

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

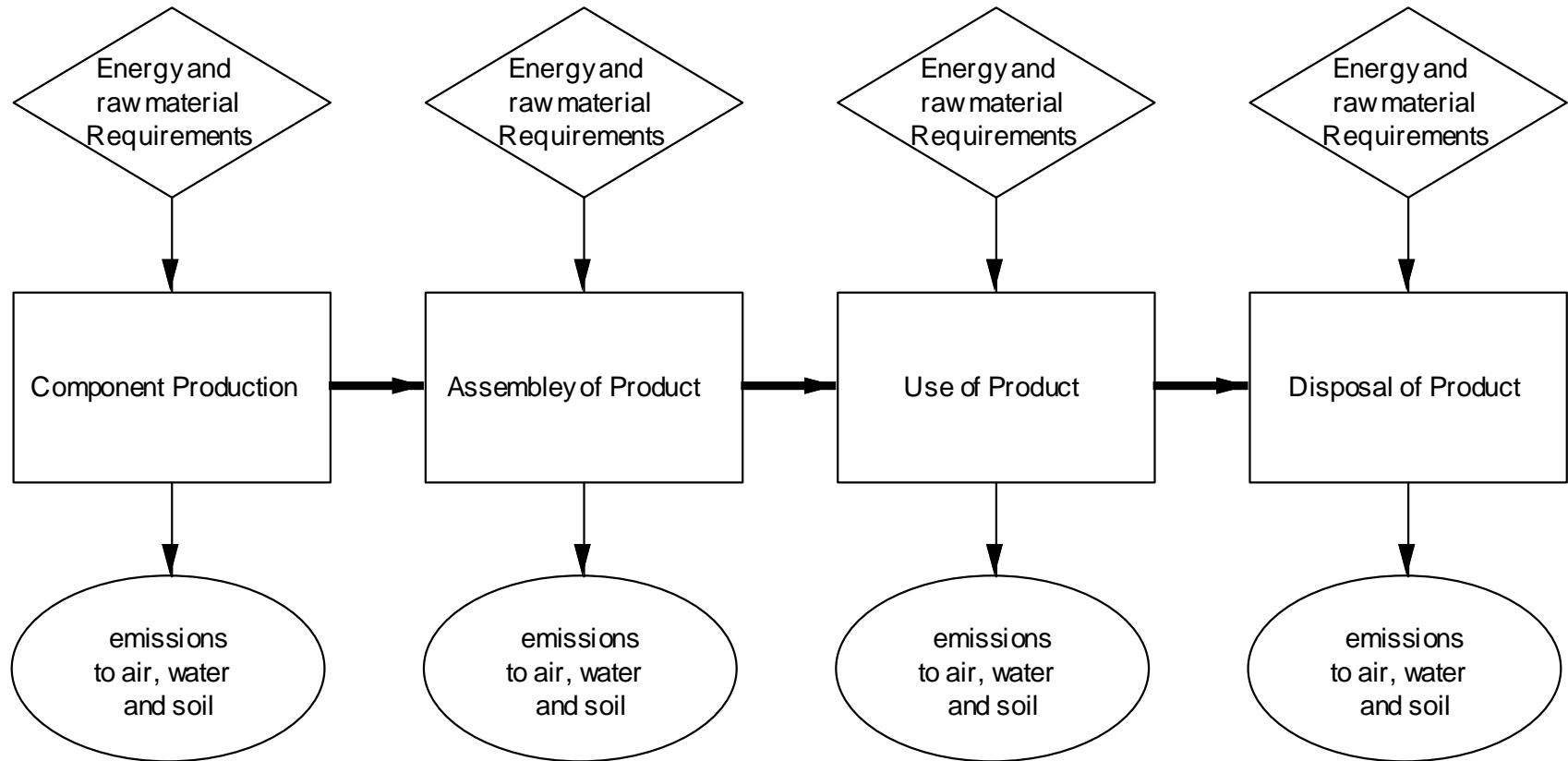
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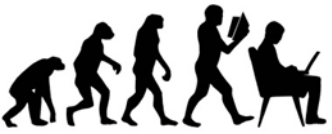
Dr Marcelle C McManus  
Sustainable Energy Research Team  
Faculty of Engineering and Design  
University of Bath, UK

# Outline

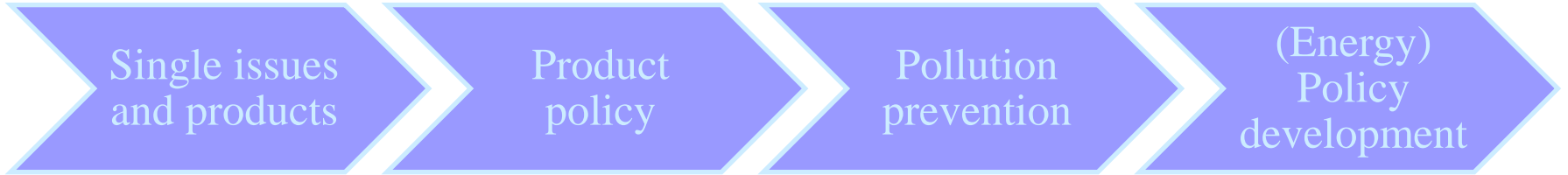
- Overview of Life Cycle Assessment
- History of use
- Bioenergy as an example
- Examples of use and associated uncertainties
- How LCA is changing
- What this means...?

# Life Cycle Assessment





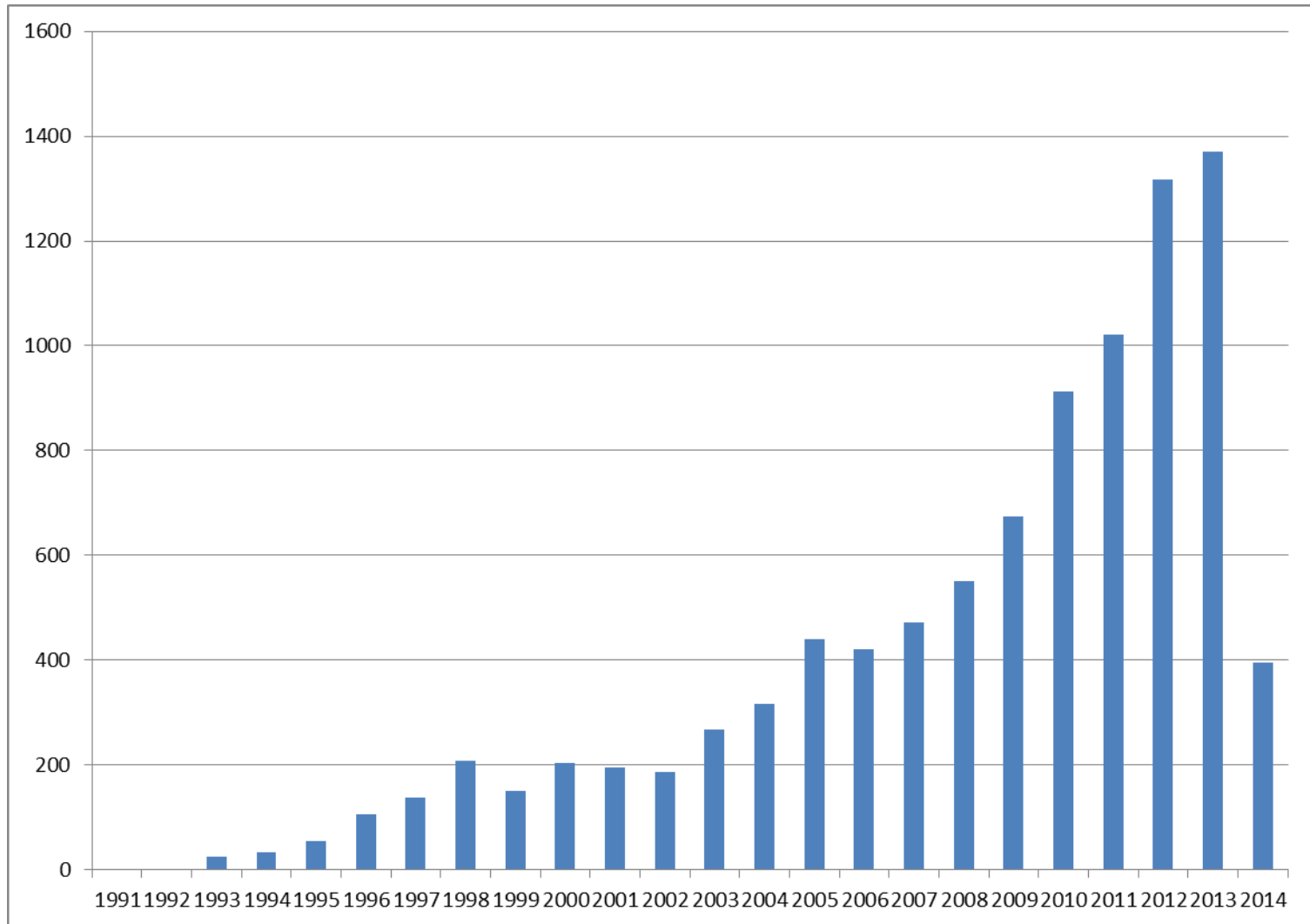
# Trajectory and Drivers in LCA development



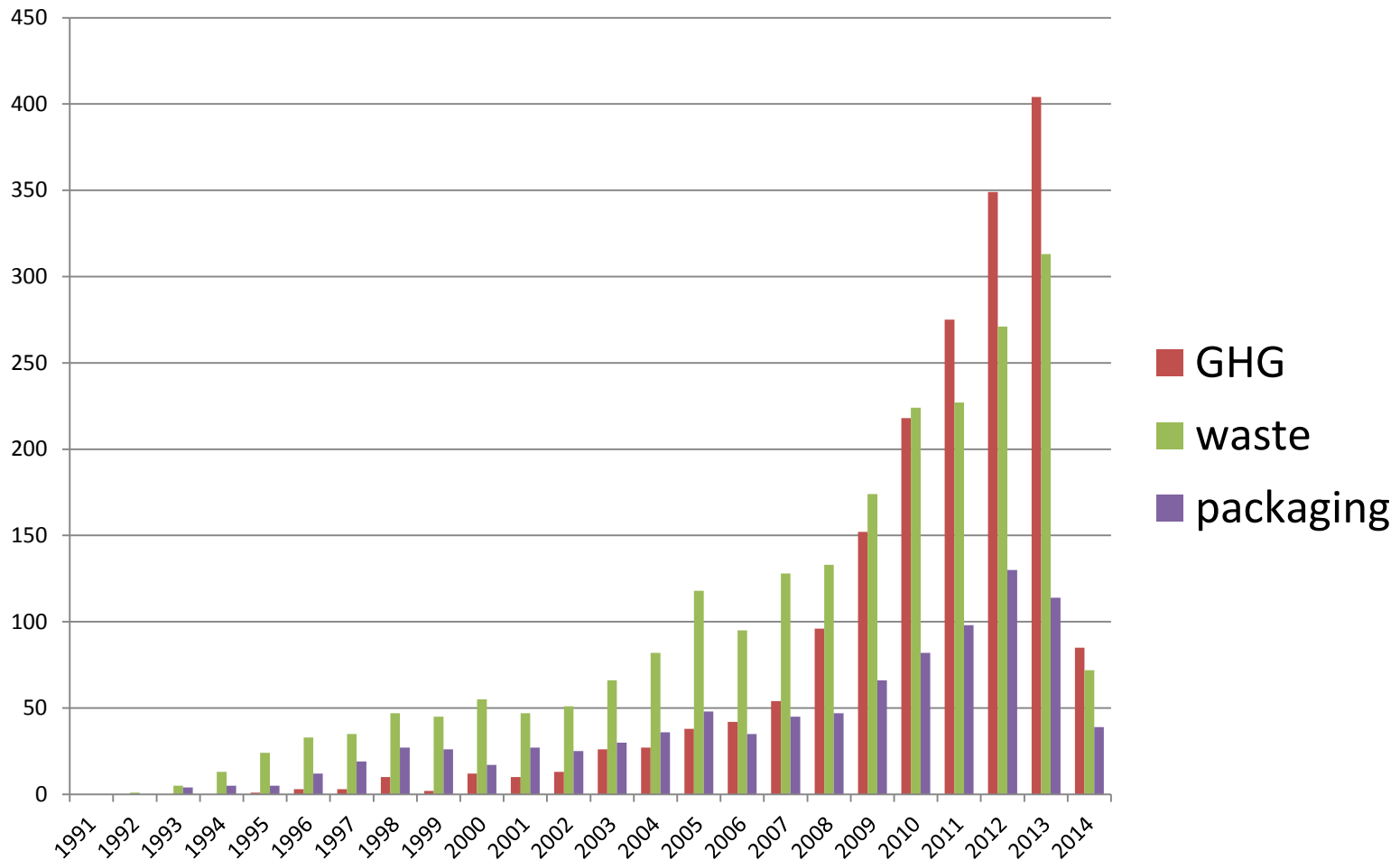
	1960s	1970s	1980s	1990s	2000s	2010s
Early		Solid waste driver in product development Methodologies developed (private clients)	Slow down in interest	First SETAC workshop  SETAC LCA framework developed  First peer reviewed papers produced	Begins to be used more widely.  Green Public Procurement  IPP	LCA 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	



