

Life Cycle Assessment of bio-based product

Tim Grant, Chair AusLCI Database Committee

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Australian Government, Department of Industry

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Acknowledgement



Australian Government
Department of Industry

ALCAS acknowledges the support from the **Department of Industry**, to undertake this preliminary study in the area of *sustainability assessments for bio-based products and particularly the benefits of using an LCA approach*.

Project had four distinct tasks:

1. Review the key (inter)national standards around bio-based product LCA.
2. Create a standardised inventory data protocol for stakeholders wishing to collect and publish company or process specific Australian bio-based LCI data.
3. Generate key common underpinning Life Cycle Inventory data in 4-5 areas of the bio based materials with not less than 25 unit processes in total.
4. Disseminate the project results and promote the use of LCA to the Australian bio-based industry.

Contents

- Standards affecting the LCA of bio-based products.
- AusLCI requirements – adjustments.
- Life Cycle Inventory of bio-based materials.
- Key challenges LCA of bio-based products.
- Next Steps

Standards affecting LCA of bio-based materials and products

Summary

- There are no standards directly related to LCA of bio-based products.
- Biofuel standards have many provisions relevant to bio-based products which may be adopted for bio-based products.
- LCA and carbon footprint standards such as ISO 14044 and ISO 14067 have important provisions which affect the assessment of bio-based products.
- There are a number of environmental product declaration (EPDs) which have provisions which affect bio-based product assessment.

ISO 14044 - Life Cycle Assessment, Requirements and Guidelines.

- *“The selection of impact categories shall reflect a comprehensive set of environmental issues related to the product system being studied, taking the goal and scope into consideration.”*

This means that companies doing LCA are compelled to include environmentally relevant impact categories.

e.g. Land use,
Water use

INTERNATIONAL
STANDARD

**ISO
14044**

First edition
2006-07-01

Environmental management — Life cycle assessment — Requirements and guidelines

Management environnemental — Analyse du cycle de vie — Exigences et lignes directrices

AusLCI impact assessment coverage

- Resource Depletion
 - Fossil fuel depletion
 - Minerals depletion
- Water depletion
- Climate change
- Ozone layer depletion
- Acidification
- Eutrophication
- Photochemical oxidant formation
- Human toxicity (air, water and soil pollution)
- Eco-toxicity (air, water and soil pollution)
- Land occupation and land transformation

ISO 14067 - Greenhouse gases — Carbon footprint of products .

TECHNICAL
SPECIFICATION

ISO/TS
14067

First edition
2013-05-15

**Greenhouse gases — Carbon footprint
of products — Requirements and
guidelines for quantification and
communication**

ISO 14067 - Greenhouse gases — Carbon footprint of products .

- This standard gives no credit for temporary storage in the calculation of carbon footprint.
- Allows a supplementary figure that does include temporal aspects to be calculated and reported separately.
- The timing of GHG emissions and removals relative to the year of production of the product **shall** be specified in the life cycle inventory.

- **AusLCI does not currently add timing to the inventory**

ISO 13065 - Sustainability criteria for bioenergy

- Currently at committee draft.
- Is looking closely at allocation approaches.
- Carbon stock change from land use needs to be explicitly dealt with.
- Alternative fate of biomass use needs to be taken into account.

PAS 2050 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

PAS 2050:2011

Specification for the assessment of the life cycle greenhouse gas emissions of goods and services



PAS 2050 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

- A calculation approach is provided for taking account of carbon storage and delayed emissions in Carbon Footprint assessment – results need to be published separately though.
- Emissions from Direct Land Use Change (due to carbon stock loss in biomass and soil) are linearly amortised over 20 years.

DIRECTIVE 2009/28/EC - Promotion of the use of energy from renewable sources.

- Has thresholds for greenhouse gas emissions reductions as compared against conventional fuel benchmarks before fuel can be included as part of renewable fuel targets.
 - Currently 35%
 - 2017 raised to 50%
 - 2018 raised to 60%
- Allocation of co-products based on energy content.
- Waste agriculture residues (eg bagasse) can be considered to have zero GHG emission up to the point of collection.

DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 23 April 2009

on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

(Text with EEA relevance)

International EPD System - Product Category Rules for plastic in primary forms

- The bio-based material content shall be declared as percentage of product content.

The screenshot shows the website interface for the International EPD System. At the top right, the logo features a horizontal bar with segments in teal, dark teal, and black, followed by the text "EPD®" and "THE GREEN YARDSTICK" below it. A navigation bar contains three tabs: "Using EPDs", "Creating EPDs", and "Product Category Rules (PCR)", with the latter being the active tab. Below this is a secondary navigation bar with links for "EPD Search", "What is an EPD®?", "The International EPD® System", "Climate Declarations", and "Contact". A search box labeled "Site search" is on the right. The main content area shows a breadcrumb trail "Home > The International EPD® System" and a heading "THE INTERNATIONAL EPD® SYSTEM". The introductory text begins with "Today, the global market has an increased demand for science-based, verified and comparable information about environmental performance of goods and services. The demand comes from several market places, such as in the raw". A sidebar menu on the right lists "Organisation", "International Cooperation", and "General Programme Instructions".

Using EPDs Creating EPDs **Product Category Rules (PCR)**

EPD Search What is an EPD®? The International EPD® System Climate Declarations Contact Site search

Home > The International EPD® System

THE INTERNATIONAL EPD® SYSTEM

Today, the global market has an increased demand for science-based, verified and comparable information about environmental performance of goods and services. The demand comes from several market places, such as in the raw

- > Organisation
- > International Cooperation
- > General Programme Instructions

EN15804 Environmental product declarations — Core rules for the product category of construction products

- Renewable resource use needs to be declared in the EPD.
- Biogenic carbon needs to be allocated reflecting its physical flow and not the allocated flow when any form of allocation is being undertaken.

CEN/TC 350

Date: 2011-02

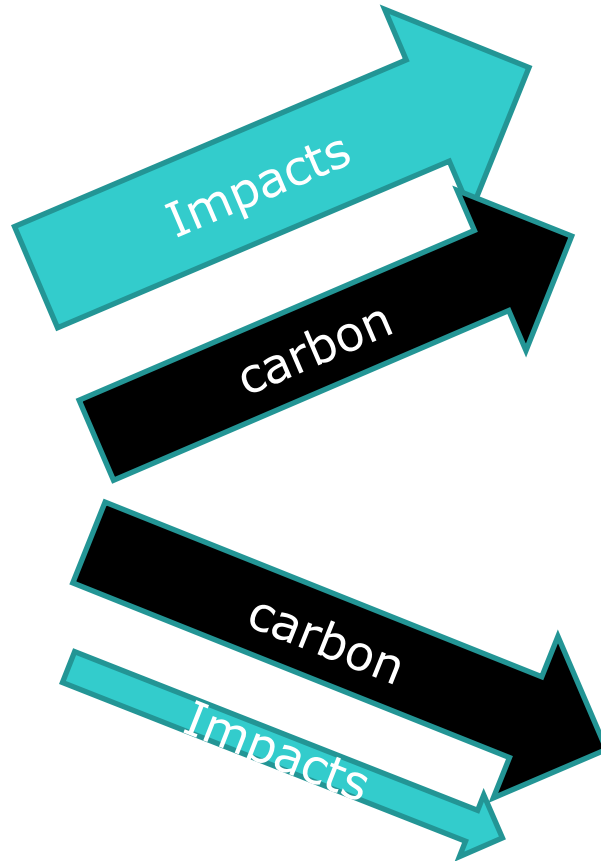
FprEN 15804:2011

Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products

Nachhaltigkeit von Bauwerken — Umweltdeklarationen für Produkte — Regeln für Produktkategorien

Contribution des ouvrages de construction au développement durable — Déclarations environnementales sur les produits — Règles régissant les catégories de produits de construction

Allocation



\$40 per M3

\$10 per M3



AusLCI requirements and bio-based products

Adoption of EN15804 method for recycling and energy recovery

- Important for energy recovery from bio-based materials.
- Credits are provided to a products which contributes to energy recovery at the end of its life.
- Only the net biofuel exported is given the credit.

Emissions timeframe

- Where emissions from processes occur over a greater than 10 year period then a description of the timeframe of the emissions shall be included.
- No standardised way in inventory to account for time as yet. Currently it will be included as a comment beside the flow.

Land use categories

Grassland, natural (non-use)	Grassland vegetation with scattered shrubs or trees (e.g., steppe, tundra, <u>savanna</u>).
Grassland, natural, for livestock grazing	Grasslands where wildlife is replaced by grazing livestock.
Arable land, unspecified use	Land suitable for crop production, in unspecified use
Pasture, man made	Arable land used for forage production or livestock grazing.
Pasture, <u>man made</u> , extensive	+ no artificial fertiliser applied, mechanically harvested less than 3 times per year or equivalent livestock grazing
Pasture, <u>man made</u> , intensive	+ artificial fertiliser applied, or mechanically harvested 3 times or more per year or equivalent livestock grazing
Annual crop	Cultivated areas with crops that occupy the land < 1 year, e.g. cereals, fodder crops, root crops, or vegetables. Includes aromatic, medicinal and culinary plant production and flower and tree nurseries.
Annual crop, non-irrigated	Annual crop production based on natural precipitation (<u>rainfed</u> agriculture).
Annual crop, non-irrigated, extensive	+ Use of fertiliser and pesticides is significantly less than economically optimal.
Annual crop, non-irrigated, intensive	+ Fertiliser and pesticides at or near the economically optimal level.

