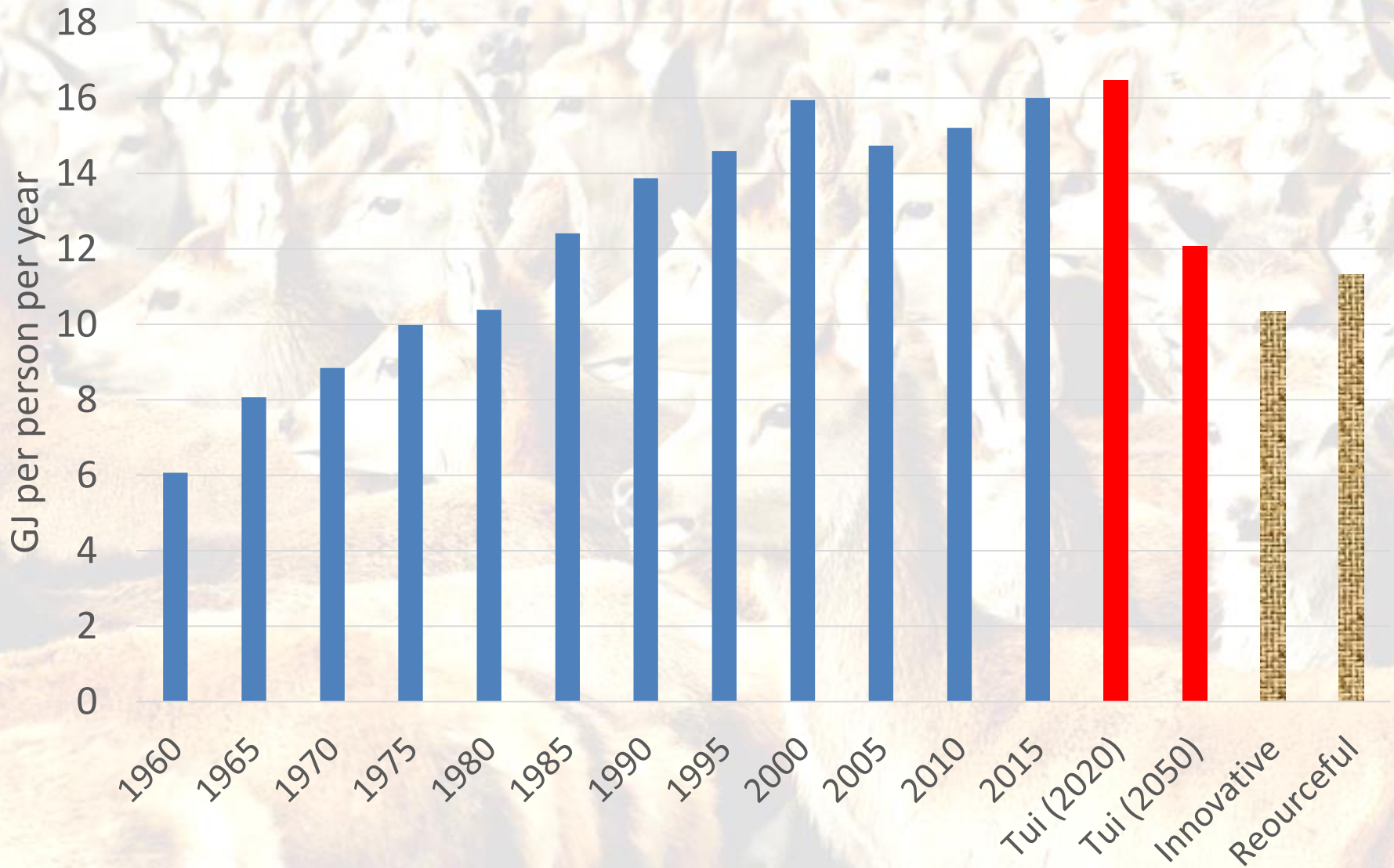
EROI now and 2050 (Tui)

Time step		2020			2050			
EROI	Tui	Fuel consumption (PJ)						
		756.8801			697.6366			
2020	2050	returned	invested	primary	returned	invested	primary	
4	4	Biogas	0.08	0.02	0.10	0.42	0.10	0.52
45	45	Coal (as thermal fuel)	39.91	0.89	40.80	21.08	0.47	21.55
18	15	Diesel	132.46	7.36	139.81	40.24	2.26	42.93
18	15	Fuel Oil	5.21	0.29	5.49	4.72	0.26	5.03
10	10	Geothermal	8.24	0.82	9.07	3.81	0.38	4.20
18	15	Jet Fuel	70.38	3.91	74.29	149.75	8.41	159.73
20	18	LPG	8.99	0.45	9.44	7.00	0.35	7.39
6	6	Natural Gas	154.78	25.80	180.57	51.88	8.65	60.53
18	15	Petrol	116.29	6.46	122.75	21.62	1.21	23.07
10	10	Solar	0.39	0.04	0.43	0.39	0.04	0.43
25	25	Wood	66.37	2.65	69.02	106.52	4.26	110.78
		Total (fuels)	603.09	48.69	651.78	407.44	26.40	436.15
		Electricity (primary)	164.37			299.43		
12	12	Coal (electricity)	2.37	0.20	2.56	0.00	0.00	0.00
10	10	Geothermal	31.49	3.15	34.64	17.68	1.77	19.44
80	80	Hydro	98.54	1.23	99.77	104.77	1.31	106.08
6	6	Natural Gas	17.24	2.87	20.12	10.22	1.70	11.92
10	10	Solar	0.70	0.07	0.77	29.11	2.91	32.02
22	22	Wind	14.04	0.64	14.67	137.32	6.24	143.56
		Electricity (total)		8.16	172.53		13.93	313.03
		Overall Total	767.46	56.85	824.31	706.53	40.33	749.18
		EROI (electricity)			21.1			22.5
		EROI (fuel)			13.4			16.5