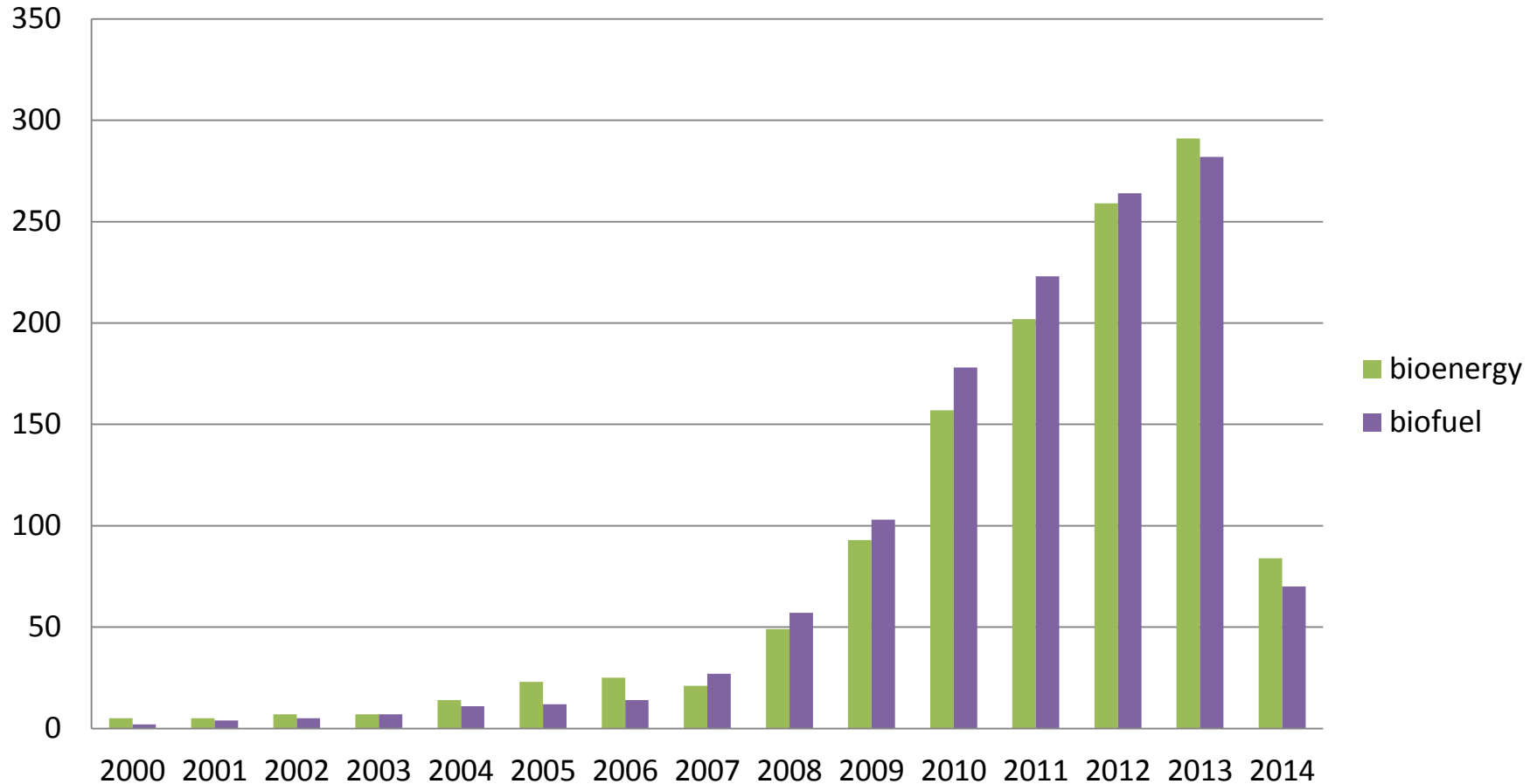
# Life Cycle Assessment Publications

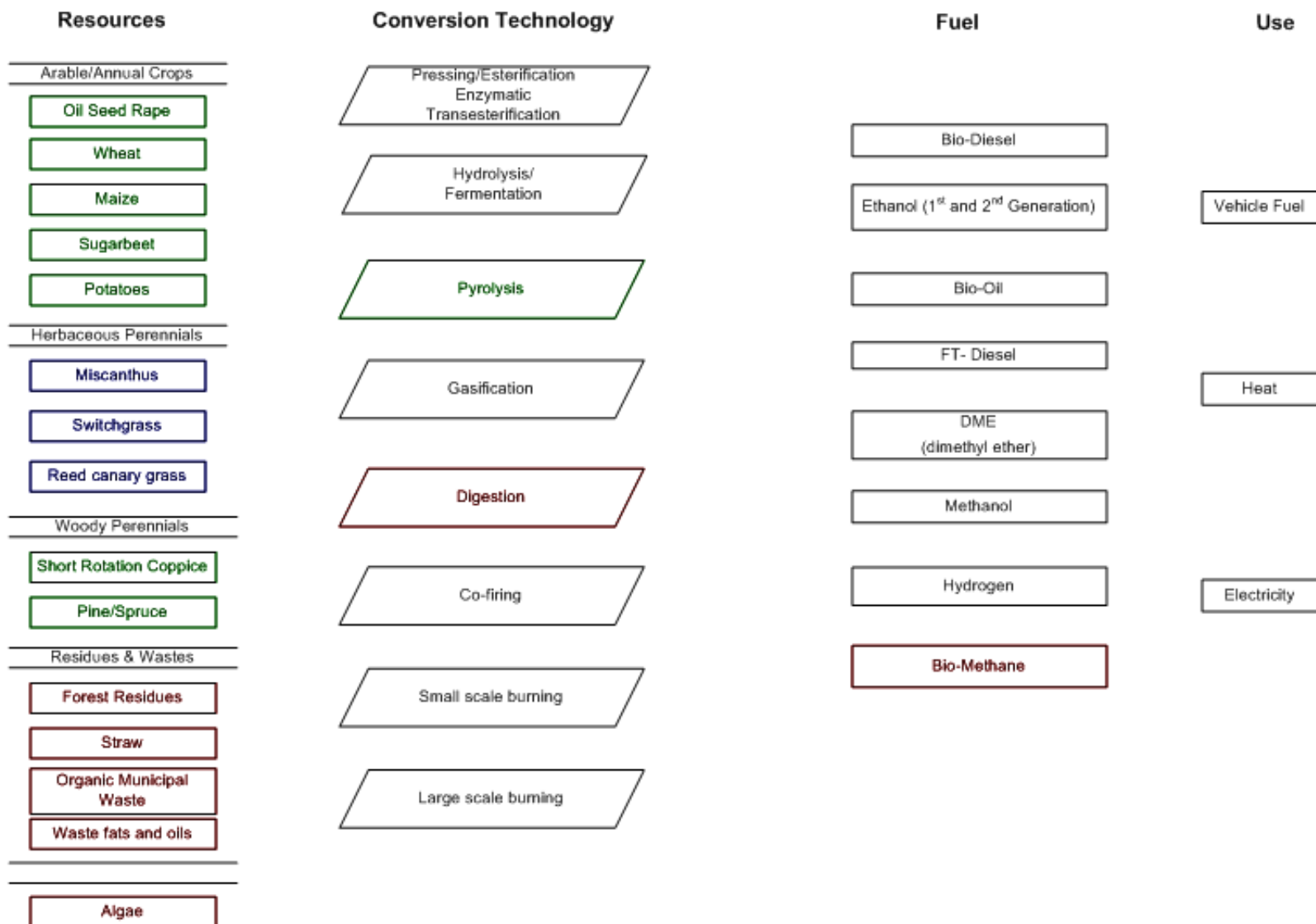


# LCA and GHG, waste & packaging publications



# LCA and bioenergy and biofuel publications



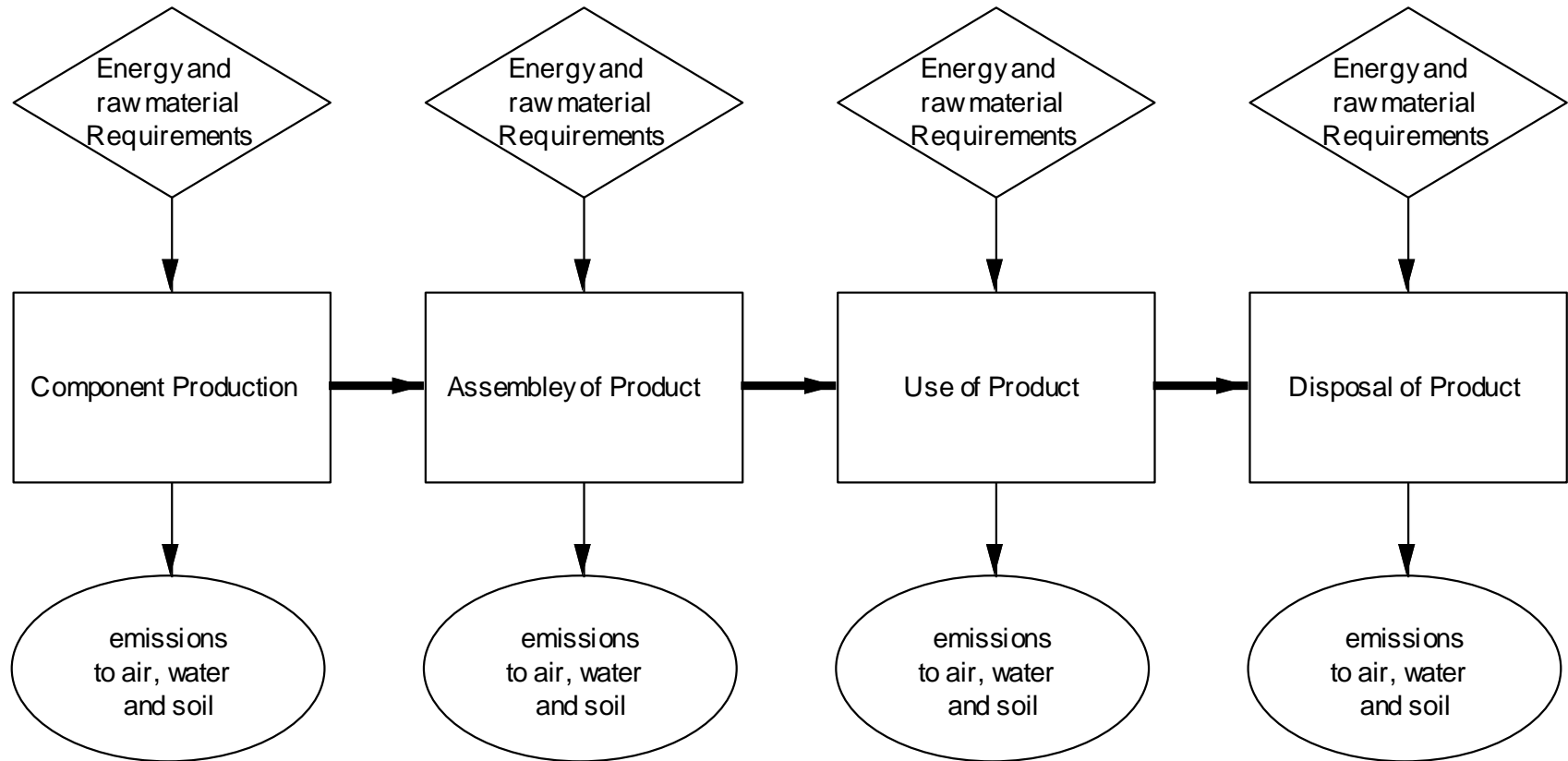




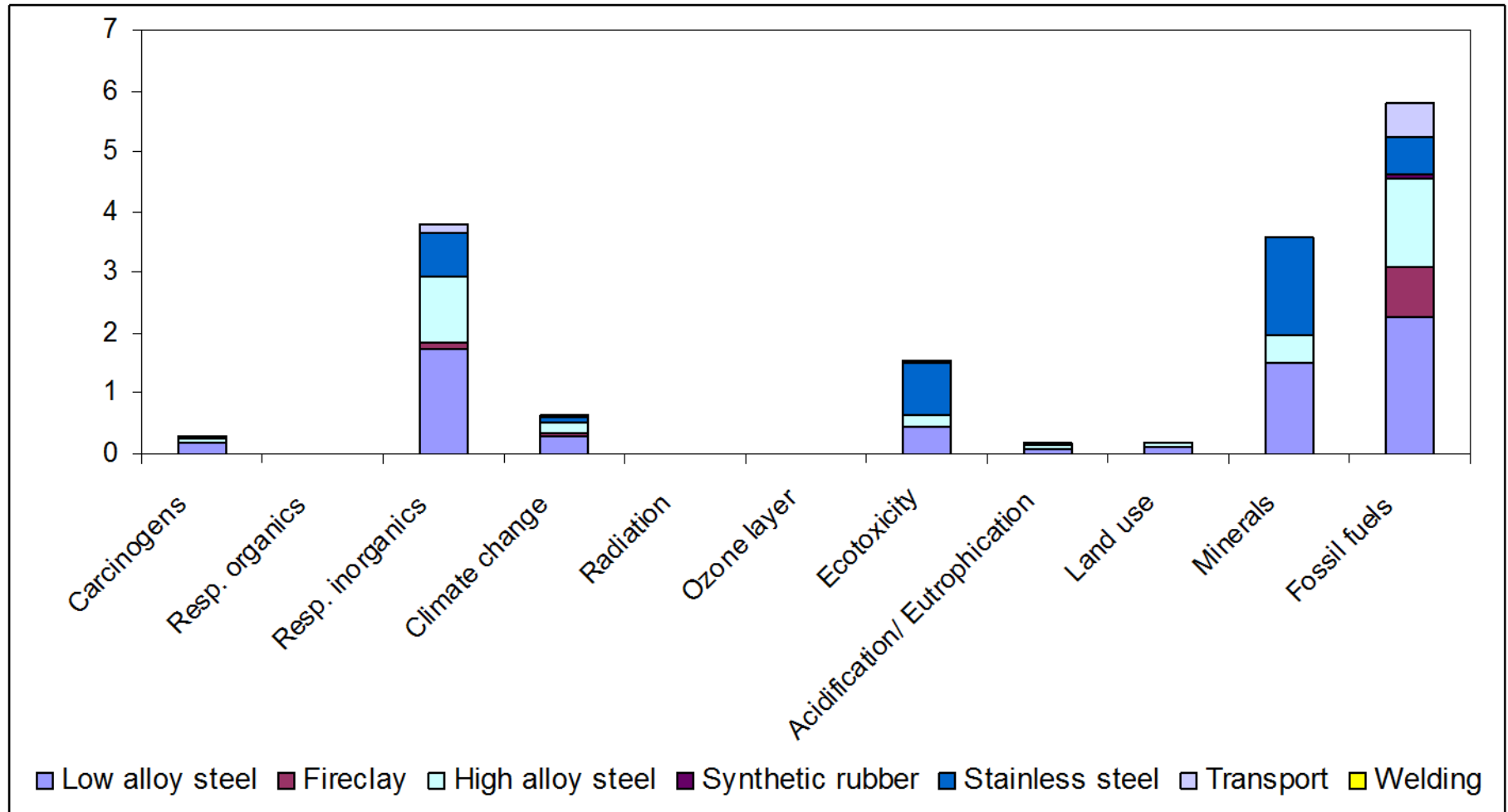
# Some current trends



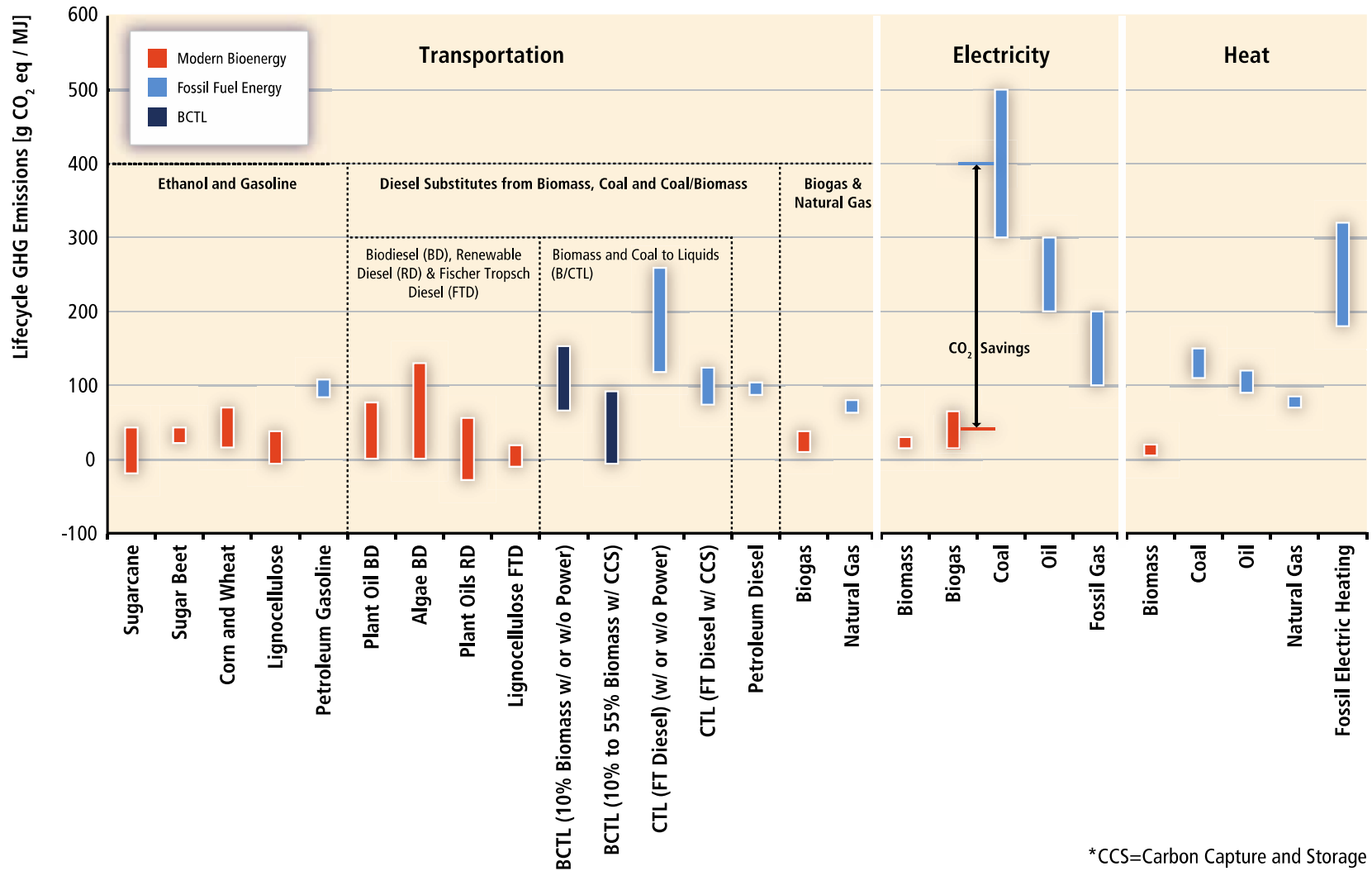
# Attributional Life Cycle Assessment



# LCA of biomass boiler

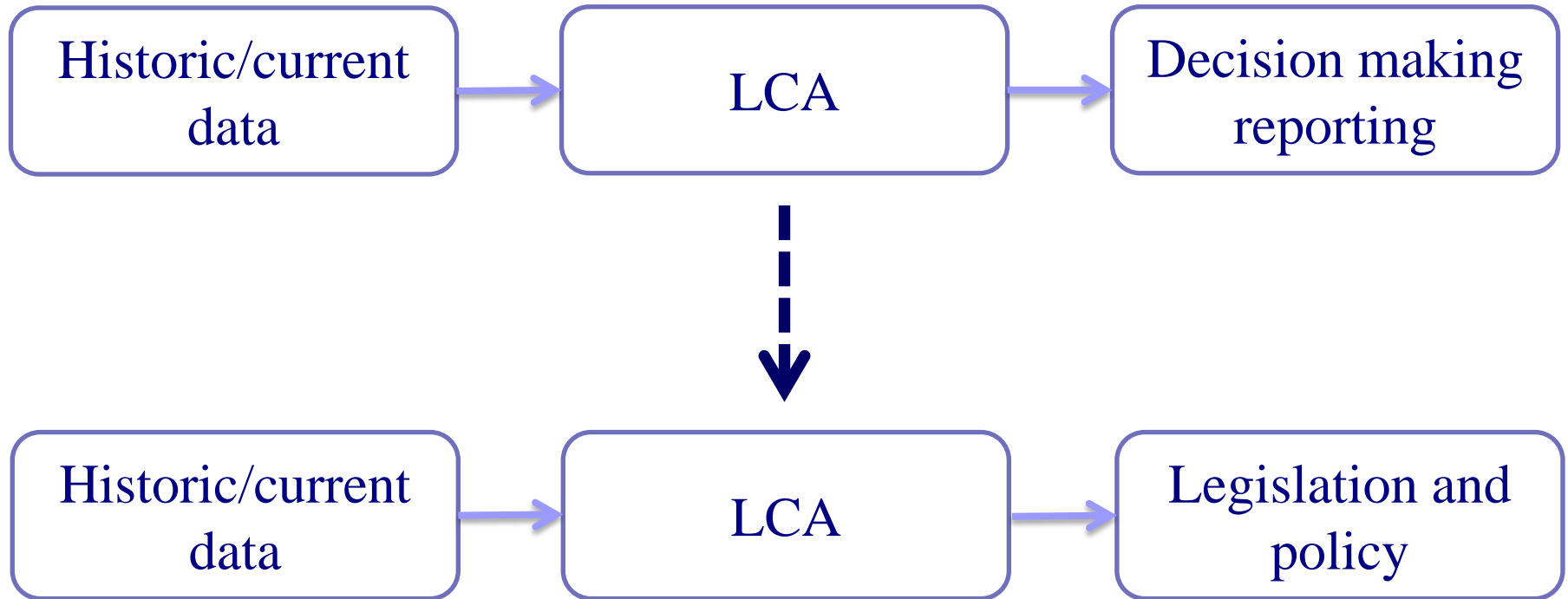


# GHG emission per unit from major bioenergy chains

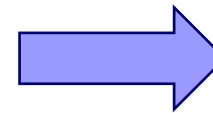
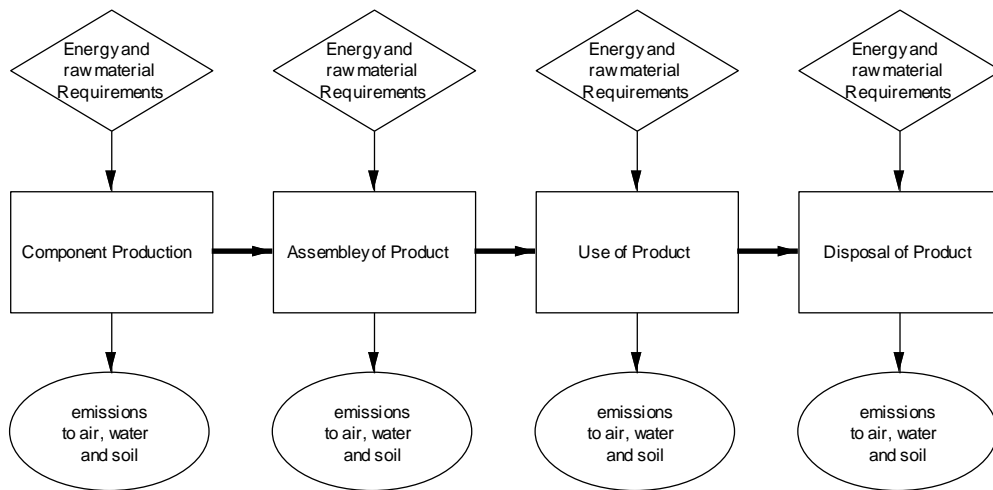


