Landcare Research
Manaaki Whenua

Life Cycle Analyses of Bioenergy

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Options Studied

- Biodiesel from Canola Oil
- Straw Combustion for CHP
- Biogas CHP from Waste Kiwifruit

Life Cycle Analysis

- A bottom-up, process accounting for a product
- Quantifies inputs and outputs according to a ‘functional unit’
  - e.g., 1 GJ useful energy
- System boundary definition not prescribed, but generally from ‘cradle to grave’

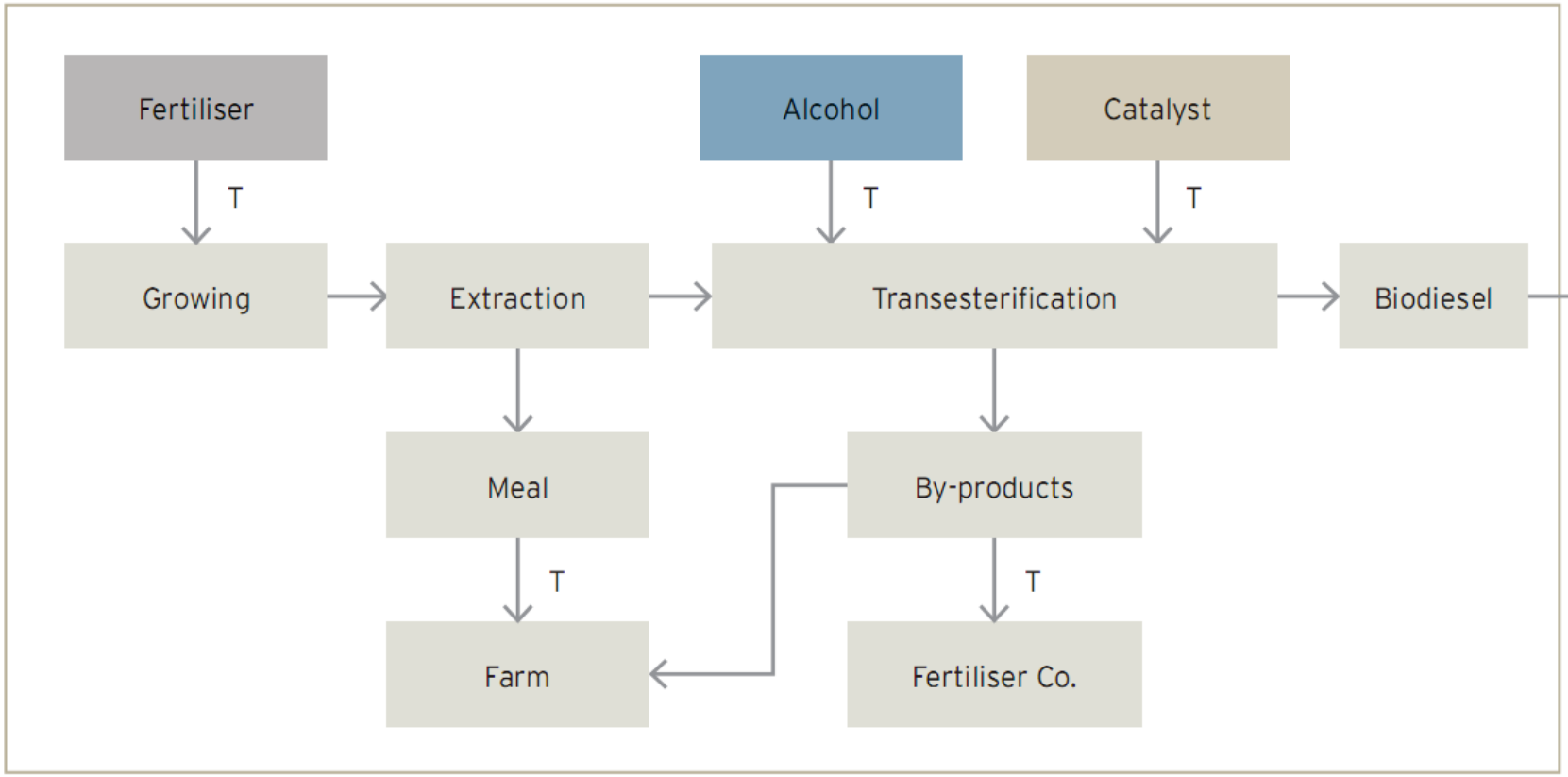
Goals of LCAs

- Determine energy inputs, greenhouse gas emissions, and costs
- Energy by Primary, Fossil-origin, Imported
- Policy issues:
  - Dependence on imported energy
  - Dependence on non-renewable resources
  - Emissions of GHGs

Canola Biodiesel

- Oil from specially grown canola is converted to biodiesel
- Grown in rotation with cereal crops
- Two existing operations in NZ
- Biodiesel Grants Scheme
- Max potential 39 PJ/yr

Canola Biodiesel: System Boundary



Canola Biodiesel: Results

- Purchase of seed from farmers major cost: $49/GJ
- Sale of byproduct meal crucial: $25/GJ
- Sale of glycerol also important: $4/GJ
- >60% reduction in GHGs compared with fossil diesel