Life Cycle Inventory for bio-based products

Challenge

- Its not practical to develop inventory for novel processes and materials.
 - Most data are not published
 - Processes often confidential
 - Technology is immature and may change relatively rapidly
- Aim was to publish available data that assist the LCA of bio-based products.
 - Data needed to be readily available – budget only covers the formatting and compliance reviewing of the datasets.

LCIs Included

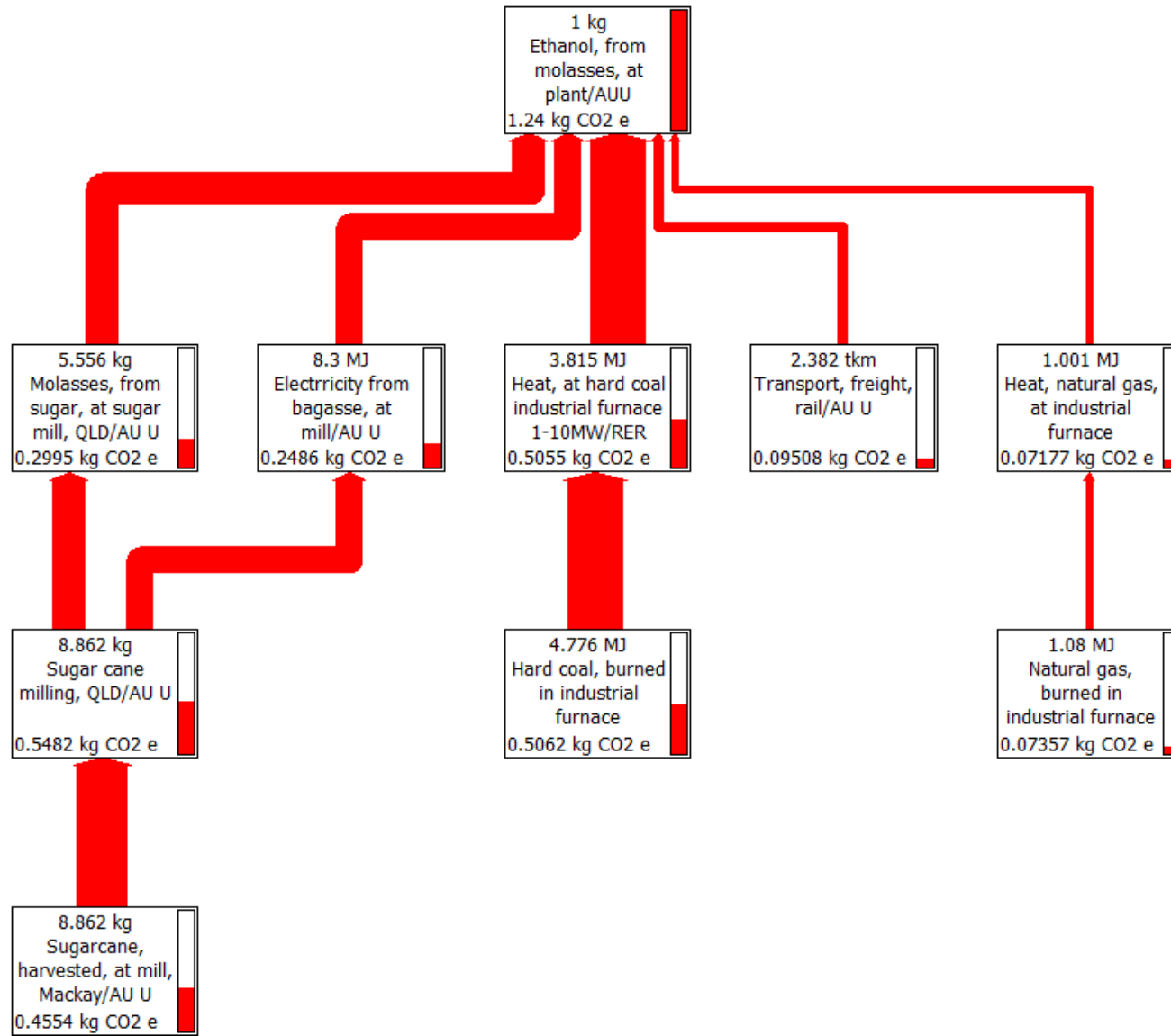
- Maize (4)
- Agriculture residues (7)
- Ethanol (3)
- Forestry(10)
- Landfill bio-based materials (13)

Ethanol from Molasses

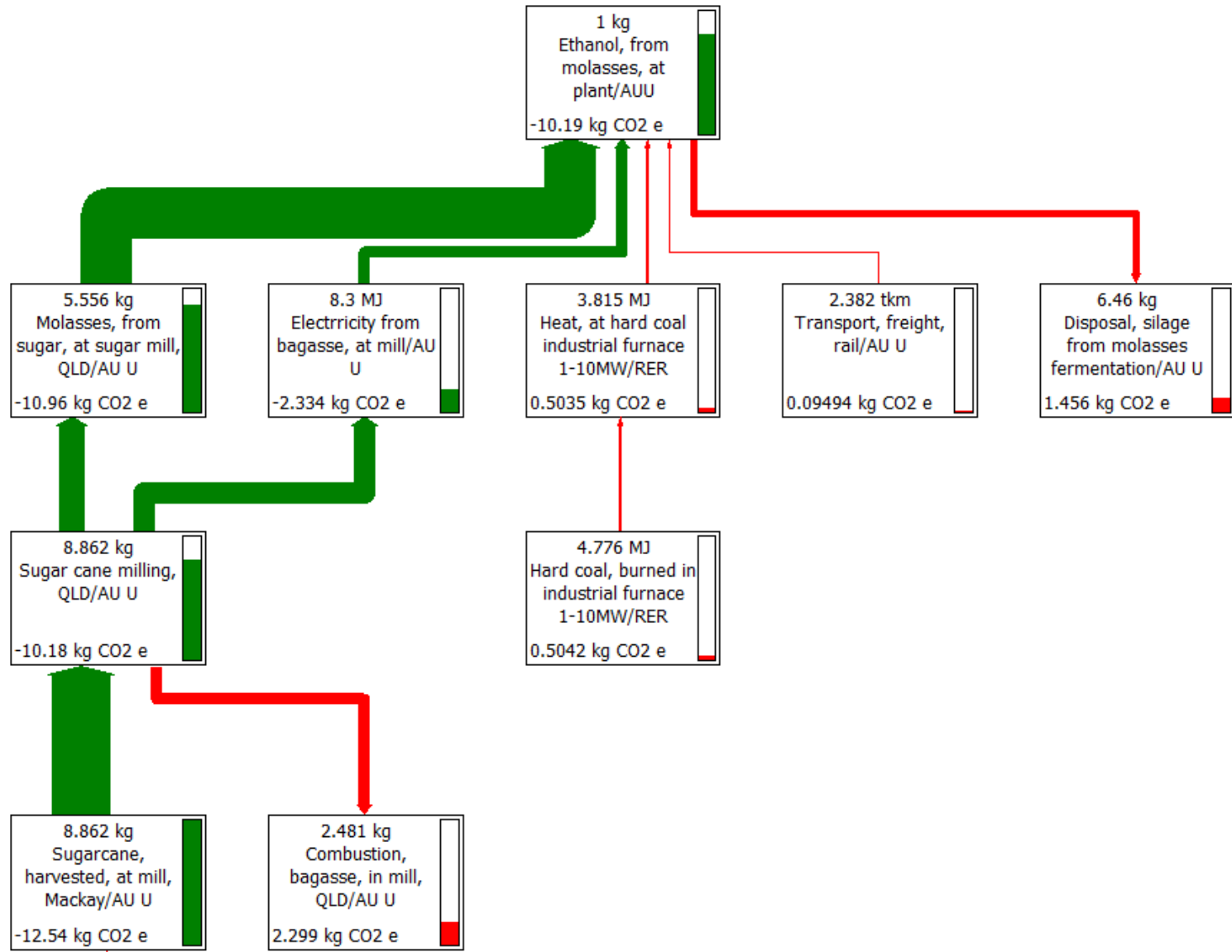
- Based on Sarina Plant in QLD
- Sugar data from AusAgLCI
- Ethanol data based on Sucrogen published LCA results.



Ethanol from Molasses GHG



Ethanol from Molasses GHG including CO2 in crop



Ethanol from Sorghum

- Based on Dalby Plant in NSW
- Typical grain to ethanol plant data used on advice from Dalby with data from US (Wang 2012)