\*CCS=Carbon Capture and Storage

# Some current trends

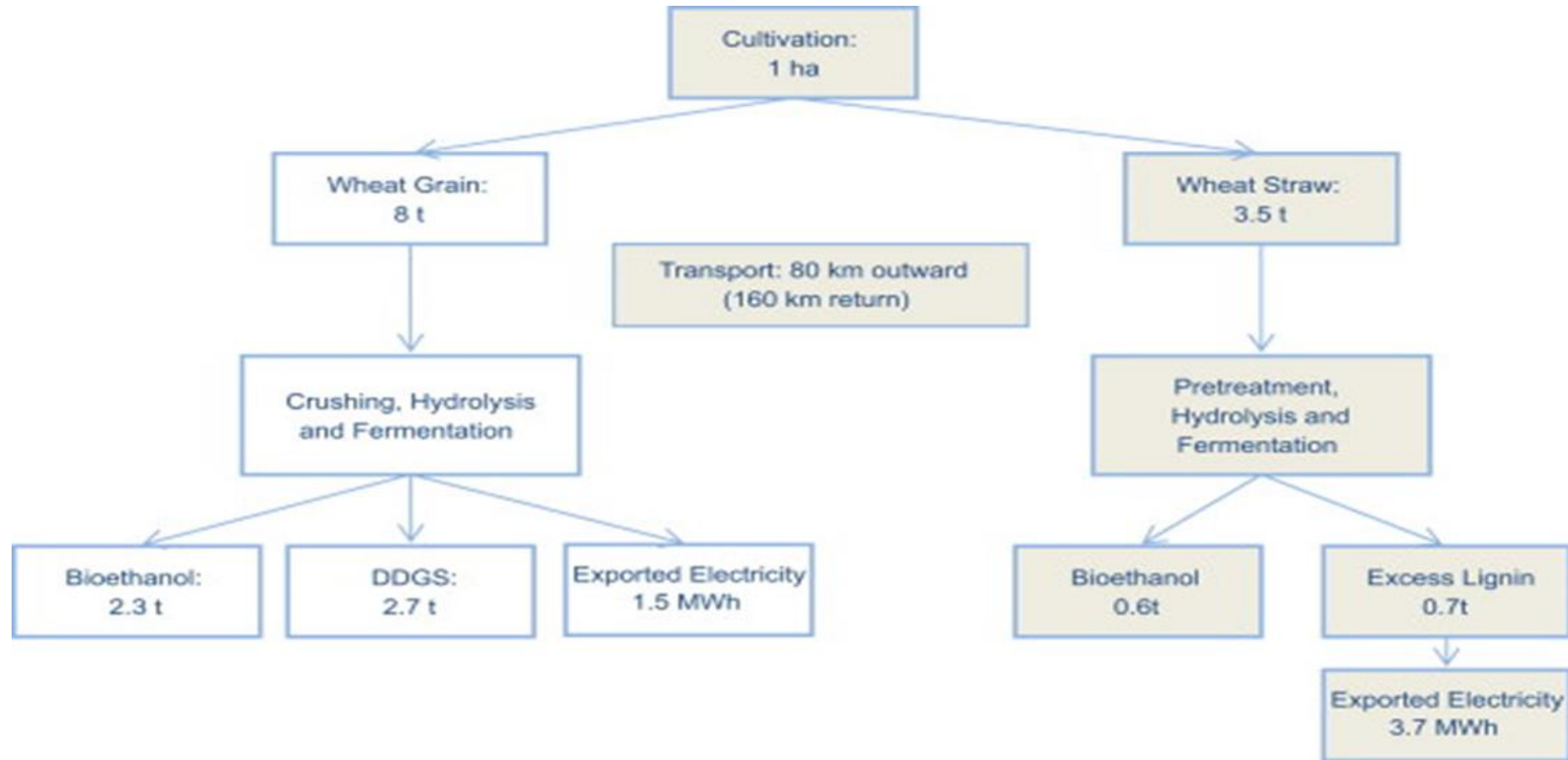


# Consequential Life Cycle Assessment

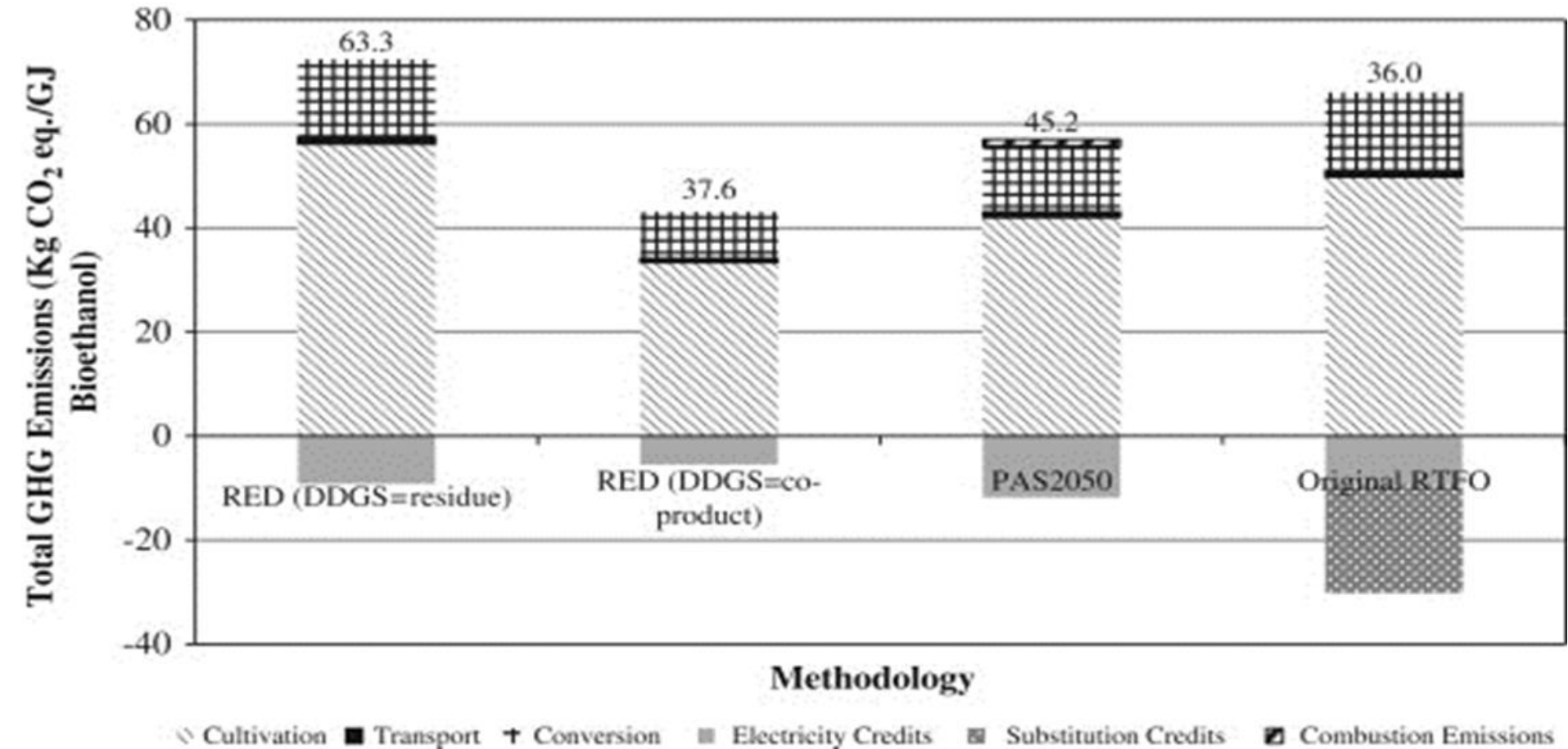


Consequences  
of using in  
wider system

# Bioethanol production from wheat grain and wheat straw

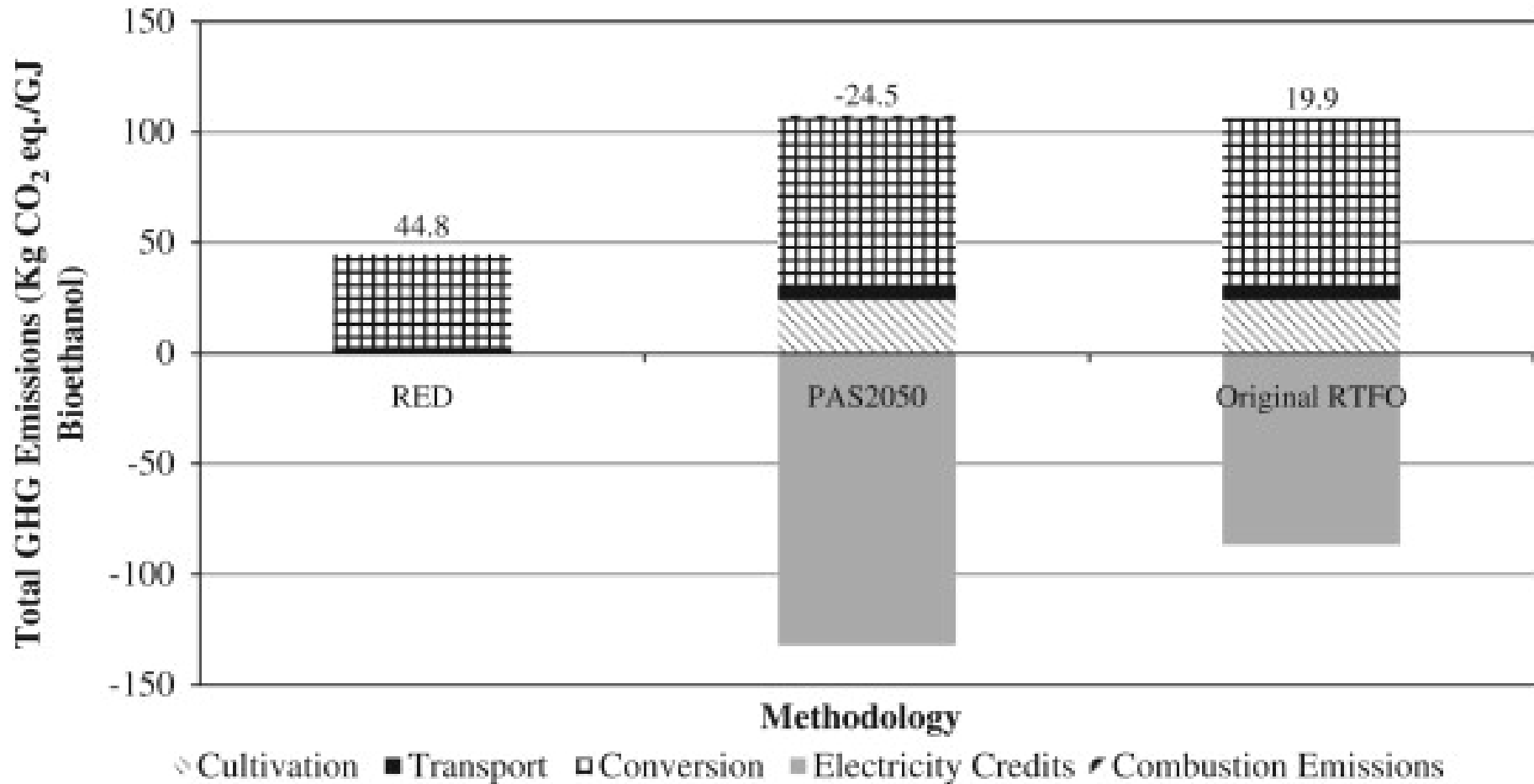


# Sources of emissions calculated according to different GHG reporting methodologies

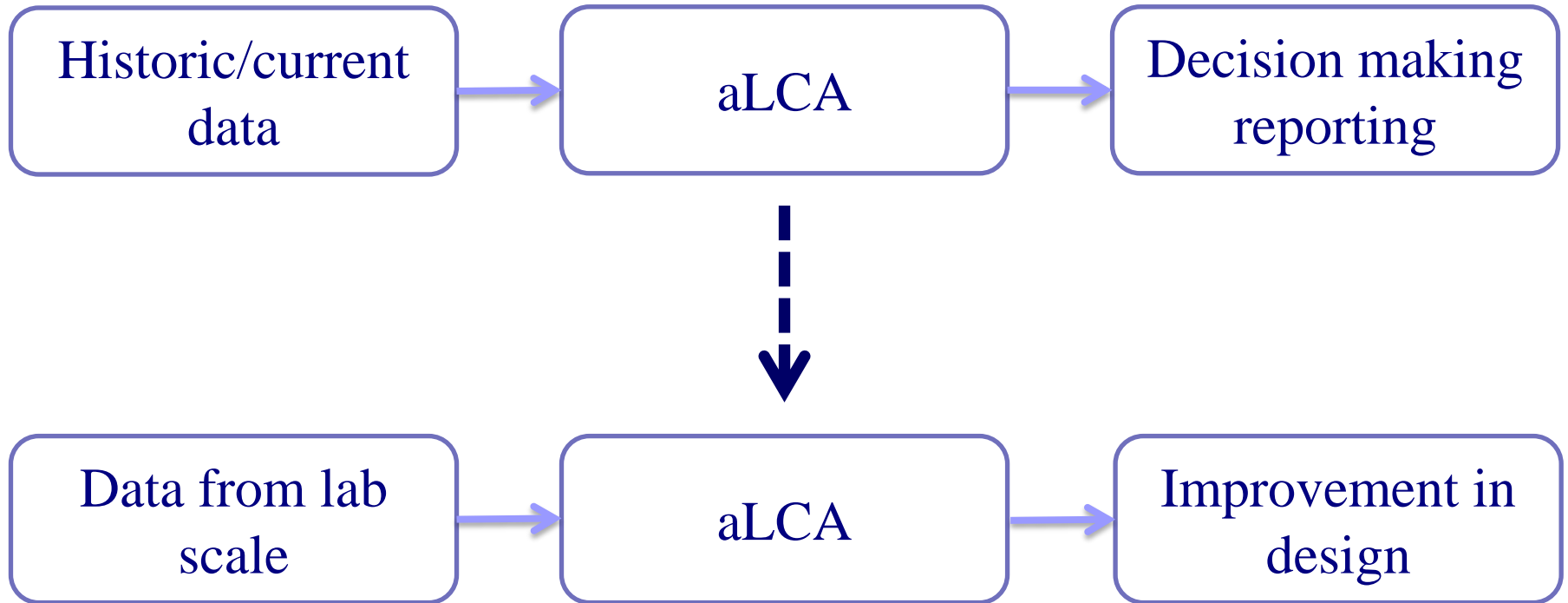




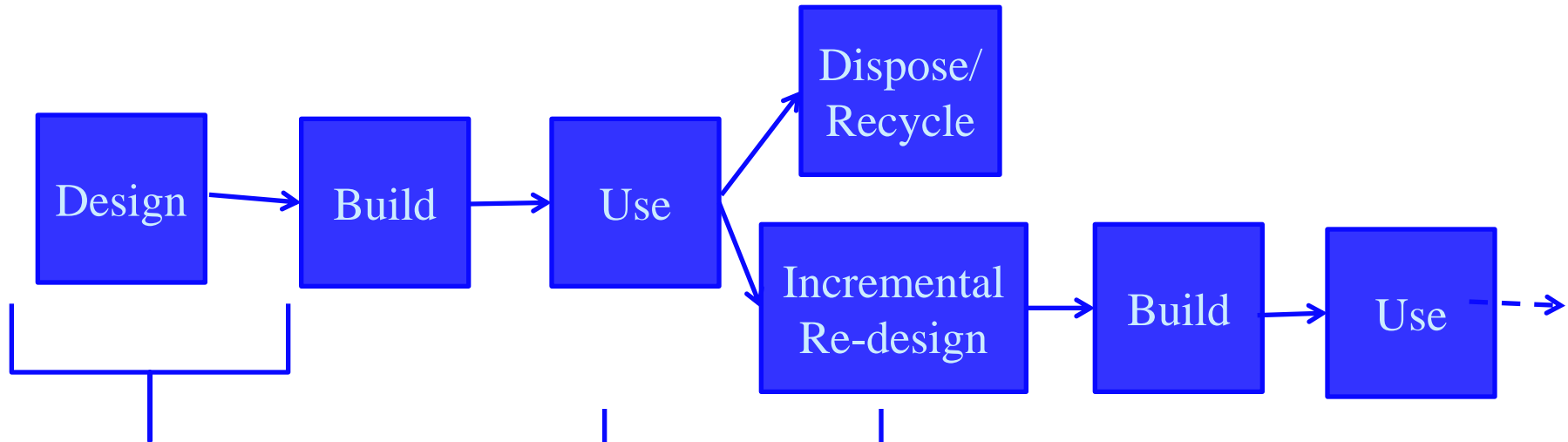