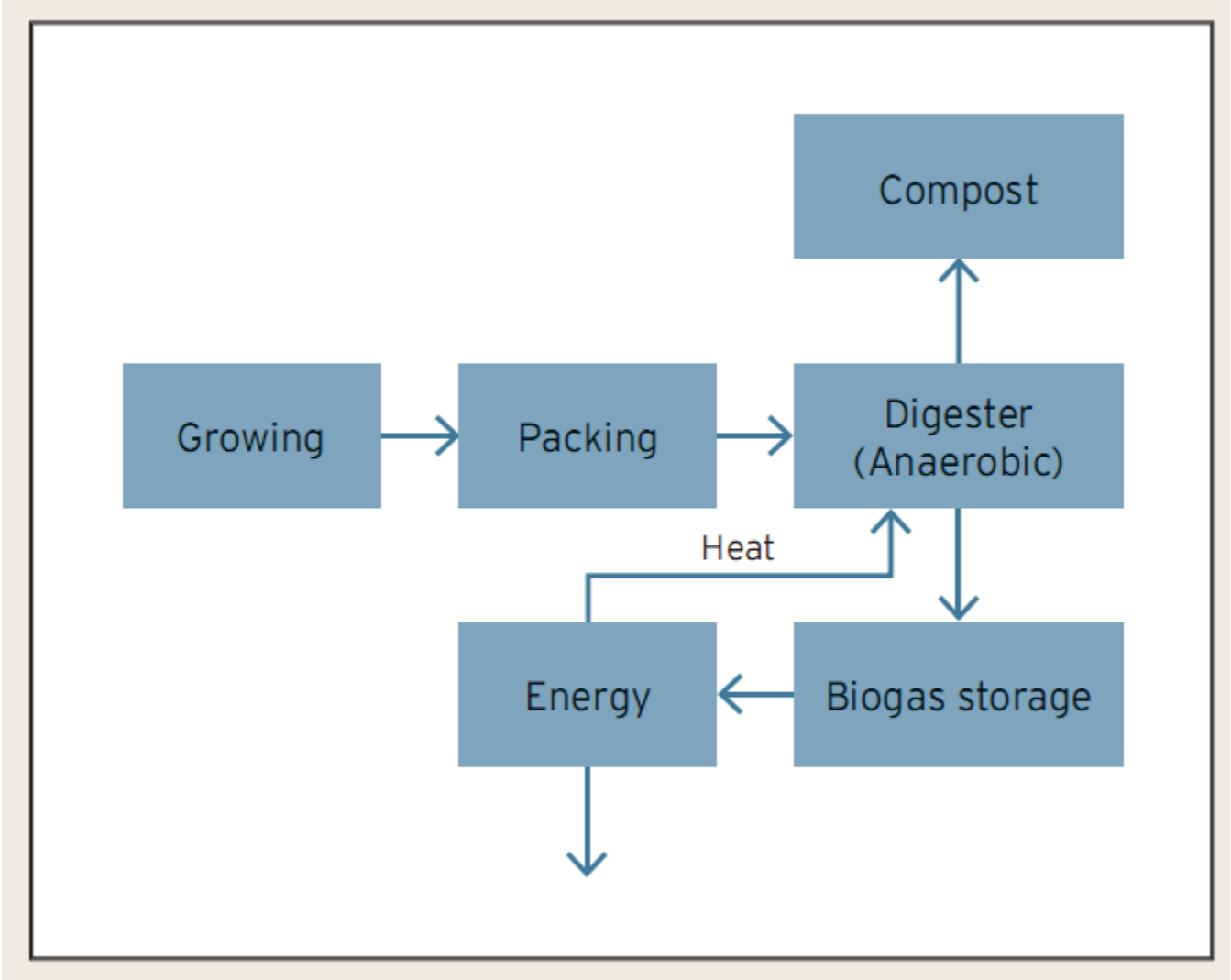
Canola Biodiesel: Conclusions

- Good EROEI: 2.2
- Large reduction in GHGs compared with fossil diesel
- Currently economic
- Meal byproduct important
- Sensitive to: prices (diesel, canola meal, glycerol), govt policy

Kiwifruit Biogas

- Waste kiwifruit are converted to biogas in an anaerobic digester
- Max potential only 0.06 PJ/yr
- Mature technology

Kiwifruit Biogas: System Boundary



Kiwifruit Biogas: Major Assumptions

- Waste KF purchased for $10/tonne
- Design based on Maunsell, 2008
- KF waste mixed with greenwaste

Kiwifruit Biogas: Results

- Significant reductions in primary energy, fossil energy, and GHGs. Imported energy about same.
- Major costs:
  - Capital + maintenance $14.75/GJ
  - waste kiwifruit $9.79/GJ
  - kiwifruit transportation $7.34/GJ
- Compost byproduct gives $6.34/GJ