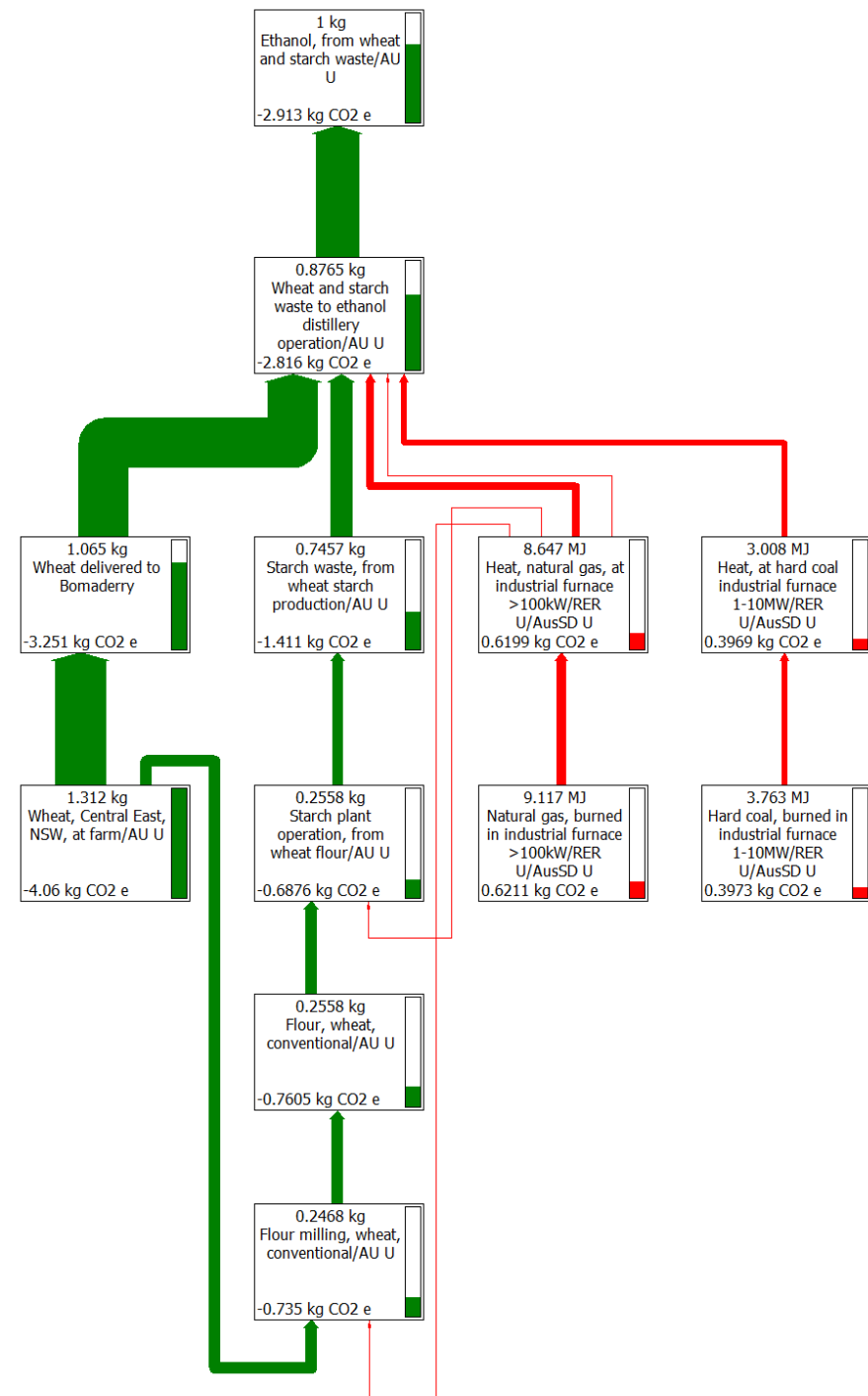
Ethanol from wheat and starch waste

- Based on Manildra plant
- Wheat data from AusAgLCI
- Ethanol data inferred from Manildra reports



Ethanol, Manildra

- Determined the balance from wheat and from starch waste.
- Many allocations through this production chain.



Forestry

- Data sourced from published papers from Forest and Wood Products Australia. England et al 2012, 2013).
- Includes softwood and hardwood production.
- 10 Products in all.



Products

Hardwood

- High value sawlogs
- Low value sawlogs
- Veneer logs
- Pulp logs
- Poles

Softwood

- High value sawlogs
- Low value sawlogs
- Pulp logs
- Poles
- Woodchips

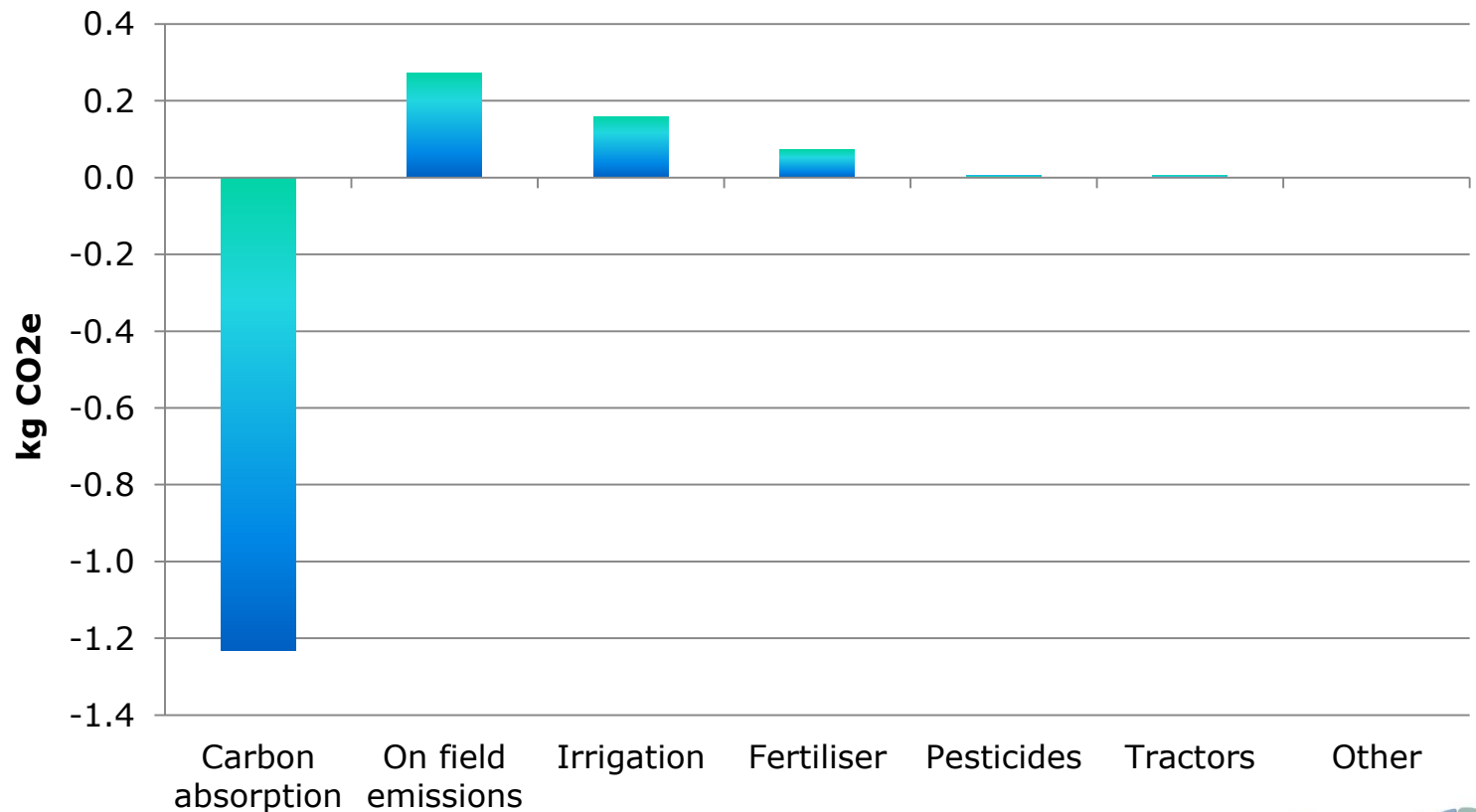
Maize

- Used as an input to starch polymers such as Plantic.
- Data was source from Gross Margins and updated with help from GRDC experts.