# Sources of emissions calculated according to different GHG reporting methodologies



# Some current trends



# Where/when to do LCA?



LCA would make most difference here, although the data is least certain

LCA often done here (although often re-design stage left out)

# Using LCA to examine differing catalytic conversion processes for converting CO<sub>2</sub> into hydrocarbons at lab scale

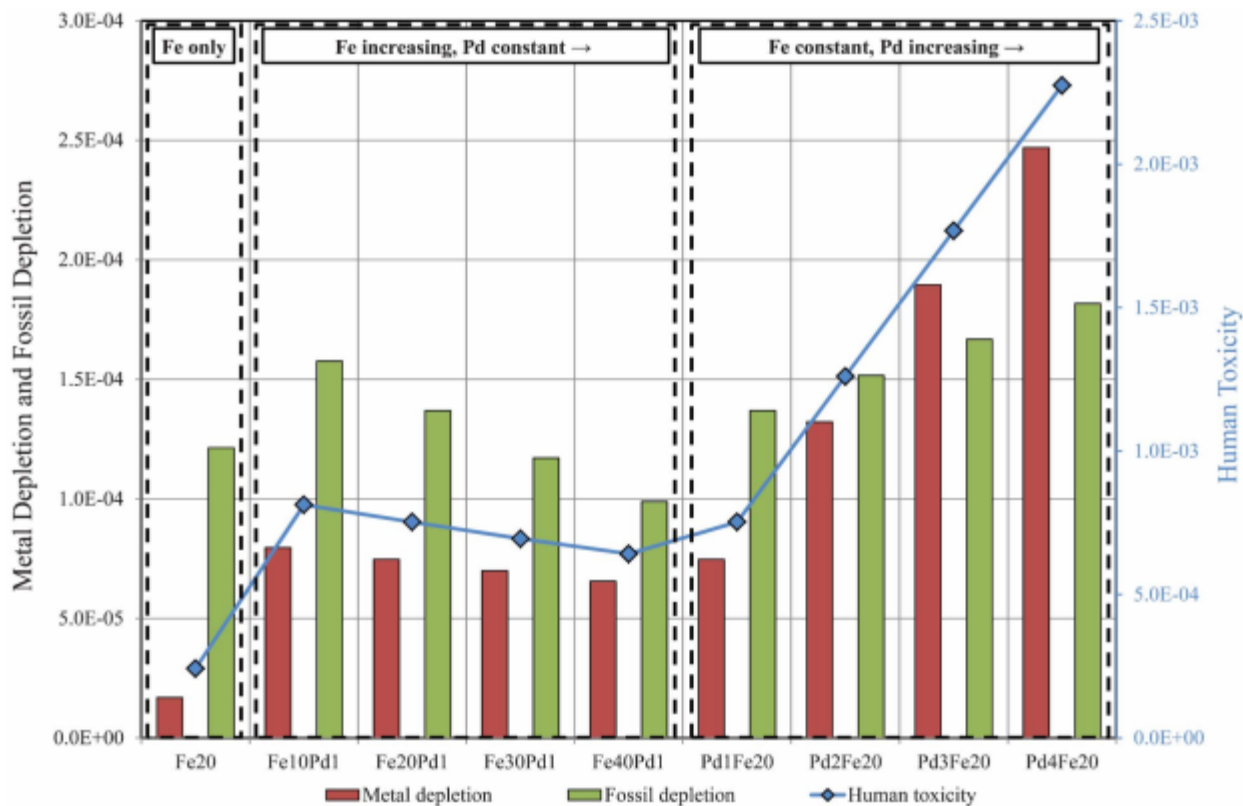
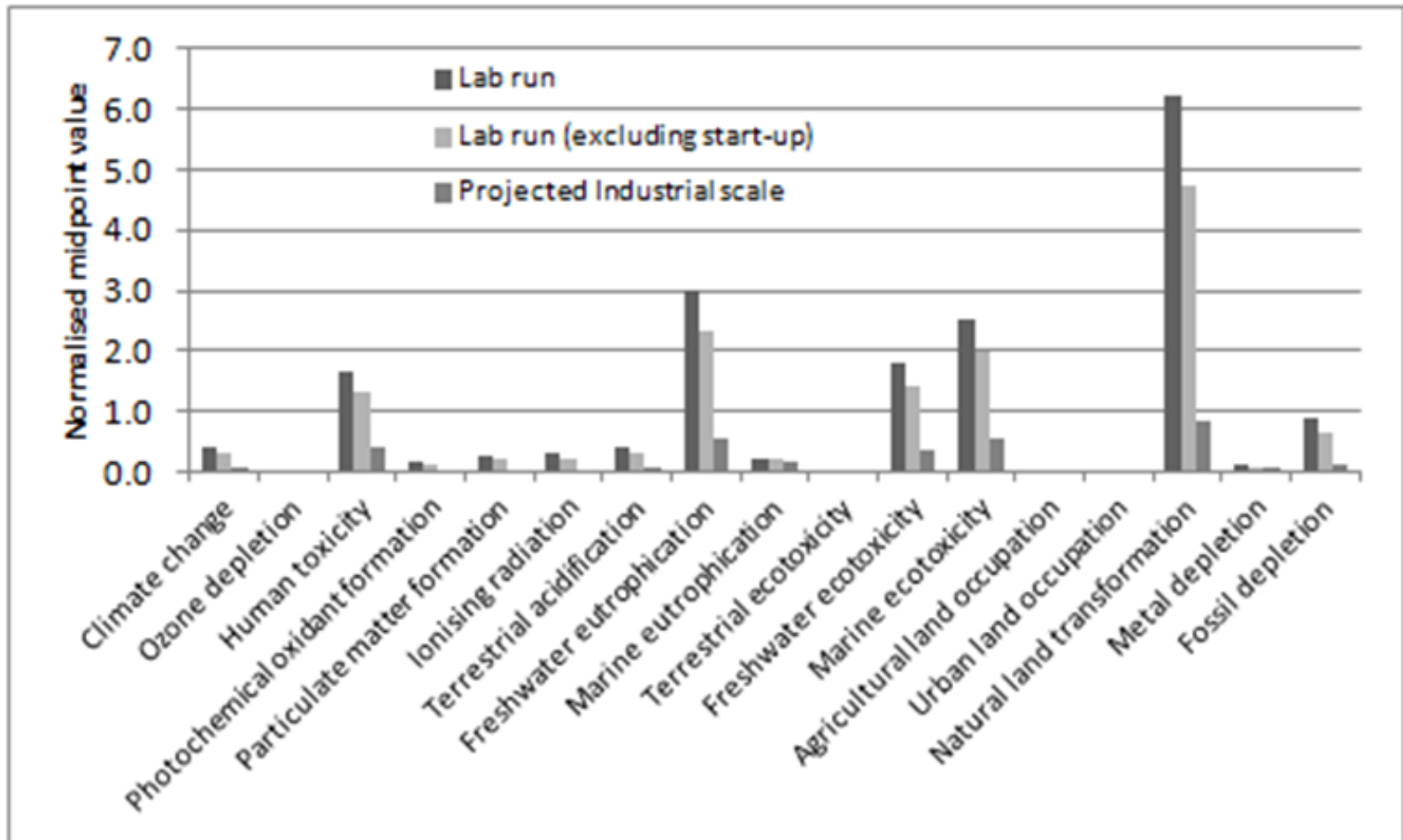
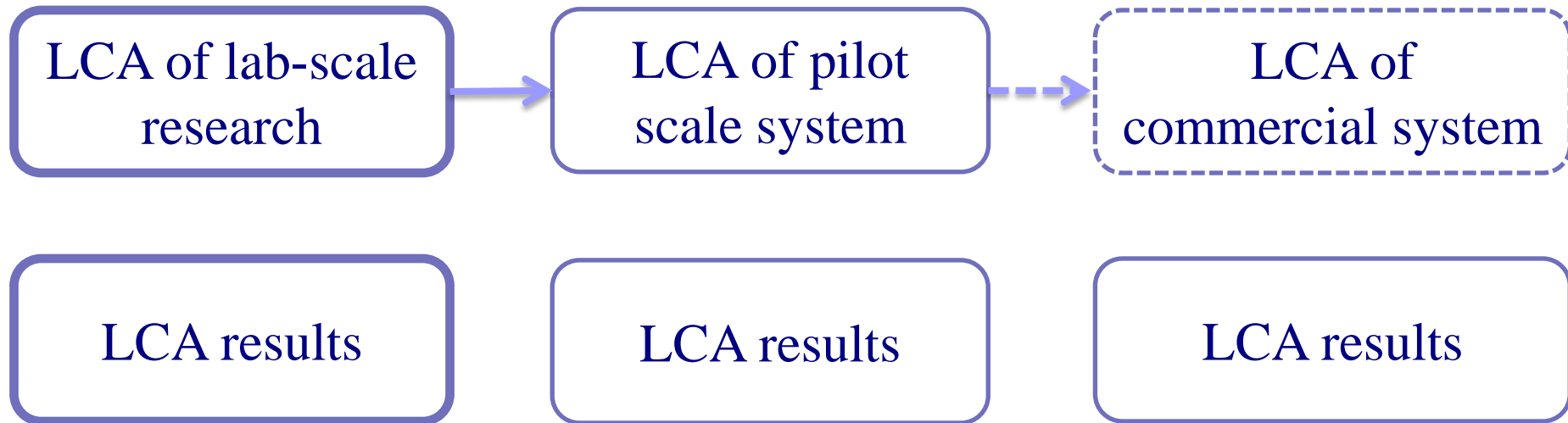


Fig. 5 Normalised ReCIpe midpoint scores for the metal depletion, fossil depletion and human toxicity impacts of the catalysts formed.

