



The use of LCA for the development of low carbon energy solutions

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Outline

- Overview of Life Cycle Assessment
- History of use
- Bioenergy as an example
- Examples of use and associated uncertainties
- How LCA is changing
- What this means...?



Life Cycle Assessment



Trajectory and Drivers in LCA development

Si an	ngle issues id products	Prod poli	uct cy	Pollution prevention	de	(Energy) Policy velopment
	1960s	1970s	1980s	1990s	2000s	2010s
Early		Solid waste driver in product development Methodologies developed (private clients)	Slow down in interest	First SETAC workshop SETAC LCA framework developed First peer reviewed papers produced	Begins to be used more widely. Green Public Procurement IPP	LCA in energy policy, especially biomass and biofuel US: LCA for market access across state lines RED include iluc calculations
Mid		Continued, but limited company interest	Concern shifted to waste management	SETAC methodology	Revised ISO standards	
Late	Coca Cola	More interest during energy crisis	Waste becomes global issue and life cycle thinking expands again	First ISO standards	Energy Policy and Regulations	
Company Driven Policy I						olicy Driven
Regulatory/Compliance Driven						



Life Cycle Assessment Publications





LCA and GHG, waste & packaging publications





LCA and bioenergy and biofuel publications







Waste fats and oils

Algae



Some current trends





Attributional Life Cycle Assessment





LCA of biomass boiler





GHG emission per unit from major bioenergy chains



Chum et al 2011: Bioenergy (Ch 2 in IPCC Special Report on Renewable Energy Sources and Climate Change)



Some current trends





Consequential Life Cycle Assessment





Bioethanol production from wheat grain and wheat straw



Whittaker, McManus & Hammond, Energy Policy, 2011



Sources of emissions calculated according to different GHG reporting methodologies



🕆 Cultivation 🔳 Transport 🕇 Conversion 🗉 Electricity Credits 📓 Substitution Credits 📓 Combustion Emissions

Whittaker, McManus & Hammond, Energy Policy, 2011



Sources of emissions calculated according to different GHG reporting methodologies



Whittaker, McManus & Hammond, Energy Policy, 2011



Some current trends





certain

Where/when to do LCA?





Using LCA to examine differing catalytic conversion processes for converting CO2 into hydrocarbons at lab scale



Fig. 5 Normalised ReCiPe midpoint scores for the metal depletion, fossil depletion and human toxicity impacts of the catalysts formed.



Comparison of oil-body LCA using lab & projected industrial scale data



Hetherington et al, (in press)





- Will pilot/commercial results give the results predicted from lab scale?
- If repeated will we find a predictive method?
- Do we have time for that....?



Assessment proposal for novel chemical processes



Patel et al. Energy Environ. Sci., 2012, 5, 8430



Technology maturity

time



Some current trends





¹ Bioenergy, biofuel and landuse publications







Estimates of ILUC vary very widely



Chum et al 2011: Bioenergy (Ch 2 in IPCC Special Report on Renewable Energy Sources and Climate Change)



Annual US Corn Grain Allocations







"Carbon Payback" Estimates are strongly sensitive to factors not historically included in LCA



Chum et al 2011: Bioenergy (Ch 2 in IPCC Special Report on Renewable Energy Sources and Climate Change)





Consequential Life Cycle Assessment









<u>BATH</u> Papers looking at consequential and social analysis









Taylor & McManus, 2013



Some current trends





Changing approach









Complexities in bioenergy

- Various feedstock and conversion technologies
- Uncertainty in data along all stages
- Complexities in land use/agricultural systems
- Uncertainties of how will fit into energy future



Bioenergy LCA and policy shape each other



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Taylor & McManus, 2013



Where LCA is heading

Traditional

Current/moving towards

- Retrospective
- Used for product and process improvement
- Attributional LCA
- Compliance
- promotion

- Forward facing
- predictive
- Policy and scene setting
- Consequential LCA
- GHG as proxy for resource use
- Indirect effects
- Social implications





Questions & comments...?

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EPSRC

Engineering and Physical Sciences Research Council







) SUPERGEN Bioenergy Hub