GHG impact per kg Maize

- Impacts heavily effected by water and Nitrogen

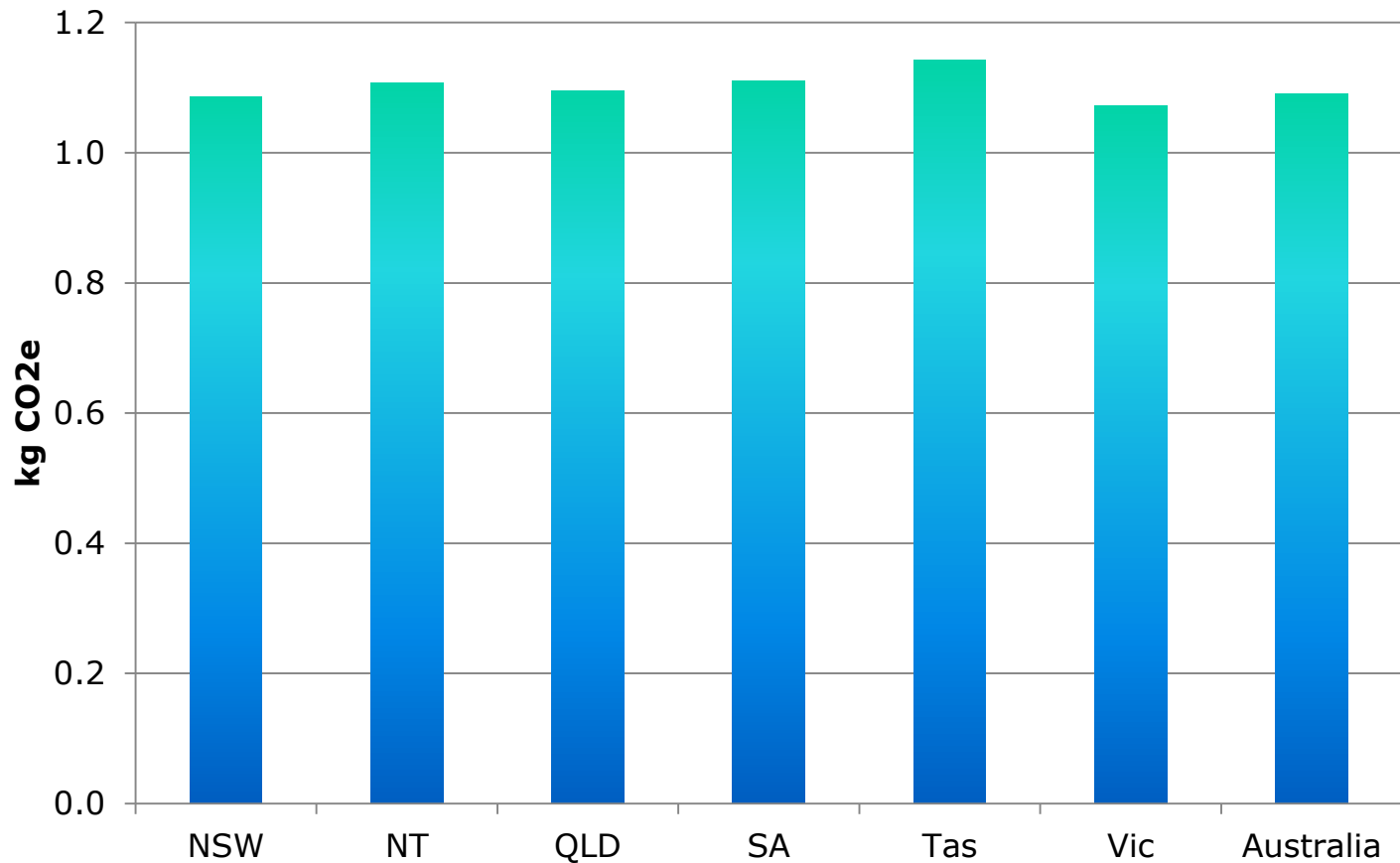


Landfill bio-based products

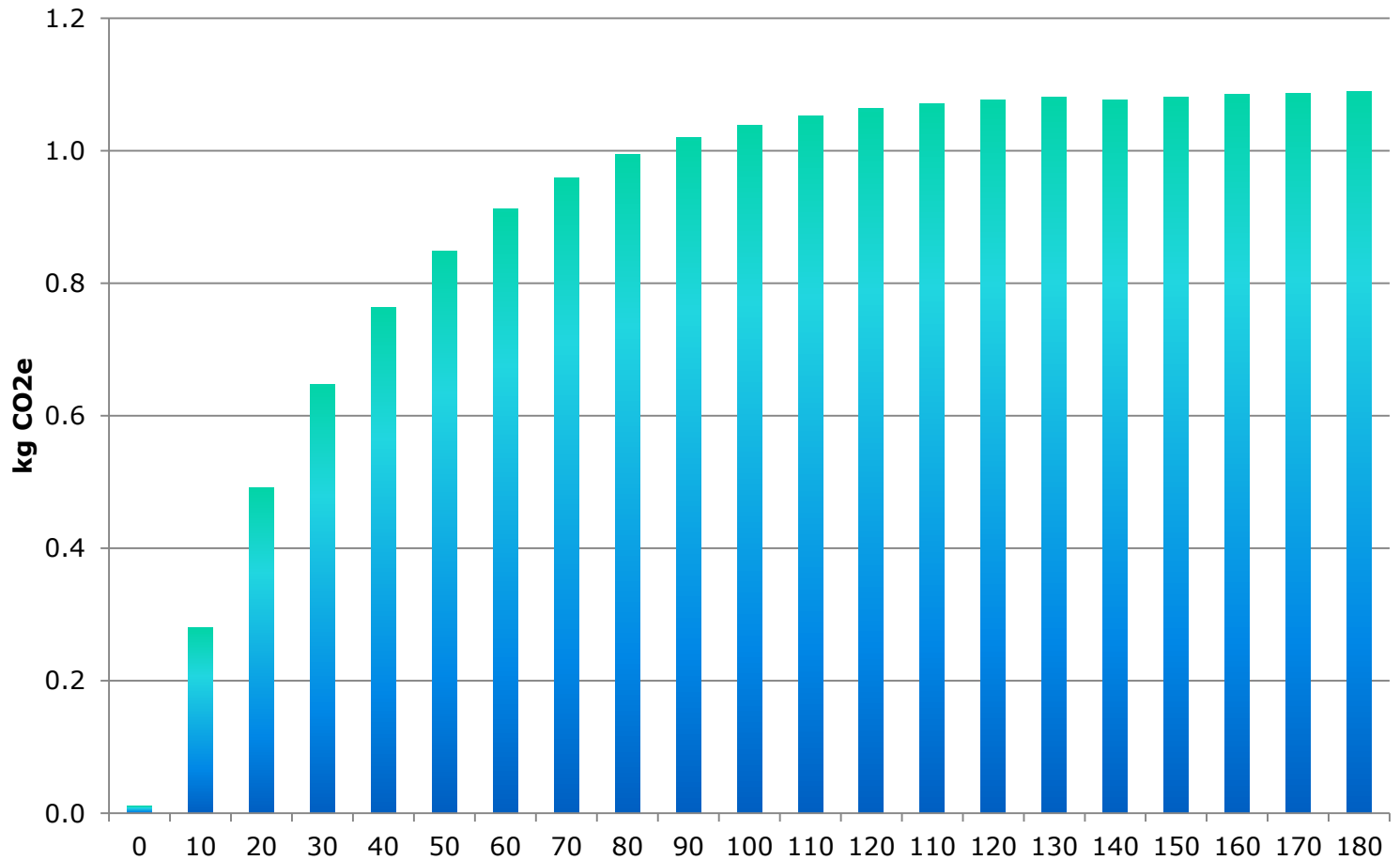
- Based on approach outline in National Inventory Report and based on IPCC guidelines
- Critical factors is degradable organic fraction (DOC) and fraction of DOC which dissimilates in landfill (DOCf)
- NSW Department of Primary Industries has worked extensively on this issue with regard to wood in landfill.
- Leachate emissions and treatment not yet included in the inventory.



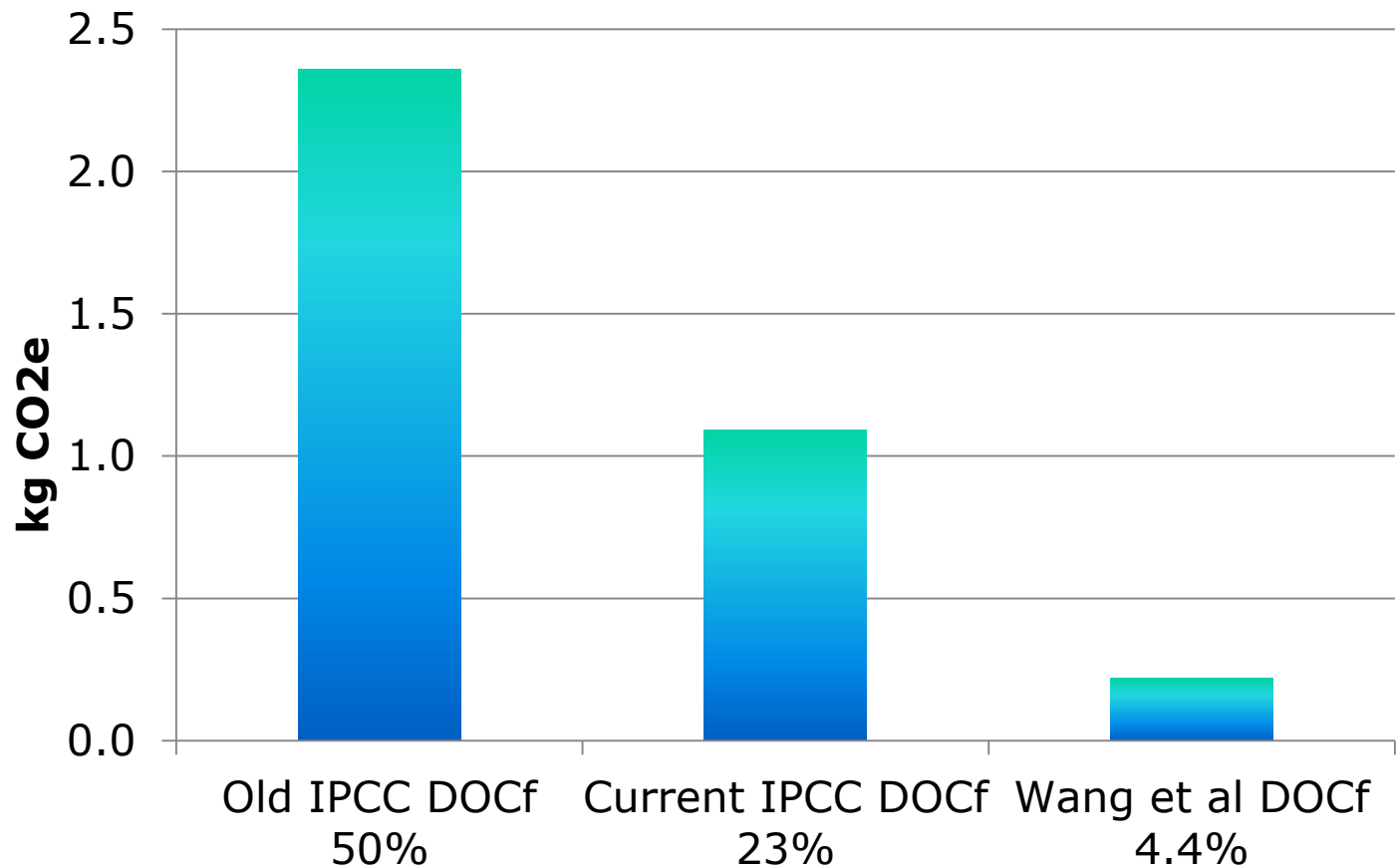
1kg Wood in landfill GHG of Landfill by state



1kg Wood in Landfill GHG emissions over time



1kg Wood in Landfill GHG results for three DOCf assumptions



Agriculture residues

- Bagasse from Sugar production.
- Cotton seed from cotton production.
- Straw from wheat – 6 regions.