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

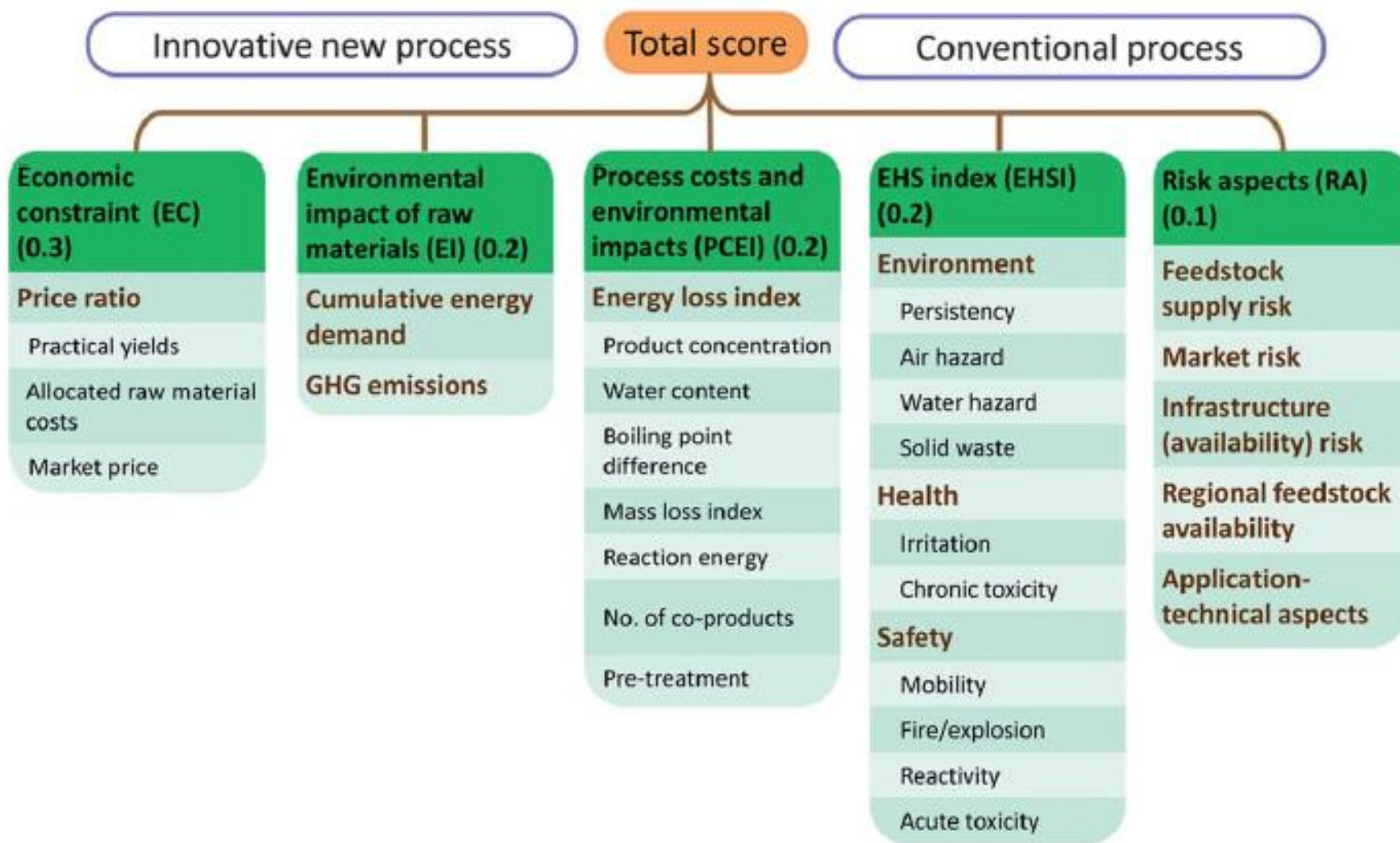


## Example: data gathering of scale up biofuels

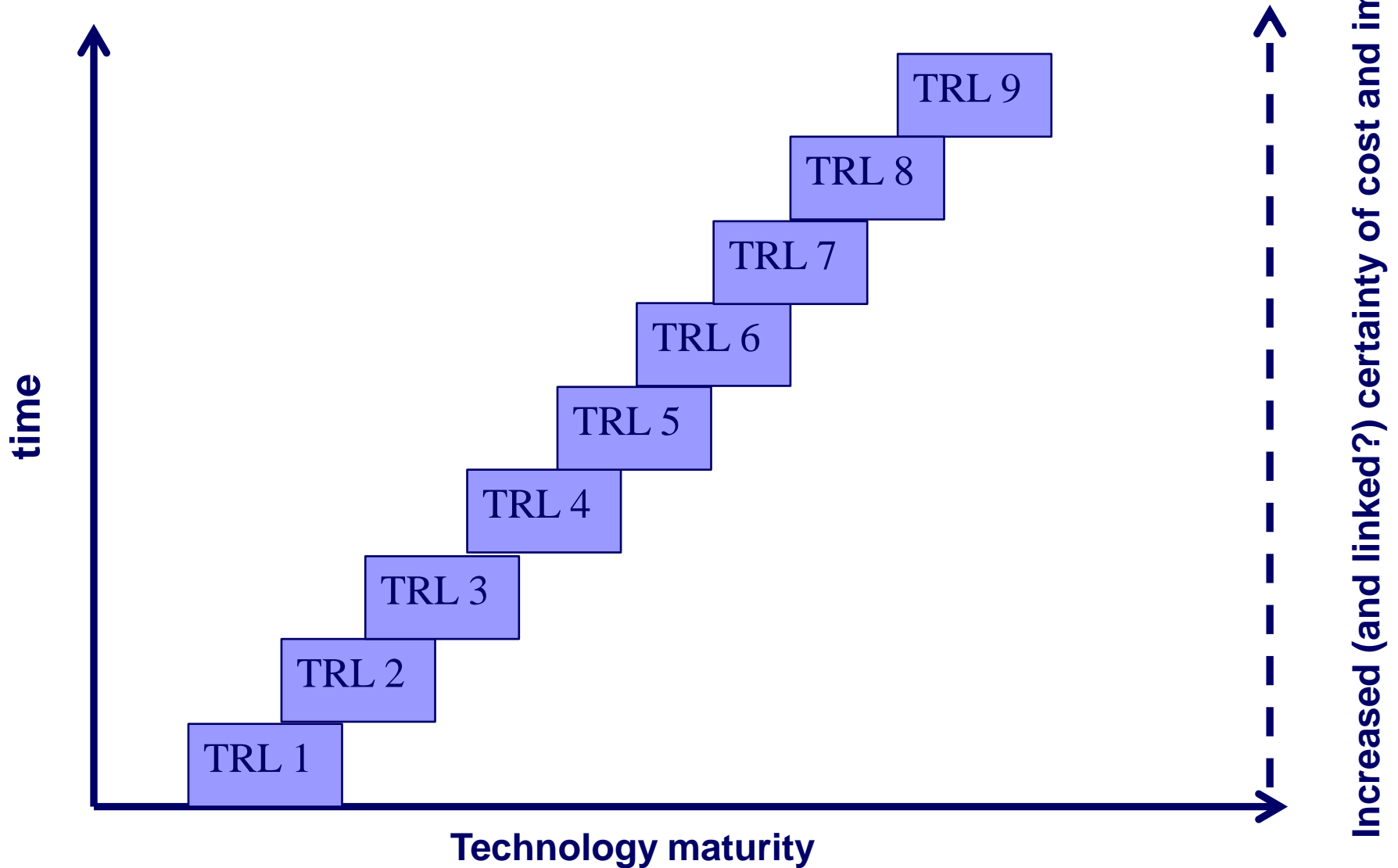


- Will pilot/commercial results give the results predicted from lab scale?
- If repeated will we find a predictive method?
- Do we have time for that....?