Points to note

- Transition depends heavily on wind (x10) & biomass (x2) replacing fossil fuels
- NZ specific EROI values for these energy sources important
- National EROI: 2020= 14 2050 = 18 > counter intuitive
- 27% decrease in energy use per capita per year
- Visualise with respect to per capita GDP & energy consumption

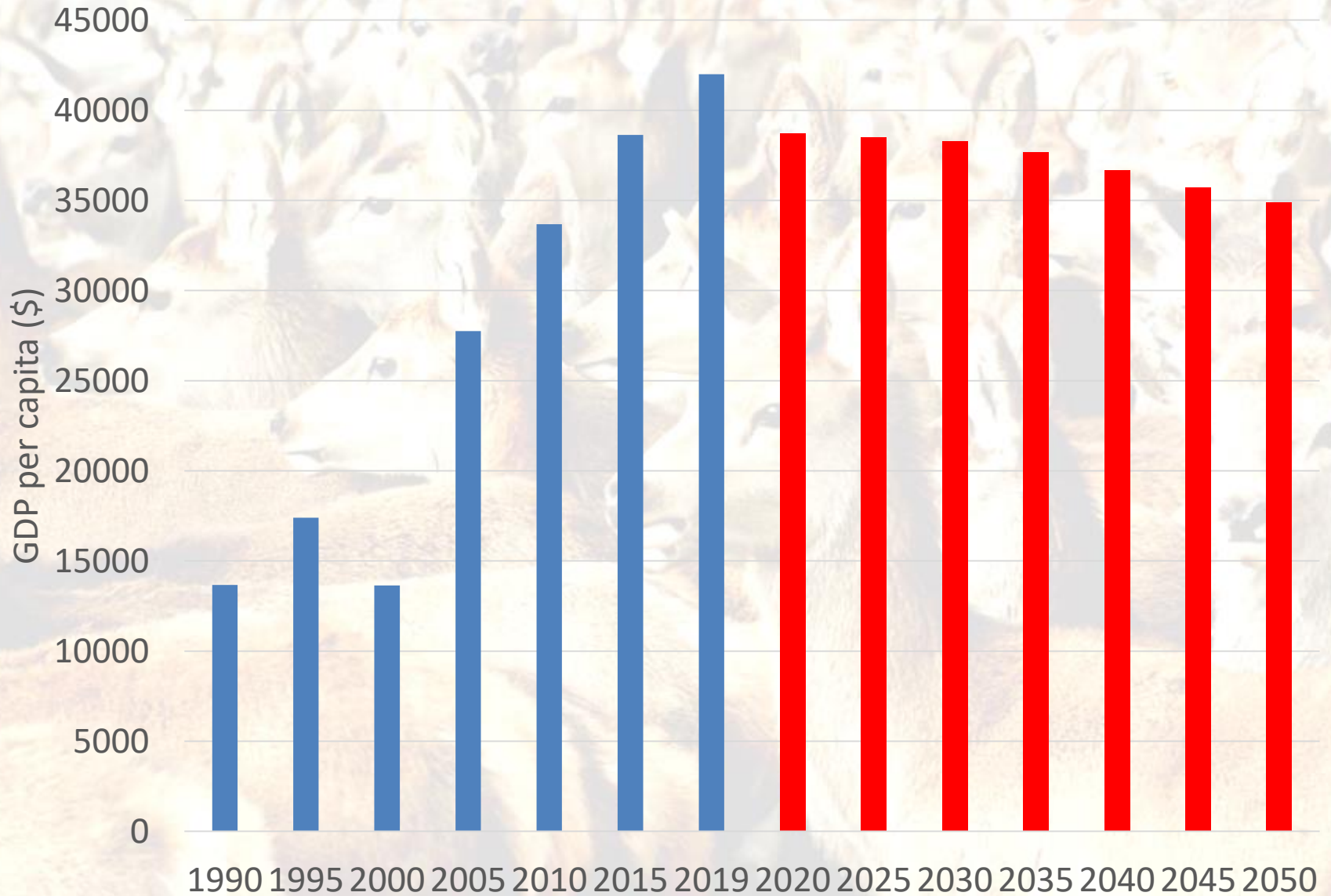
Per capita energy consumption





Main street of Auckland, 1985

Per capita GDP projection





Conclusion

- This high level EROI analysis highlights:
- Values for biomass & wind, plus oil products need refining
- Counter intuitive national EROI now and 2050
- Substantially lower per capita energy use & GDP
- Merit of contrasting approaches in achieving economically sound progress within biophysical limits – we should do more

Thank you

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