- Using data developed in AusAgLCI database and adding allocation for coproducts.



Challenges for Bio-based LCA

Carbon balance

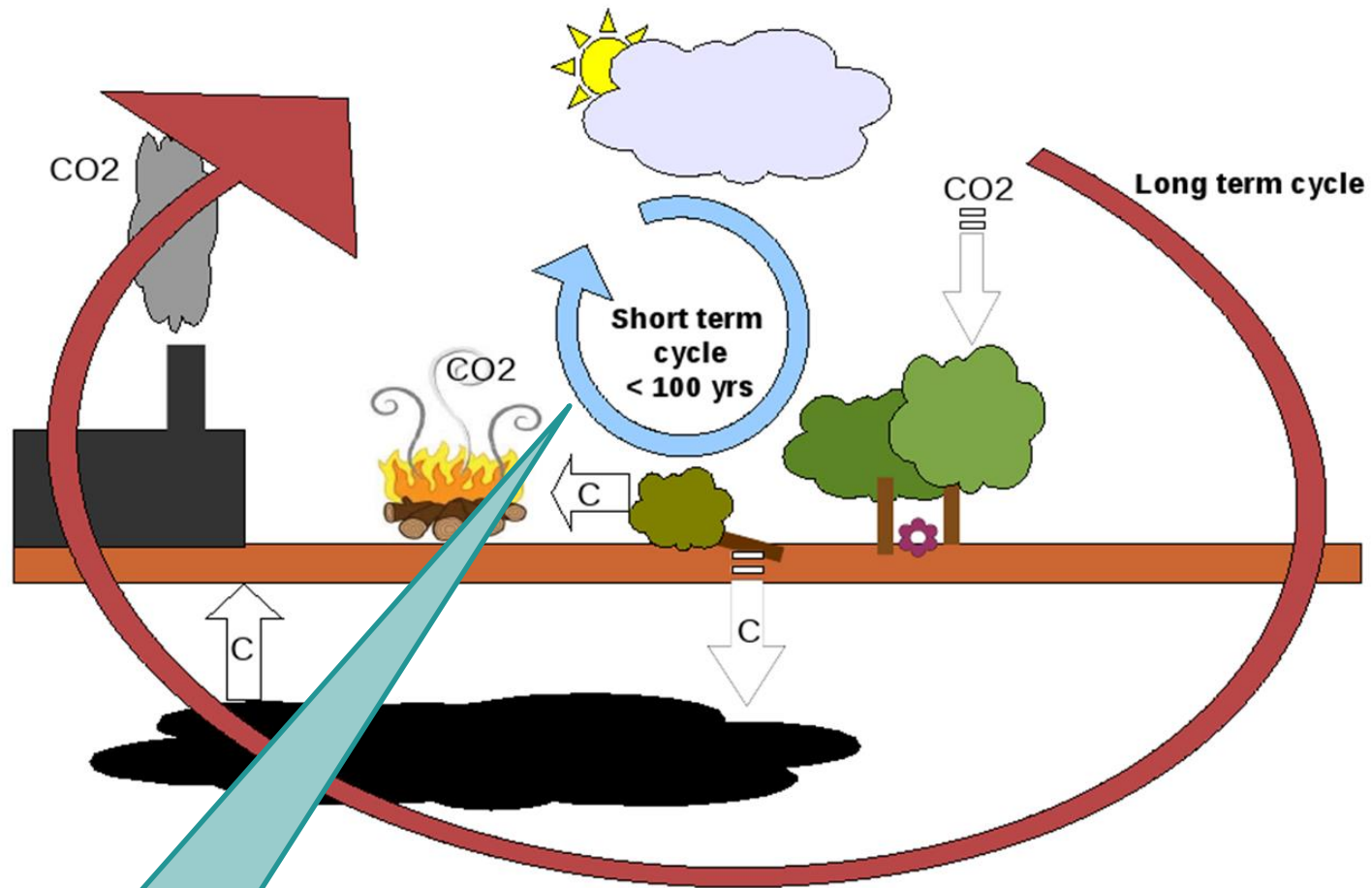
- Completing a full balance of fossil derived and atmospheric carbon through the product system.
- Accounting for timing of carbon flows and carbon storage.
- Accounting for direct and indirect land use change.
- Determining the environmental load assigned to the use of co-product's and residues and wastes.

Timing of Emissions

Timing of emissions, why worry?

- Idea behind “bio-based” from perspective of climate change was that CO₂ is in a short-term cycle between atmosphere and plants : no net effect

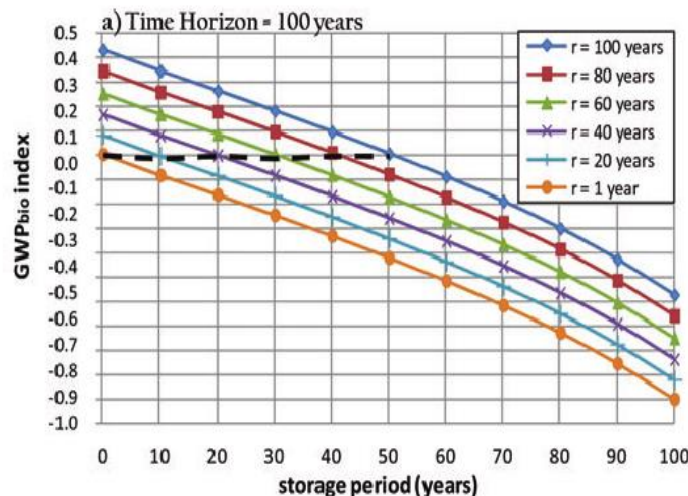
Timing of emissions, why worry?



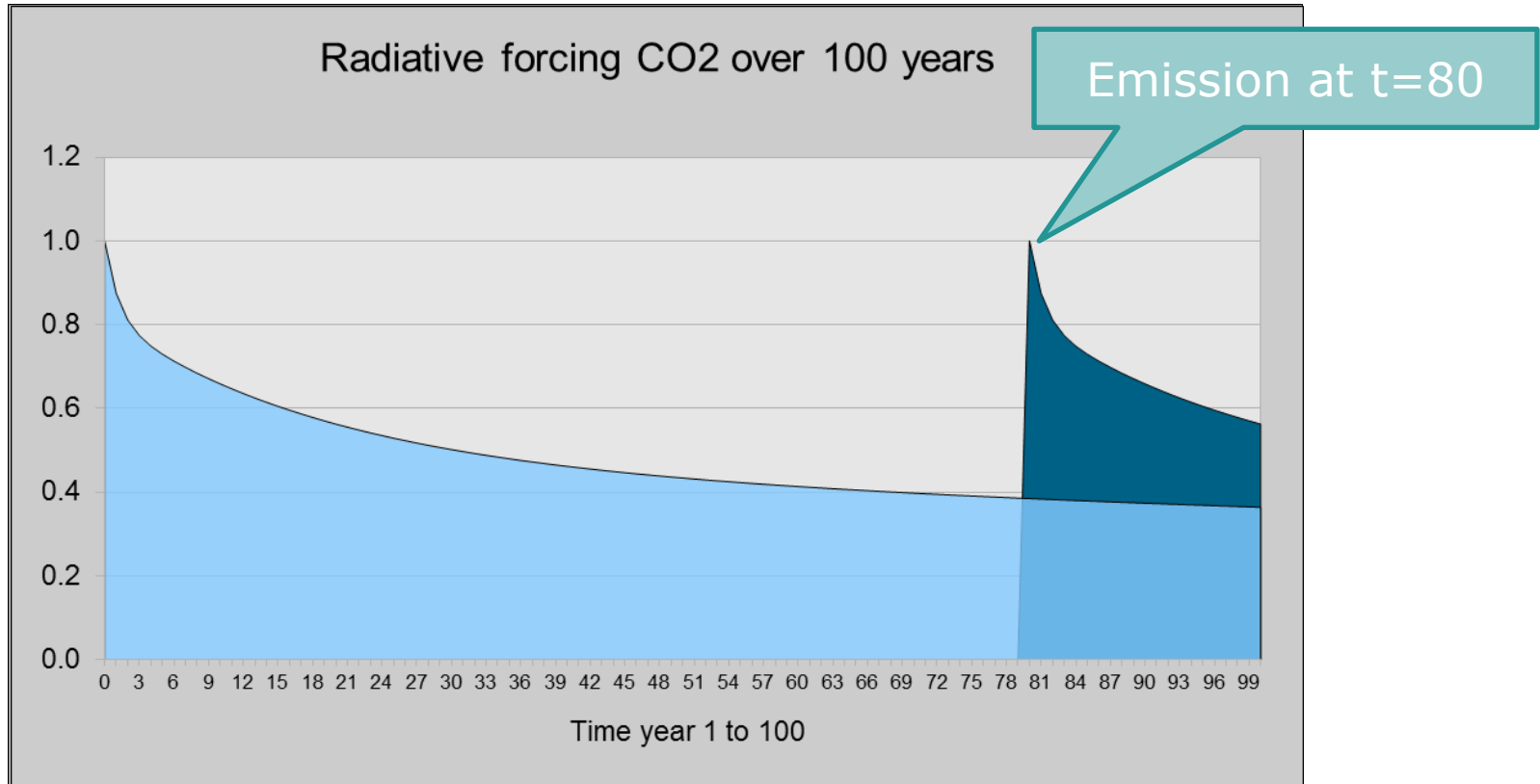
But how short is short??