# Assessment proposal for novel chemical processes

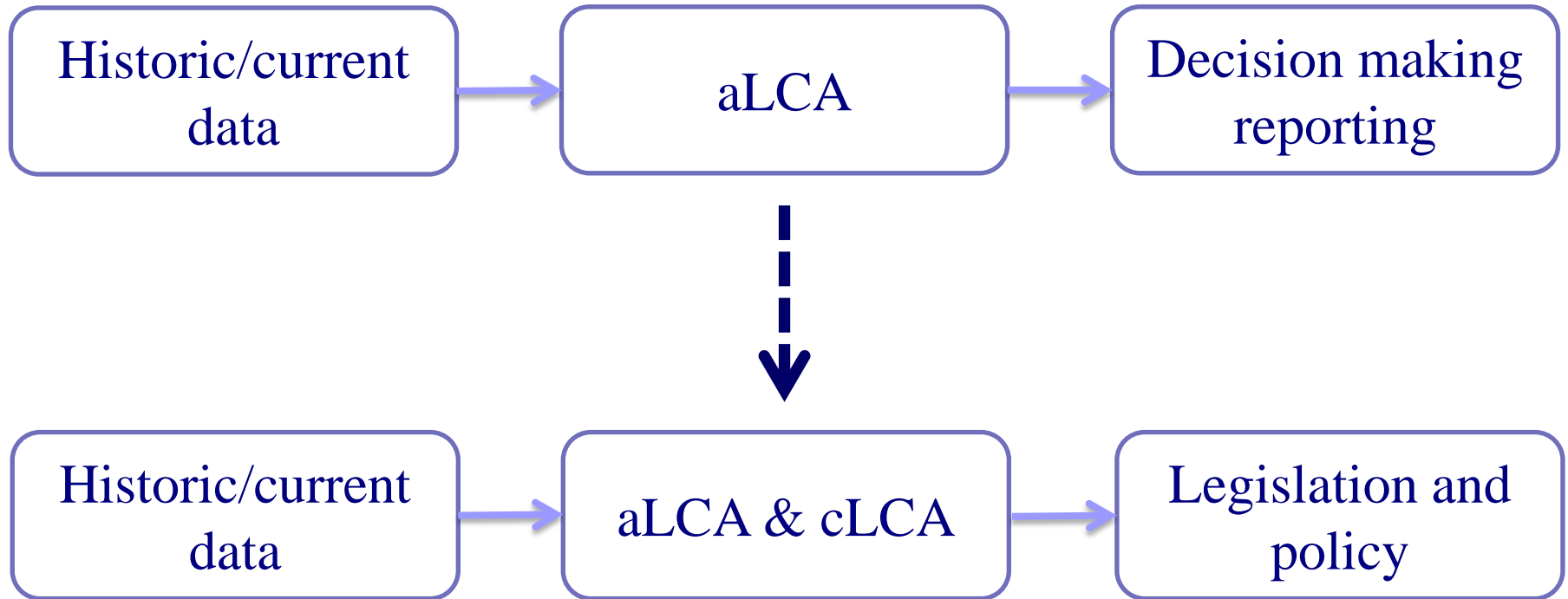


# Can impacts relate to TRL and cost?

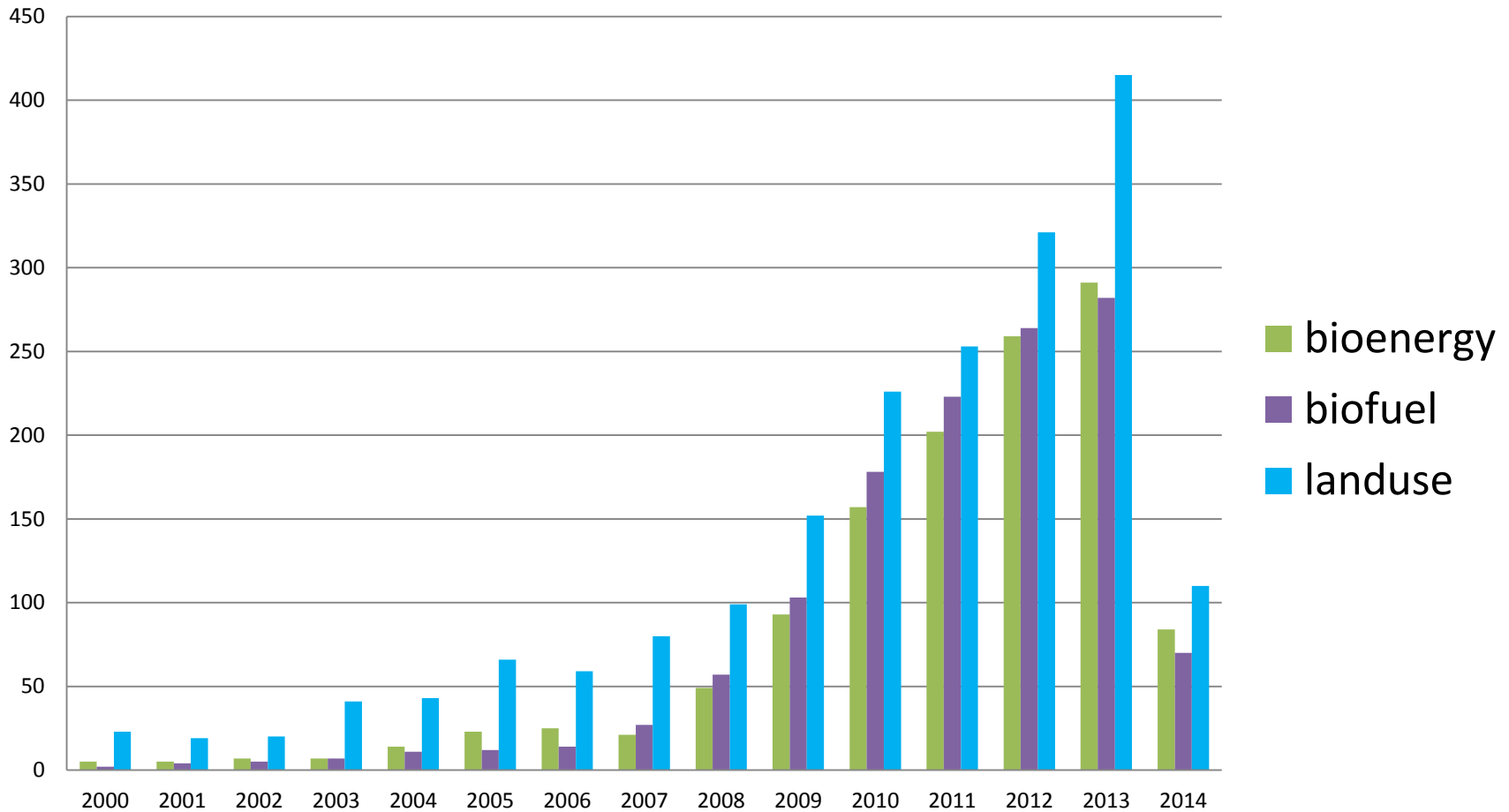


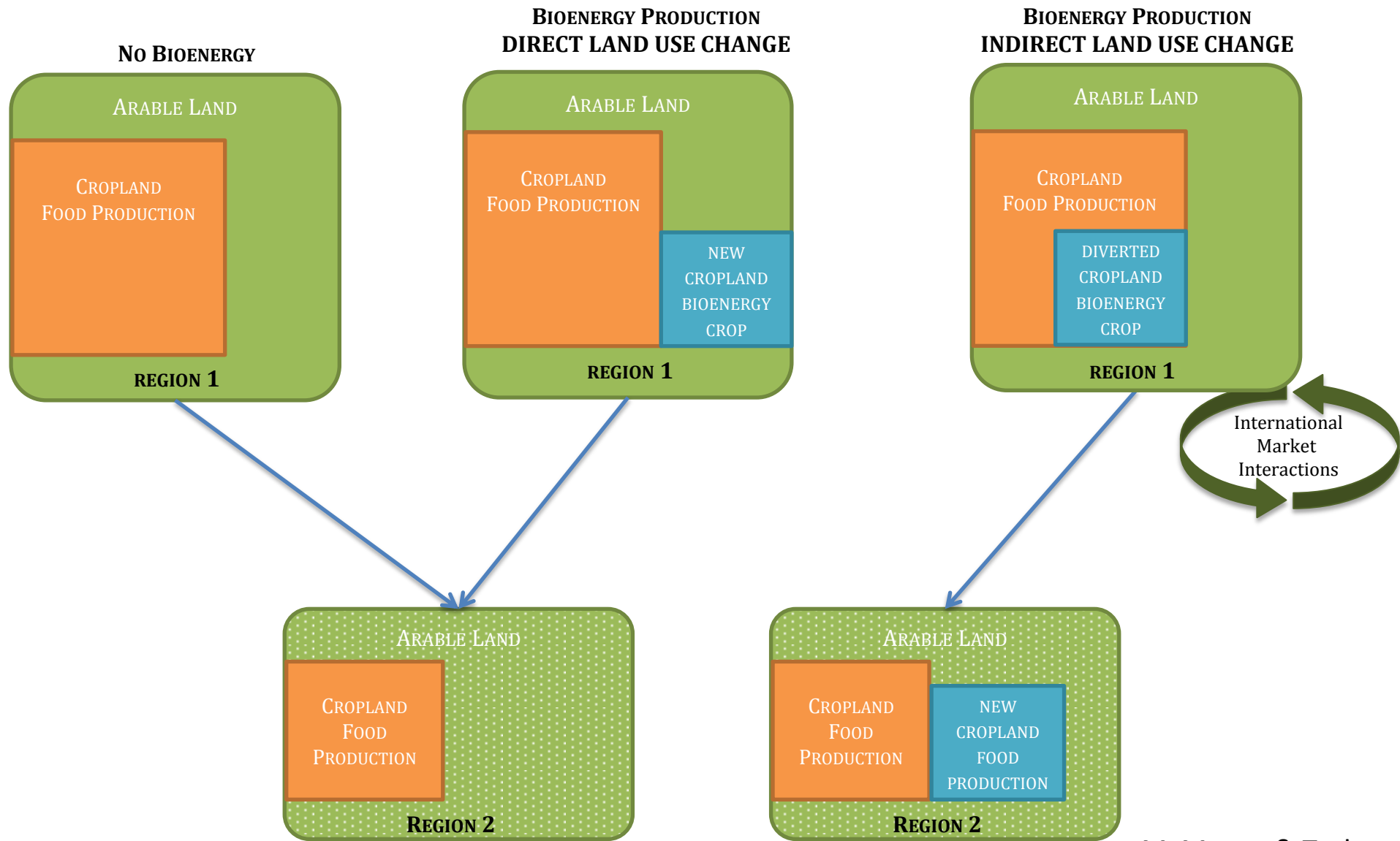


# Some current trends

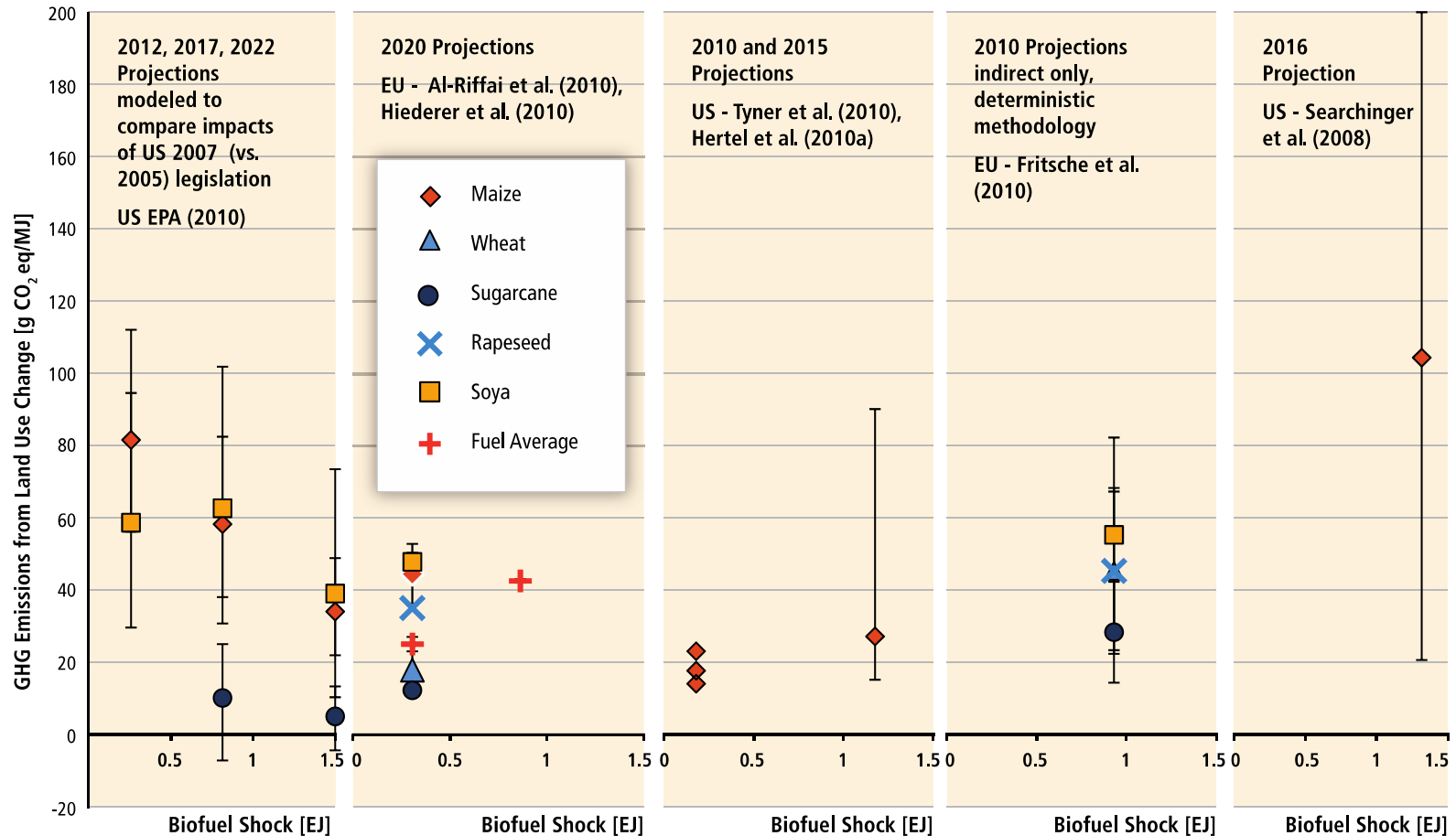


# Bioenergy, biofuel and land-use publications



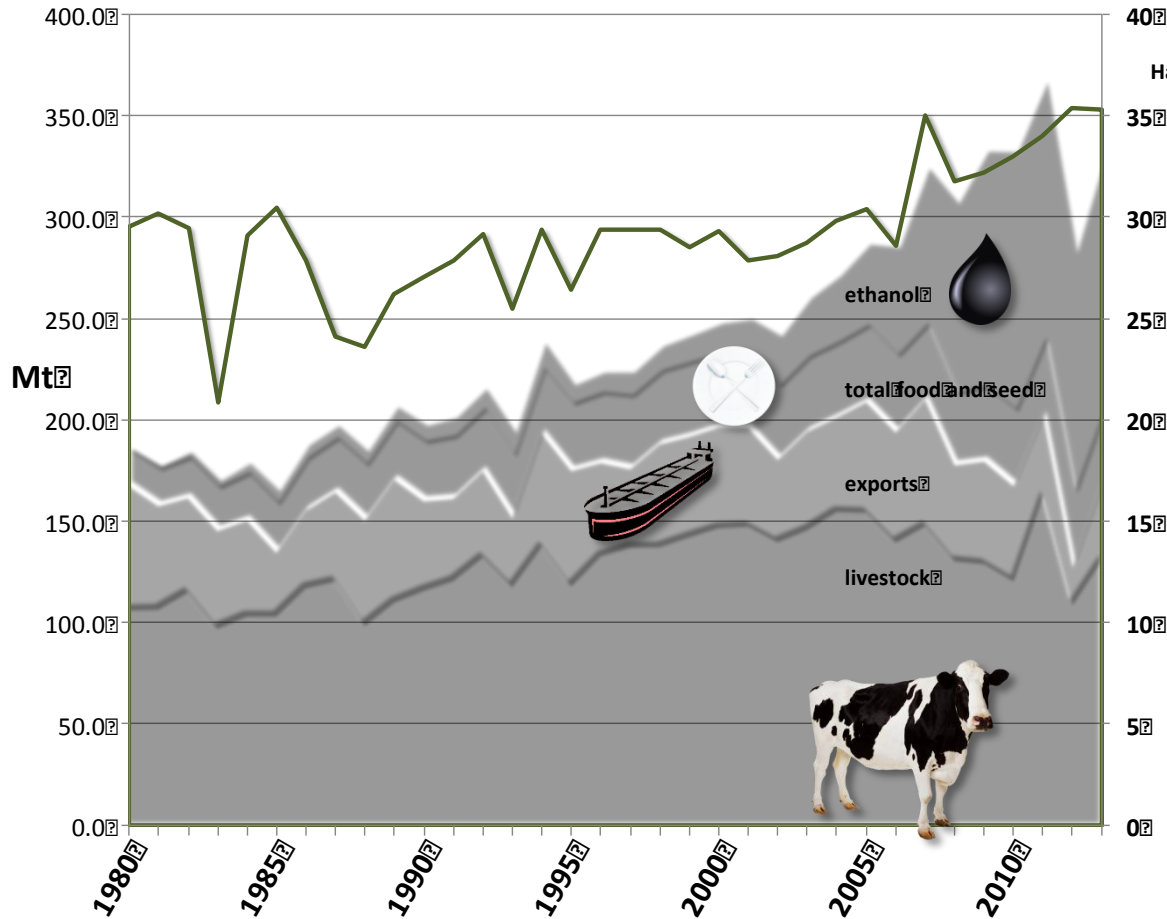


# Estimates of ILUC vary very widely

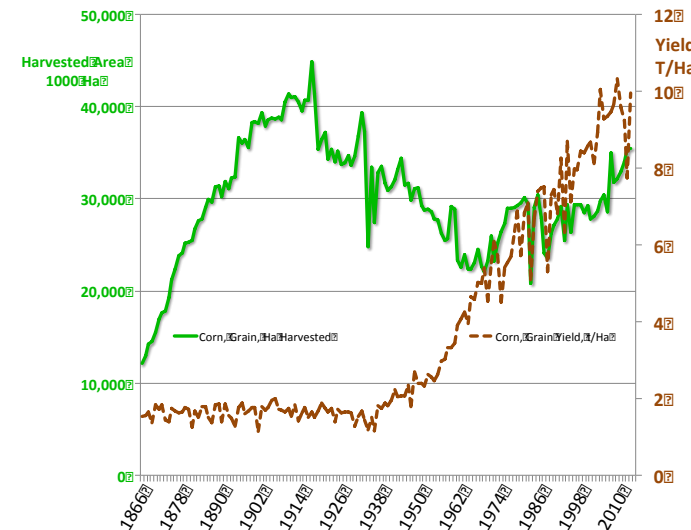


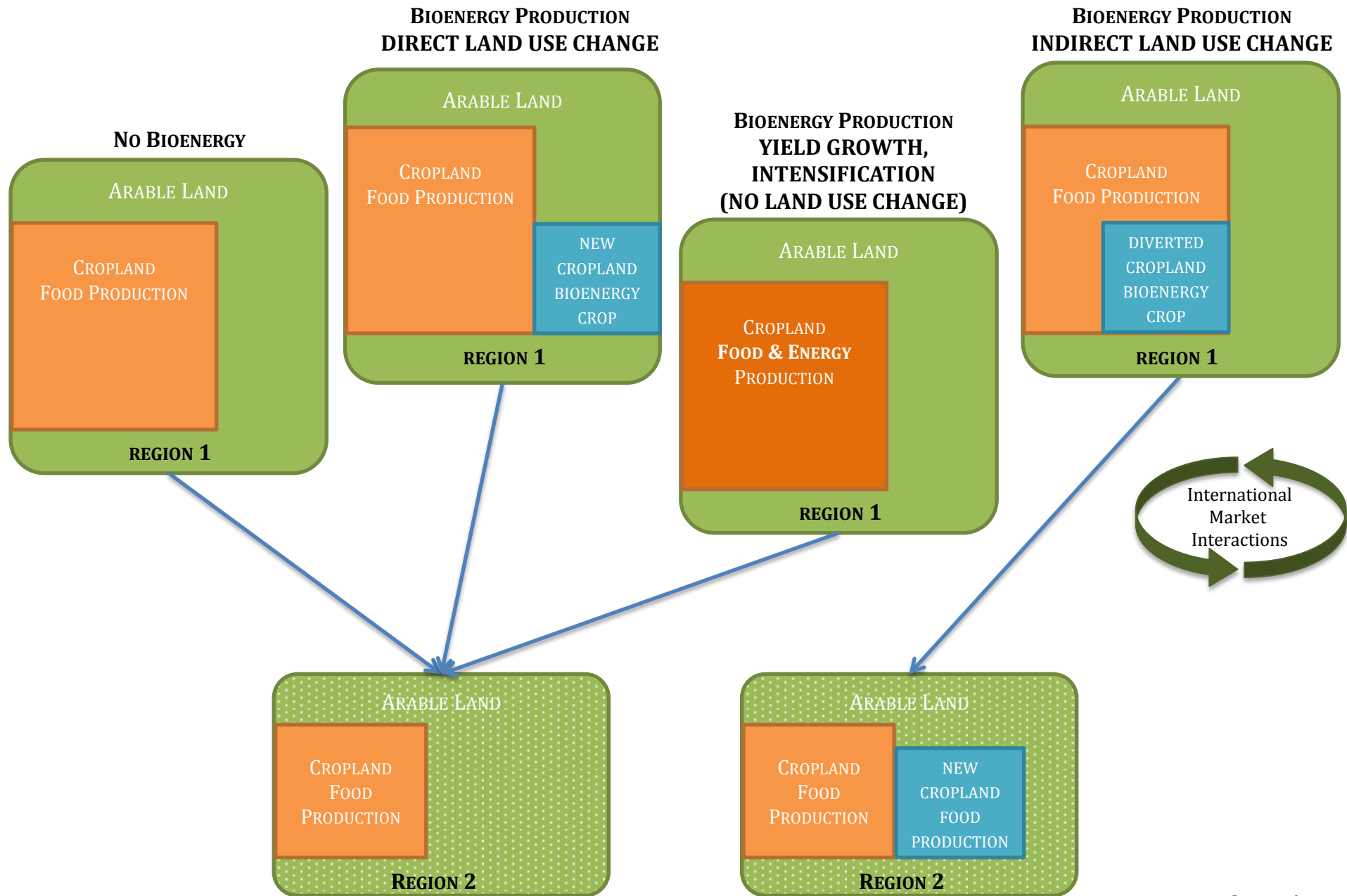
← Increased Spatial Resolution of Land Use Distribution and/or Use Options