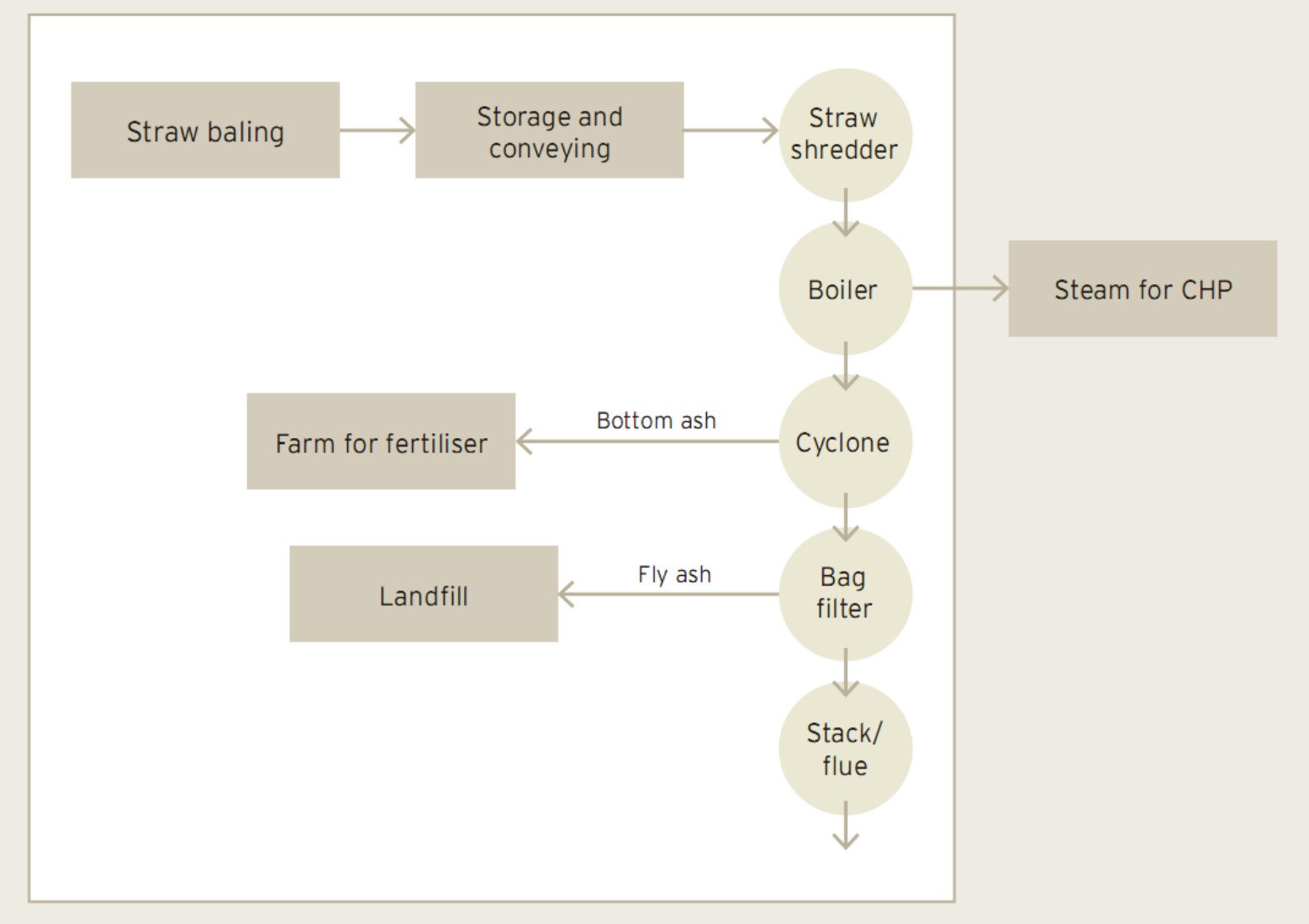
Kiwifruit Biogas: Conclusions

- Small resource
- High EROEI: 11.3
- 90% reduction in GHGs compared with conventional options
- Not economic at $10/t waste KF, but adds brand value, and $10/t is an upper limit on price
- Sensitive to: waste KF price, carbon credits, brand value, price of gas

Straw CHP

- Harvest of residual straw and combustion in boilers to produce both electricity and process heat
- Max potential 2.4 PJ/yr
- Mature technology

Straw CHP: System Boundary



Straw CHP: Results

- Total cost $15.68/GJ
- Capital purchase and maintenance over 50% of cost ($8.62/GJ)
- Baling $2.15/GJ, straw transport $1.15/GJ
- Plastic covers for straw bales 18MJ/GJ

Straw CHP: Conclusions

- High EROEI: 17.6
- >90% reduction in GHGs compared with coal CHP
- Possibly economic if compared with new-build coal-fired boiler

Overall Results

	Quantity	Description	Cost ($NZ)	Primary MJ	Fossil MJ	Imported MJ	kg CO_2-e
Canola Biodiesel							
	1 GJ	Canola Biodiesel	$32.30	449	318	123	27
	1 GJ	Fossil Diesel	$38.67	1193	1193	1152	83
Kiwifruit CHP							
	1 GJ	Kiwifruit CHP	$30.23	97	90	75	7
	1 GJ	Grid elec + Gas	$23.65	1643	910	77	59
Straw CHP							
	1 GJ	Straw CHP	$15.68	63	60	58	4
	1 GJ	Grid elec + coal	N/A	1255	935	34	85

Thank you

Full reports available here: www.bkc.co.nz

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