Timing : worth to worry about !

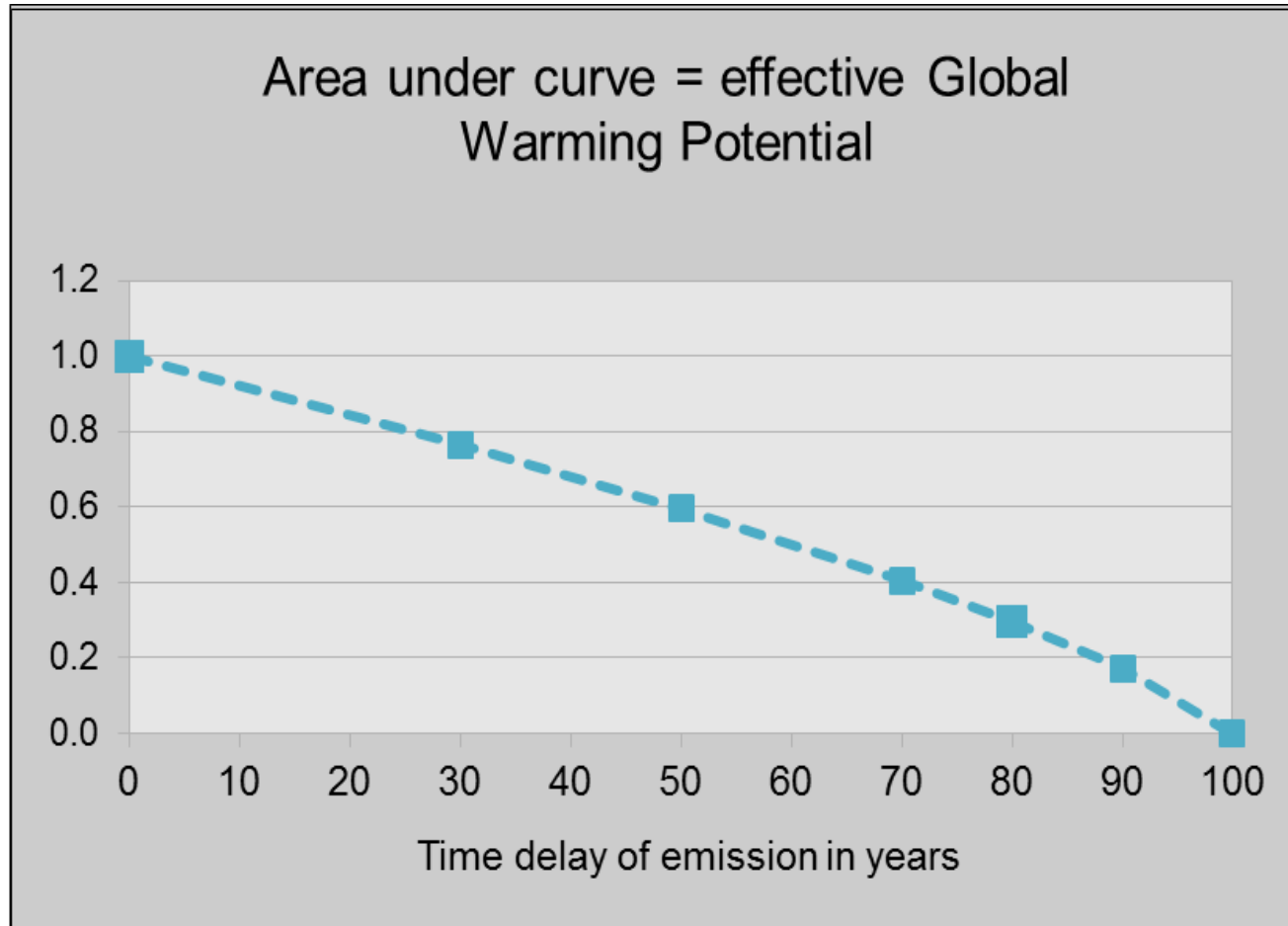
- Not as easy as we thought in 2004...
- Forestry has longer cycle than annual crops (storage in nature: uptake long time after harvest)
- Wood products have longer life time than e.g. biofuels (storage in economy: emission long time after harvest)



Effect of emission “delay”

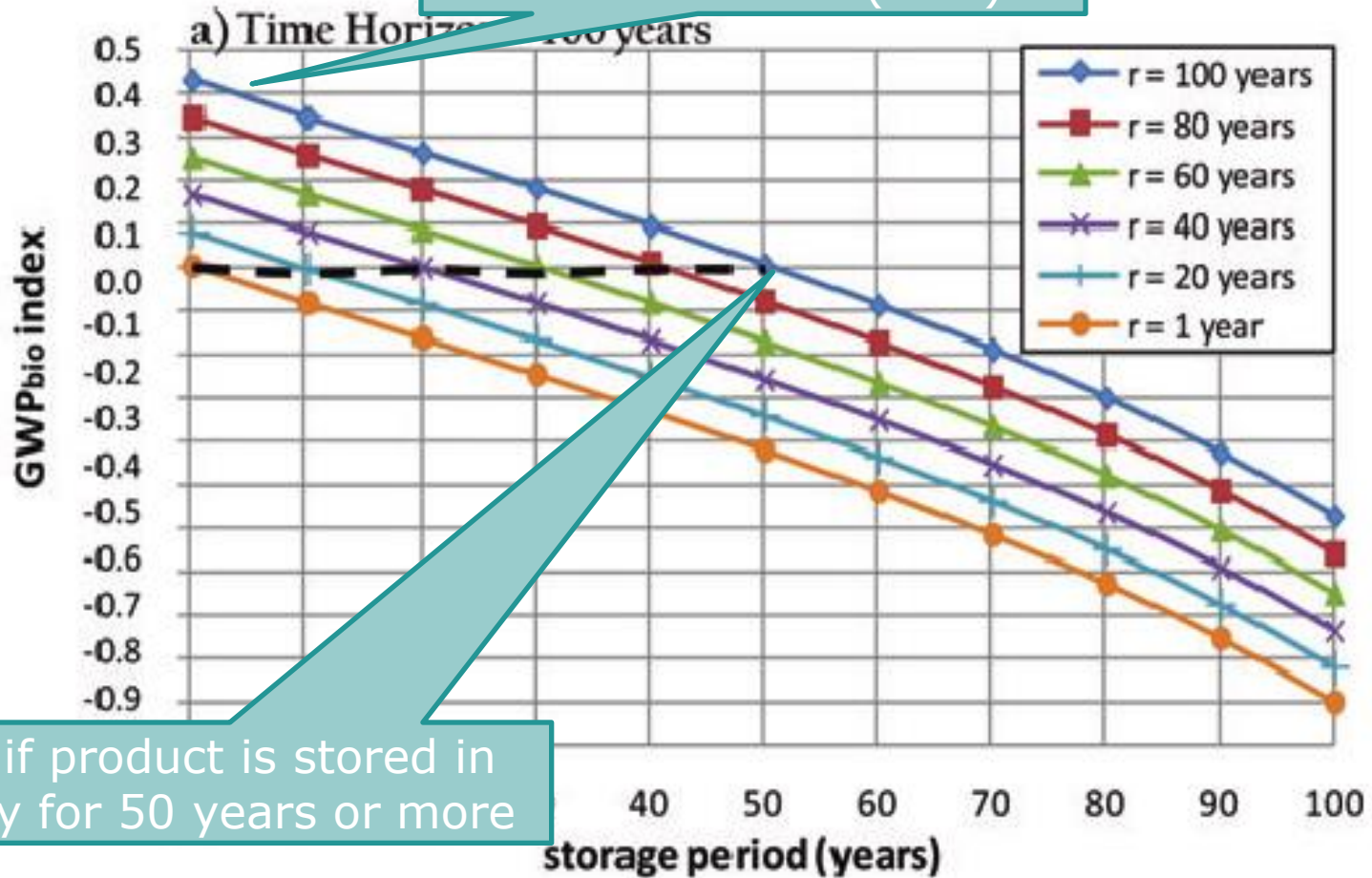


Effect of emission “delay”



Storage and crop rotation cycle

Longer rotation is not climate neutral (zero)