# Annual US Corn Grain Allocations

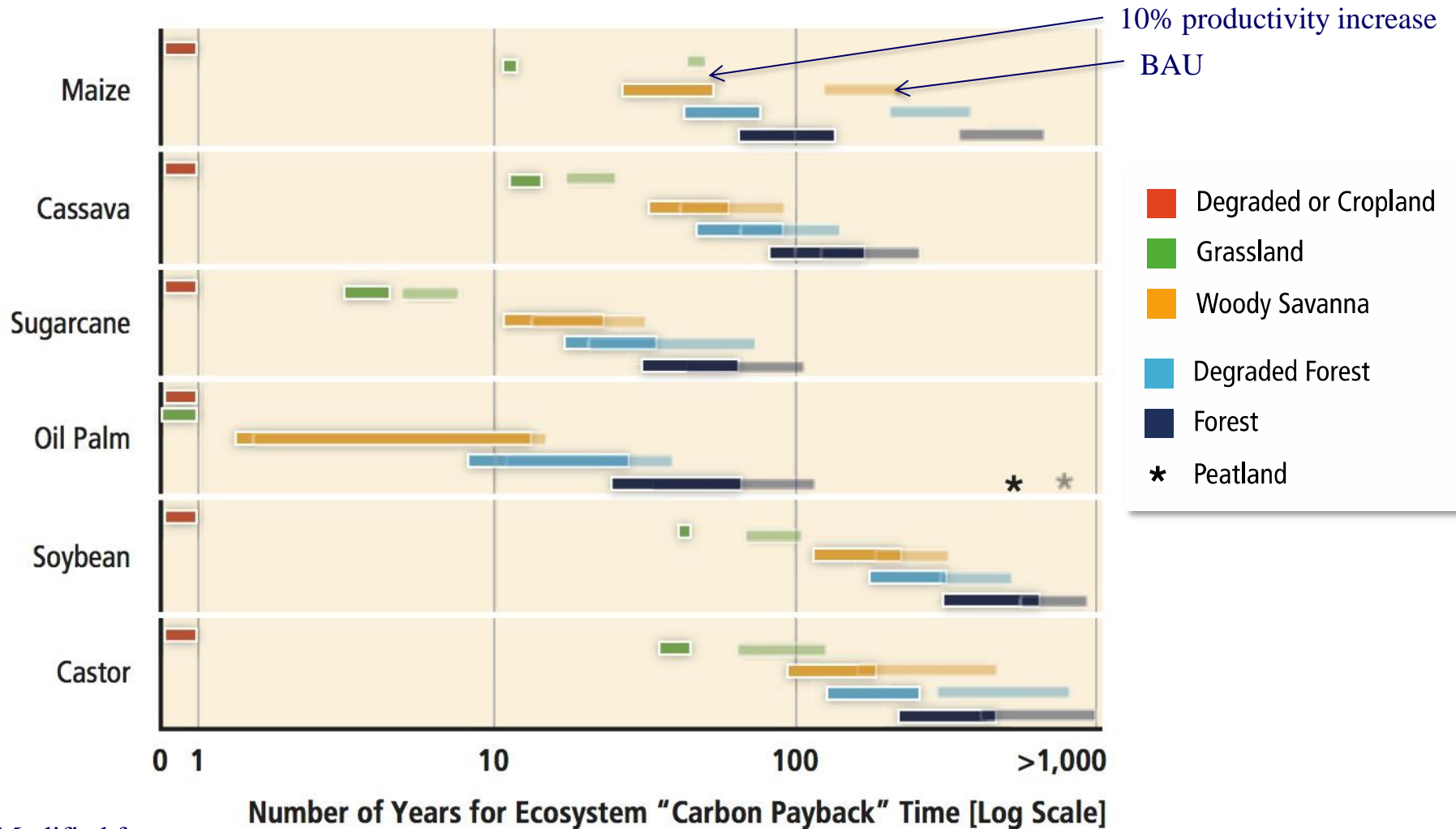


Historical Harvested Areas and Yields



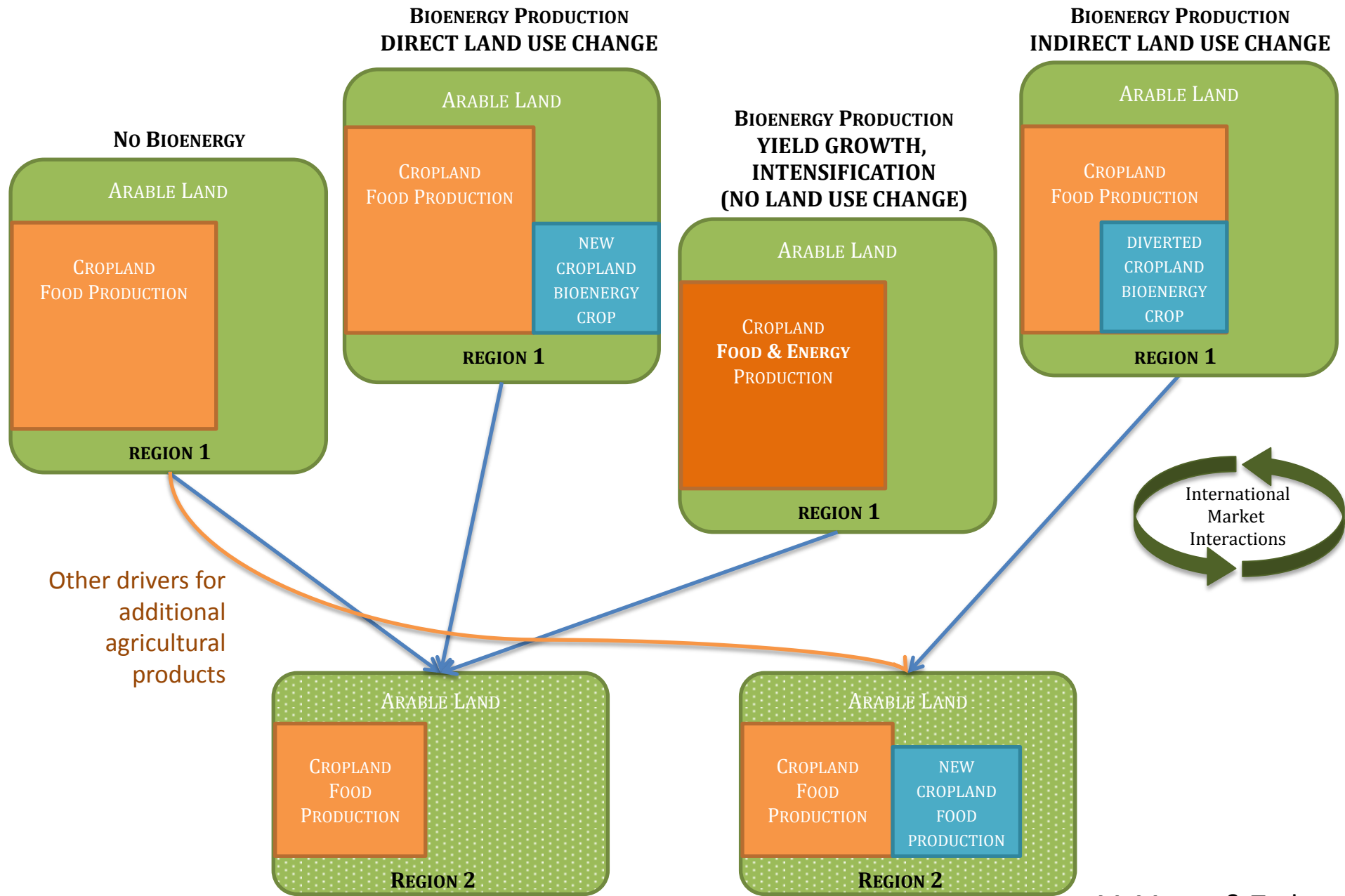


# “Carbon Payback” Estimates are strongly sensitive to factors not historically included in LCA



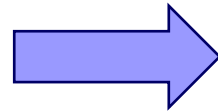
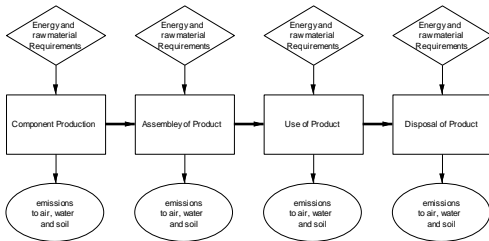
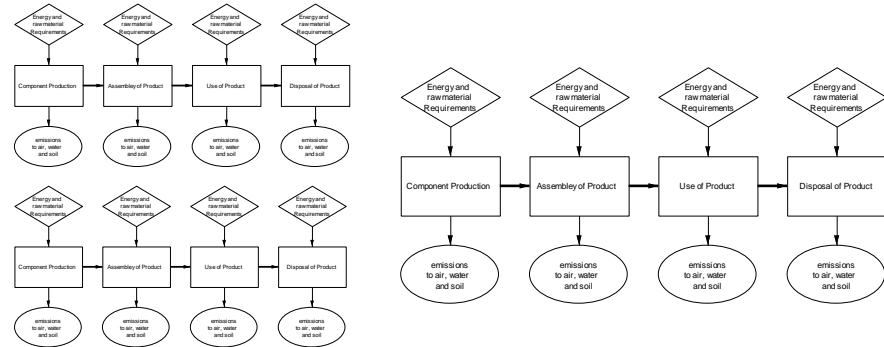
Modified from

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

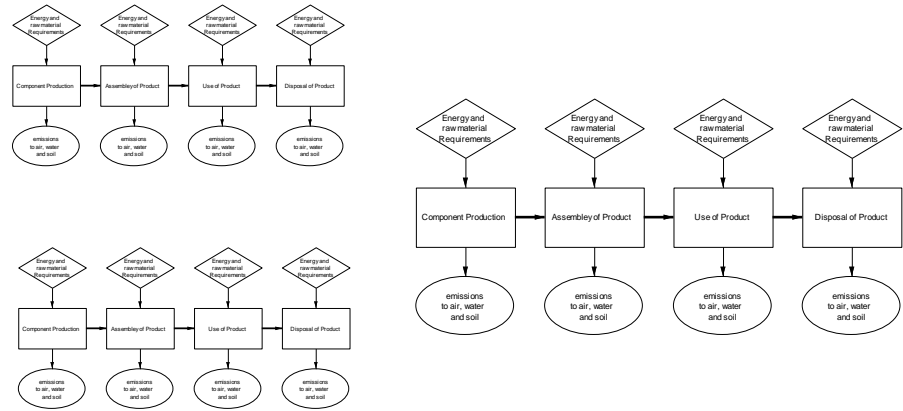




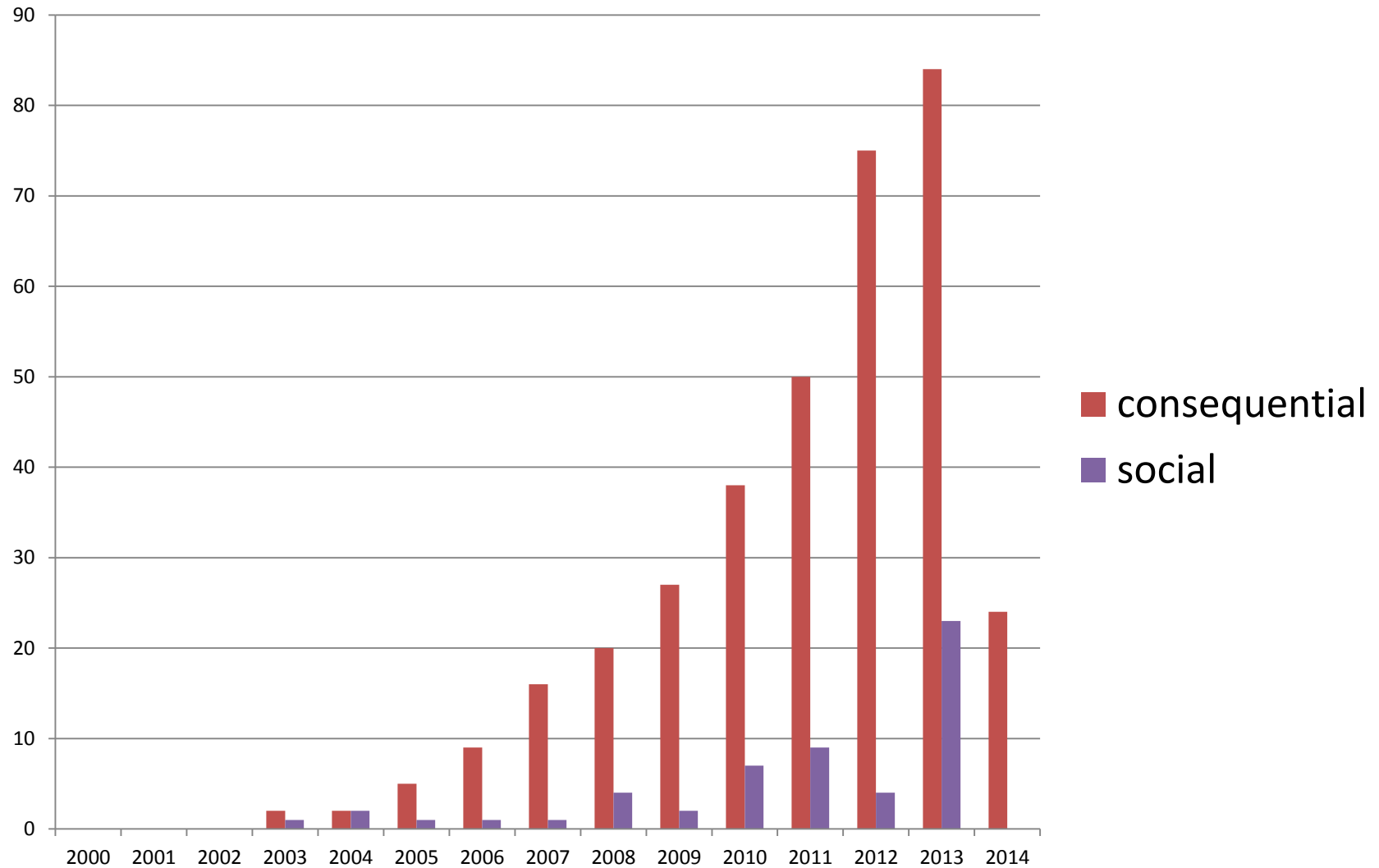
# Consequential Life Cycle Assessment



Consequences  
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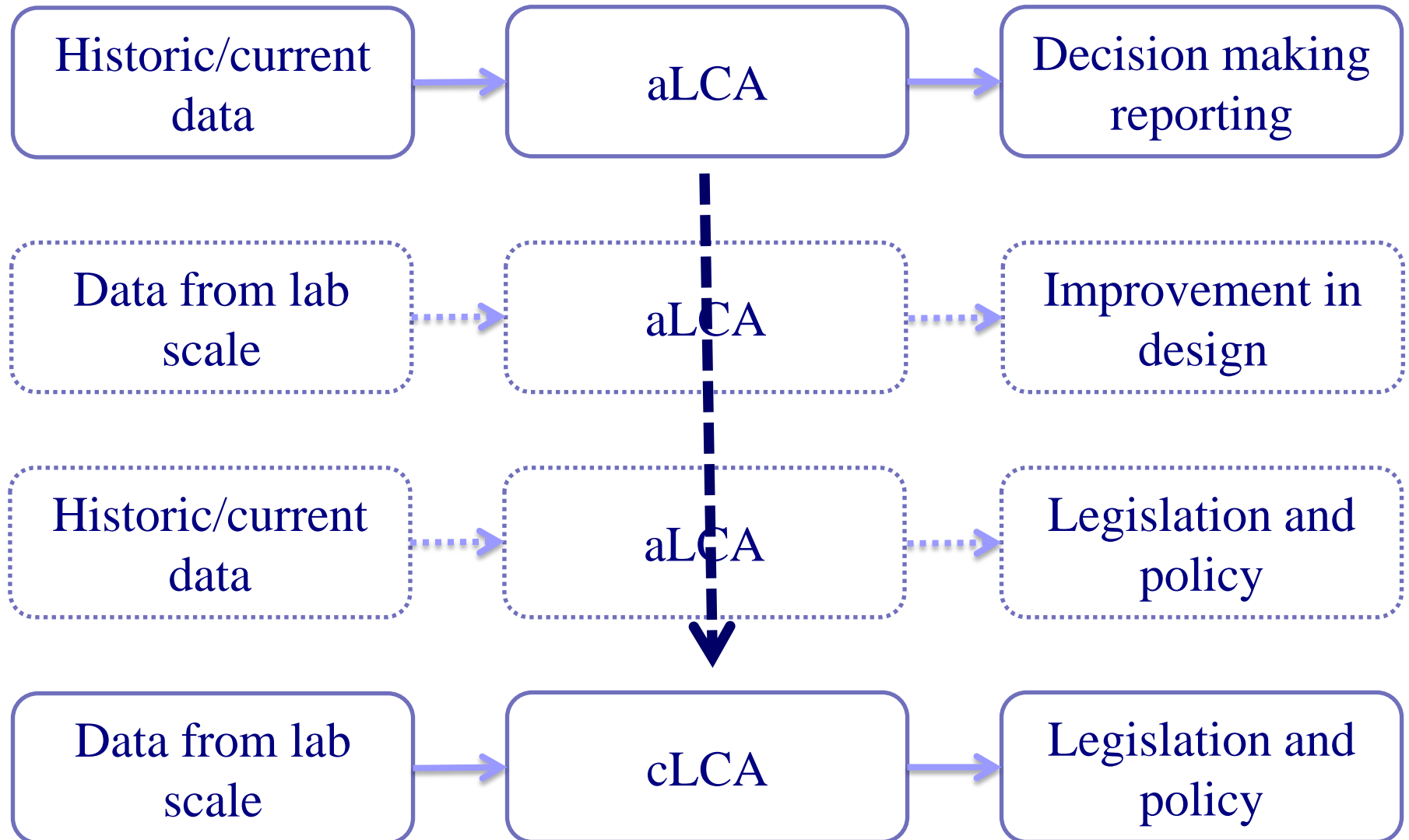


# Papers looking at consequential and social analysis

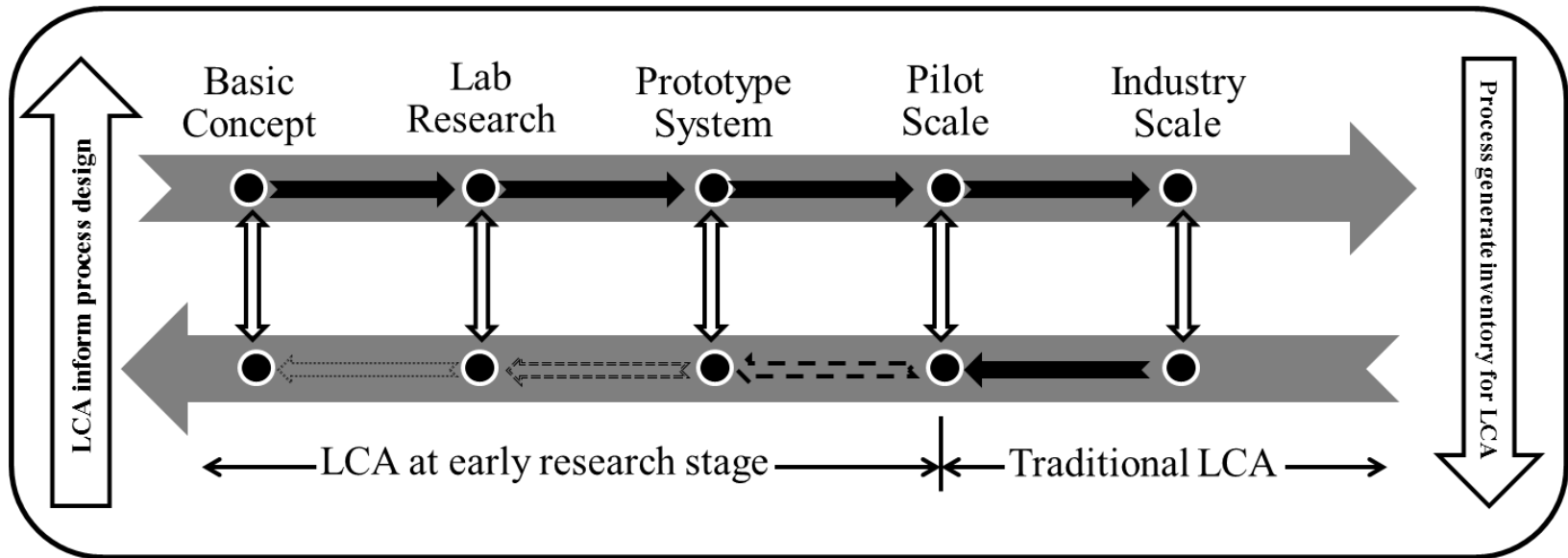


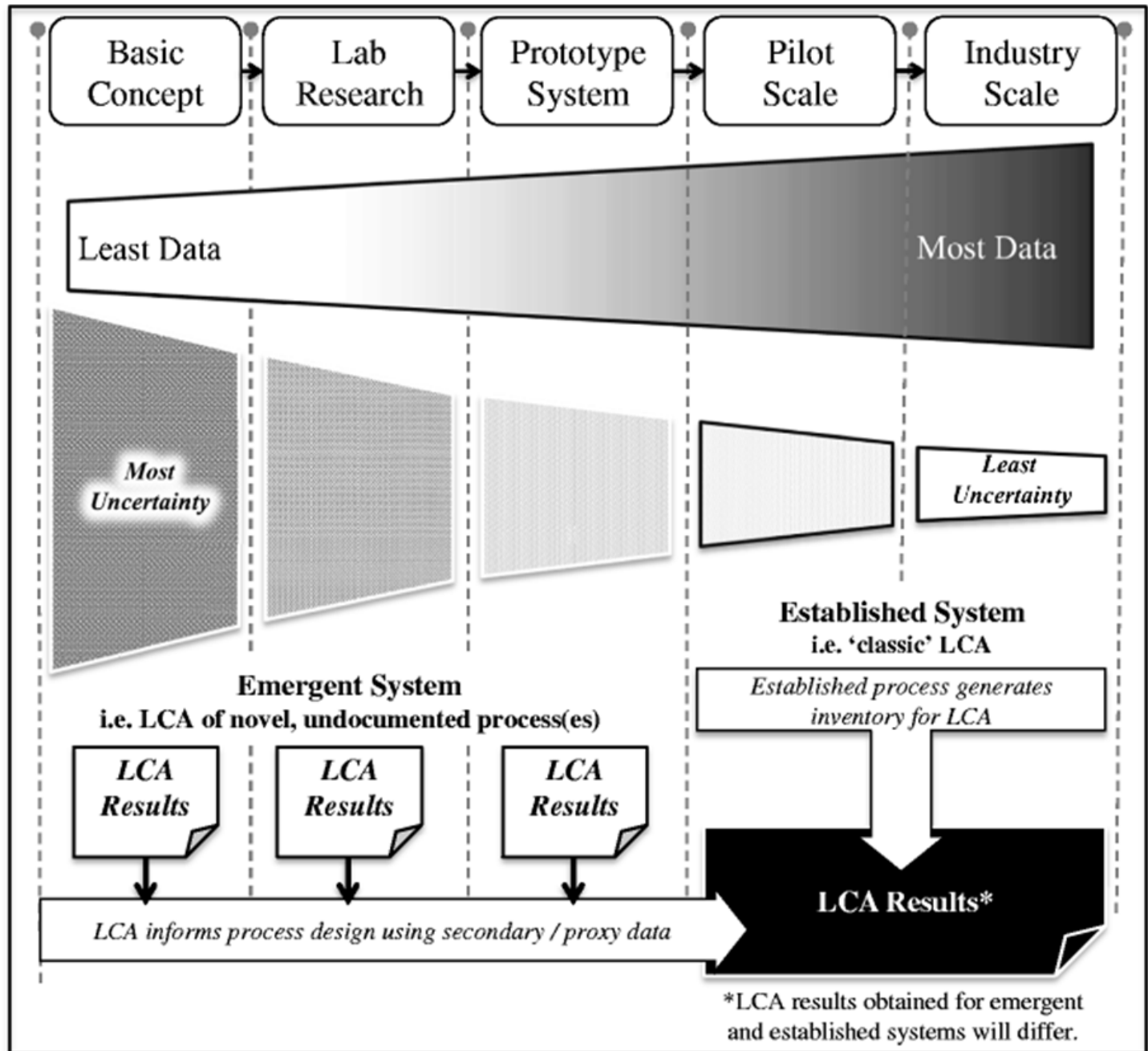


# Some current trends



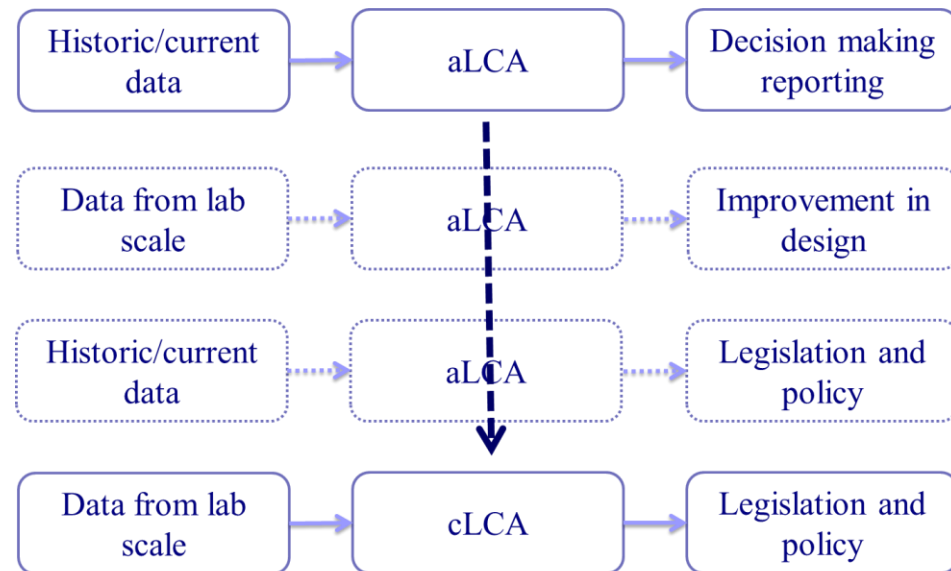
# Changing approach



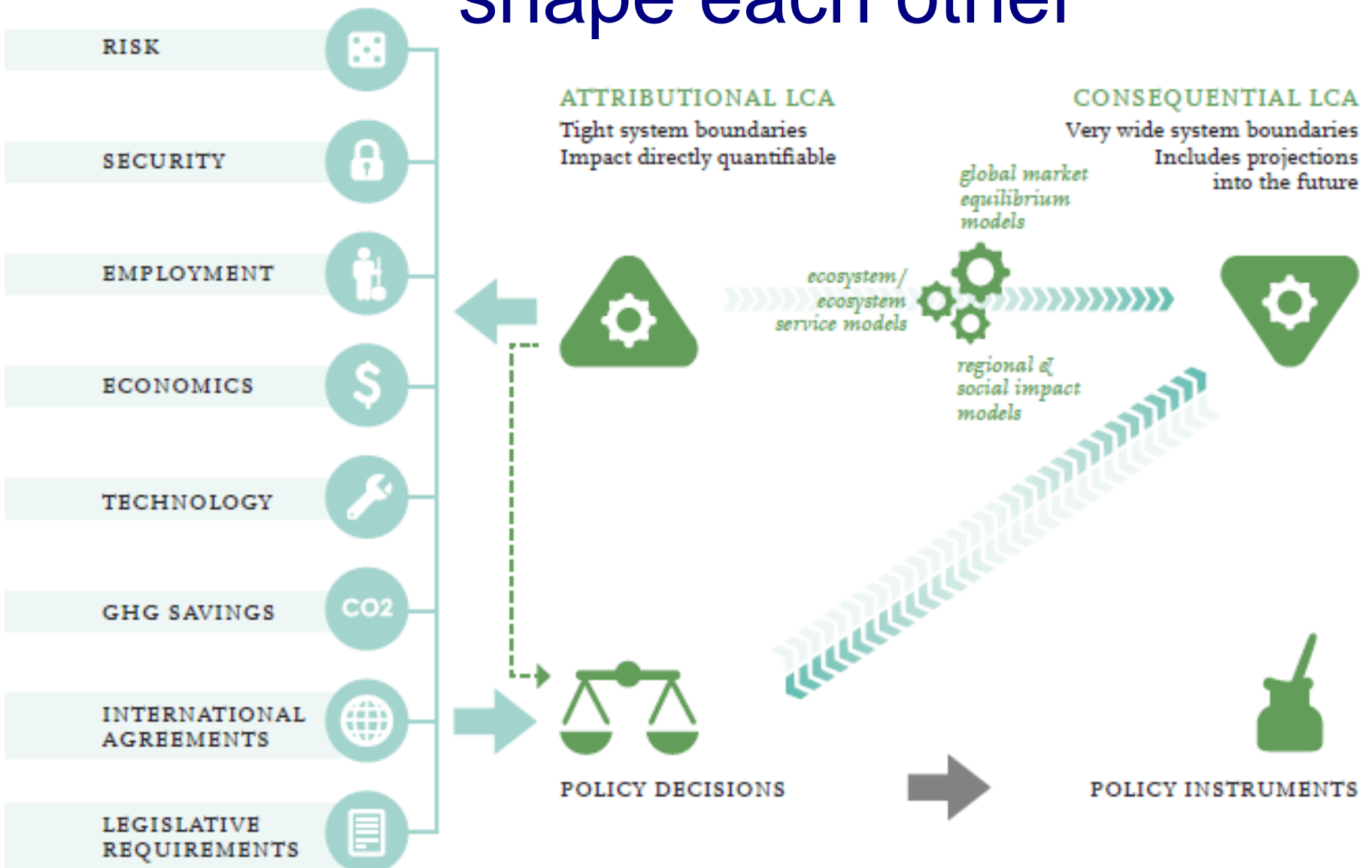


# Complexities in bioenergy

- 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





# 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...?

M.McManus@bath.ac.uk



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