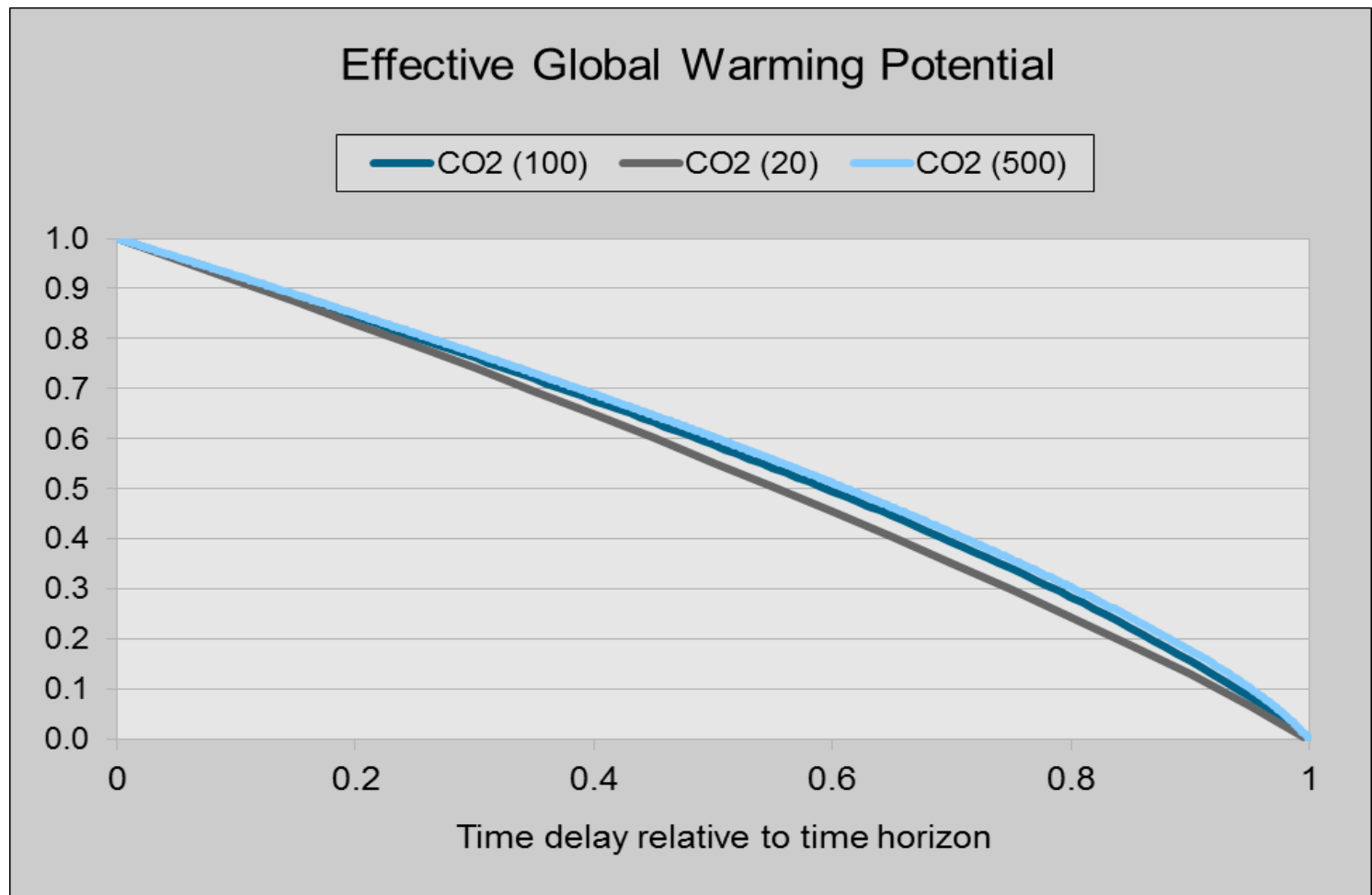
Except if product is stored in economy for 50 years or more

Source : Guest et al. 2012

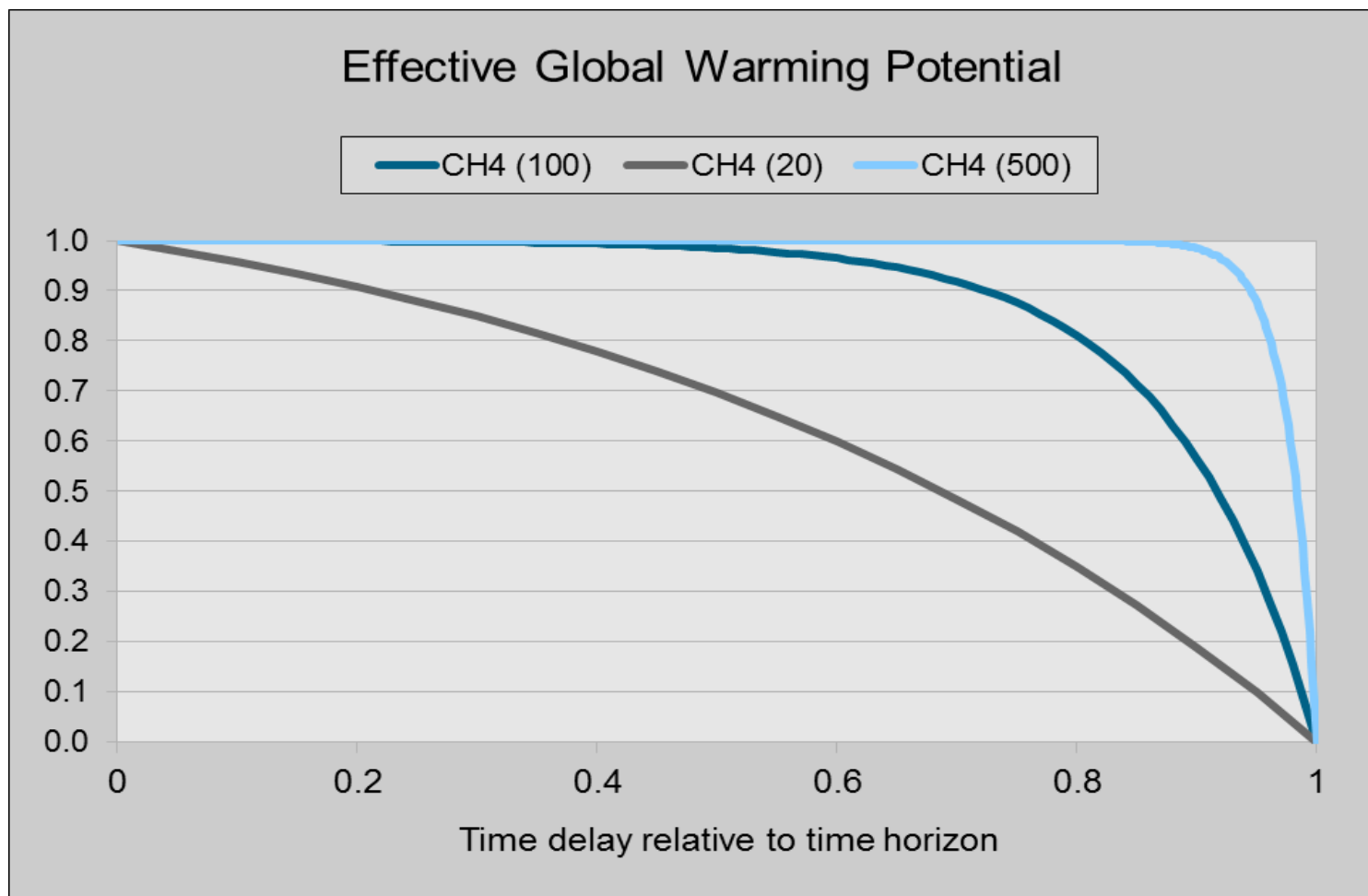
Challenges

- Not so much in the calculations but in the assumptions :
 - Time horizon (100 years ?)
 - Lower limit (10 years?)
 - Indicator (GWP ?)

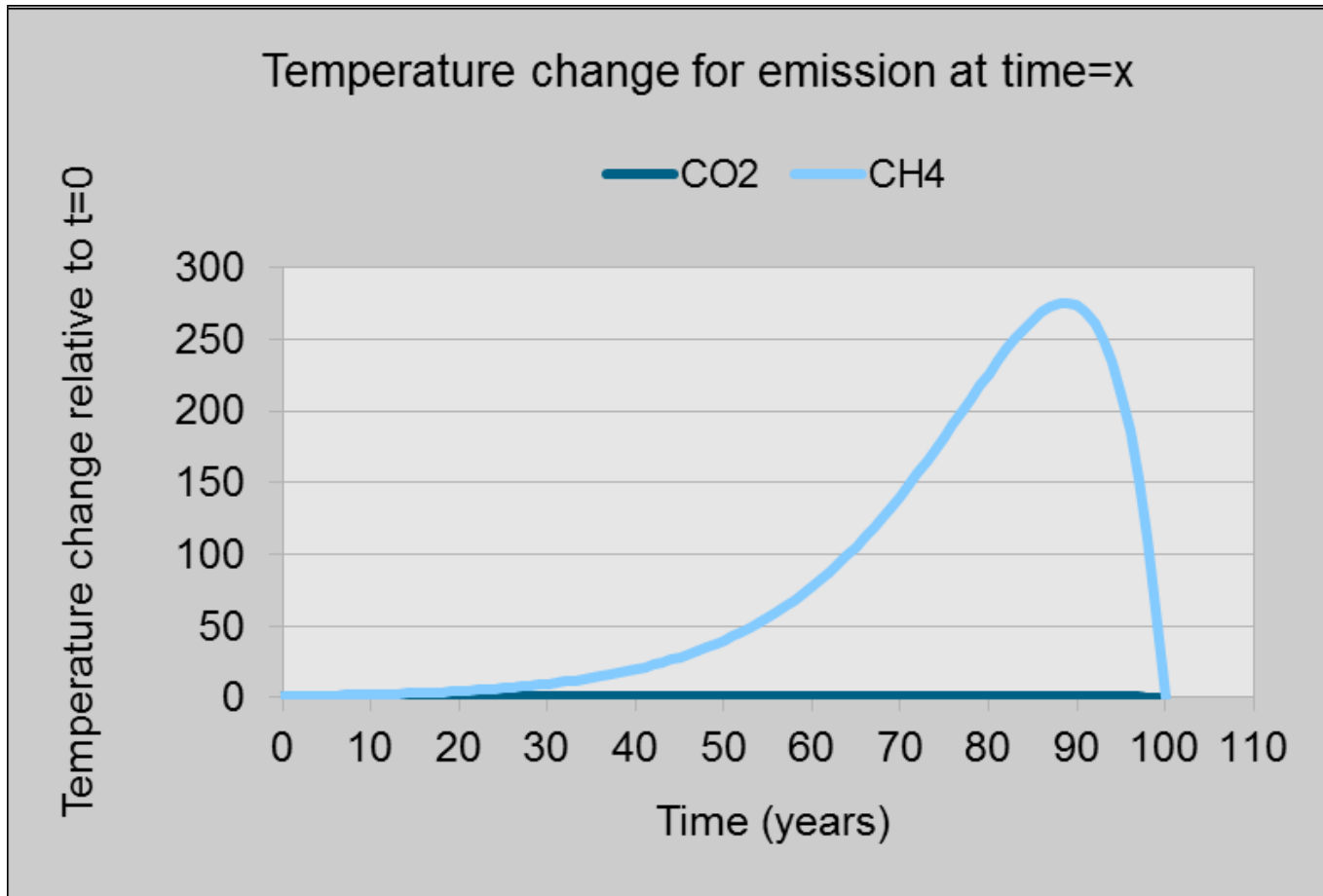
Time horizon : CO2



Time horizon : CH4



Temperature in 2114



Conclusions

- Current approach of standards is correct one : don't add the effects of timing to other effects
- Keeping them separate means visible
- More discussion necessary to decide what we need to measure

Next steps to Promote Bio-based LCA

Poll

Question

For new bio-based products entering the global market LCA is

Answer

A pre-requisite

31

Important to engage customers

Desirable but not essential

Irrelevant

I'm not qualified to judge



Poll

Question

The biggest priorities for LCA in relation to bio-based products is

Answer

Better life cycle inventory data

Environmental Product Declaration Schemes (EPDs)

Better indicators/impact assessment approaches

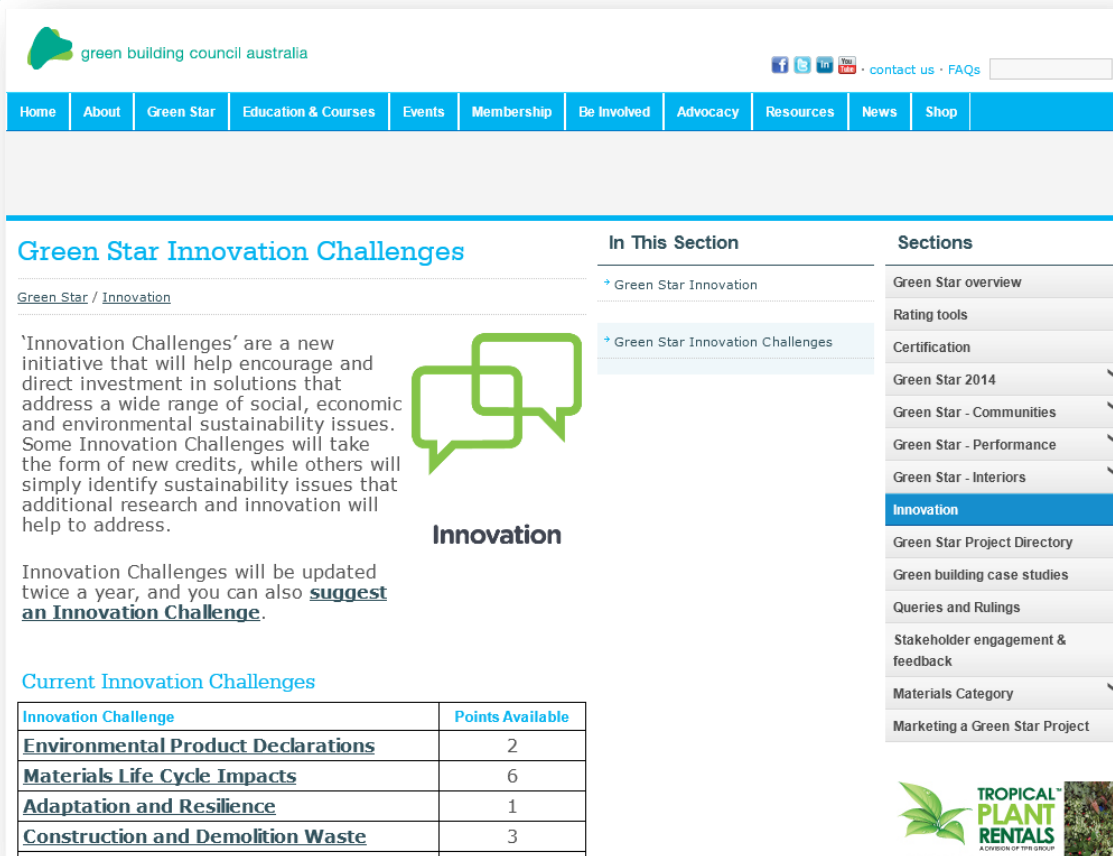
Education of the industry and public

Add to LCI data resources

- Continue to grow the inventory base for common inputs to bio-based products.
 - Char production inputs
 - Char production
 - Bio-based building materials – strawboard, compressed rice hull products etc.

Develop EPDs for bio-based products

- Green Building Council now provide credit points for LCA's and products with EPD's



green building council australia

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Green Star Innovation Challenges

Green Star / Innovation

'Innovation Challenges' are a new initiative that will help encourage and direct investment in solutions that address a wide range of social, economic and environmental sustainability issues. Some Innovation Challenges will take the form of new credits, while others will simply identify sustainability issues that additional research and innovation will help to address.

Innovation Challenges will be updated twice a year, and you can also **suggest an Innovation Challenge**.

Innovation

Current Innovation Challenges

Innovation Challenge	Points Available
Environmental Product Declarations	2
Materials Life Cycle Impacts	6
Adaptation and Resilience	1
Construction and Demolition Waste	3

In This Section

- Green Star Innovation
- Green Star Innovation Challenges

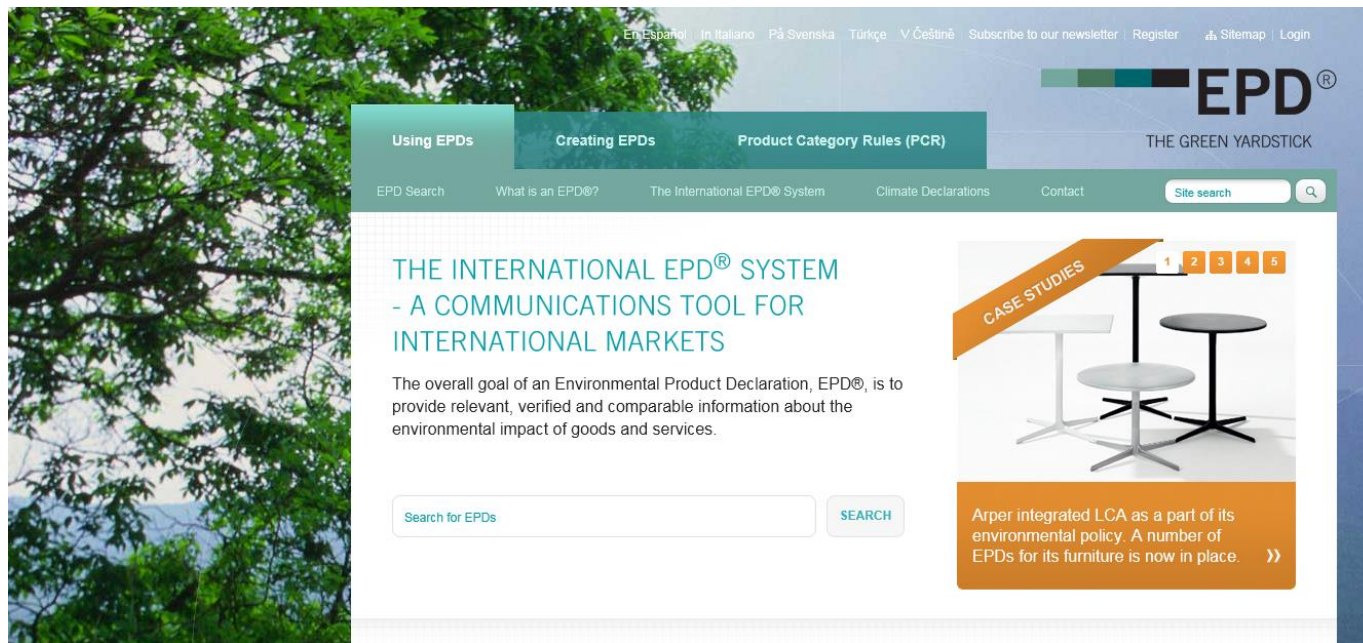
Sections

- Green Star overview
- Rating tools
- Certification
- Green Star 2014
- Green Star - Communities
- Green Star - Performance
- Green Star - Interiors
- Innovation**
- Green Star Project Directory
- Green building case studies
- Queries and Rulings
- Stakeholder engagement & feedback
- Materials Category
- Marketing a Green Star Project

TROPICAL PLANT RENTALS

Develop EPDs for bio-based products

- ALCAS/ALCANZ are launching national EPD schemes based on the International EPD System.



Watching brief on international bio based certification schemes

- Important to make sure sensible schemes are developed based on life cycle approach
- Need to align our inventory processes to these schemes where possible.

Development of Indicators

- Land use and land quality remain poorly represented in LCA.
- Caring for our Country project is funding CSIRO in the development of soil quality indicators.
- GRDC sponsoring ALCAS workshop in May 2014 to kick off this work.
- ALCAS Impact Assessment Committee is reviewing *ALCAS Best Practice Guide to LCIA in Australia*.

Future Sector Engagement

Acknowledgement

Thank you once again to the



Australian Government
Department of Industry

ALCAS
AUSTRALIAN
LIFE CYCLE ASSESSMENT
SOCIETY

AusLCI 
Sustainable Products, Sustainable Futures