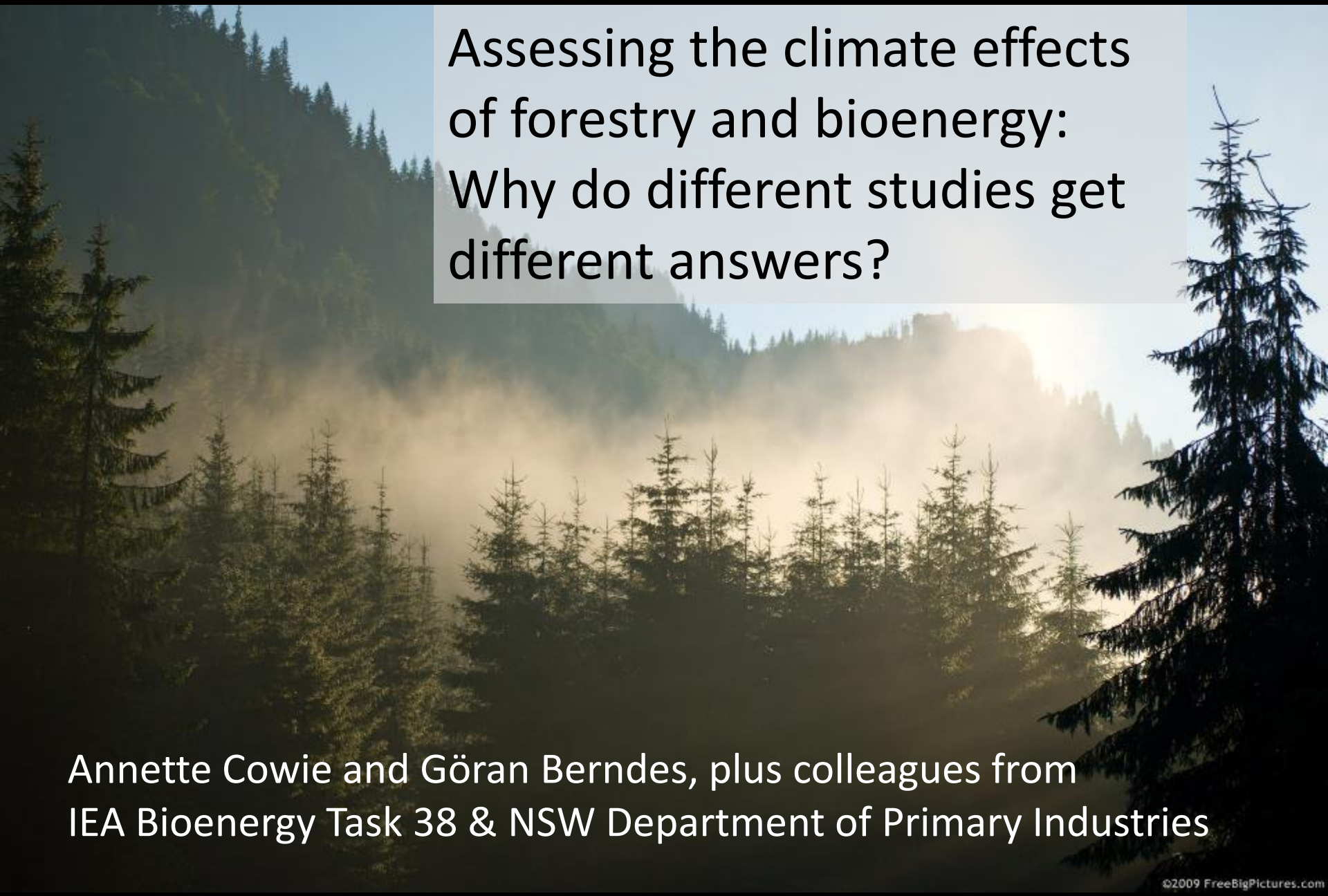
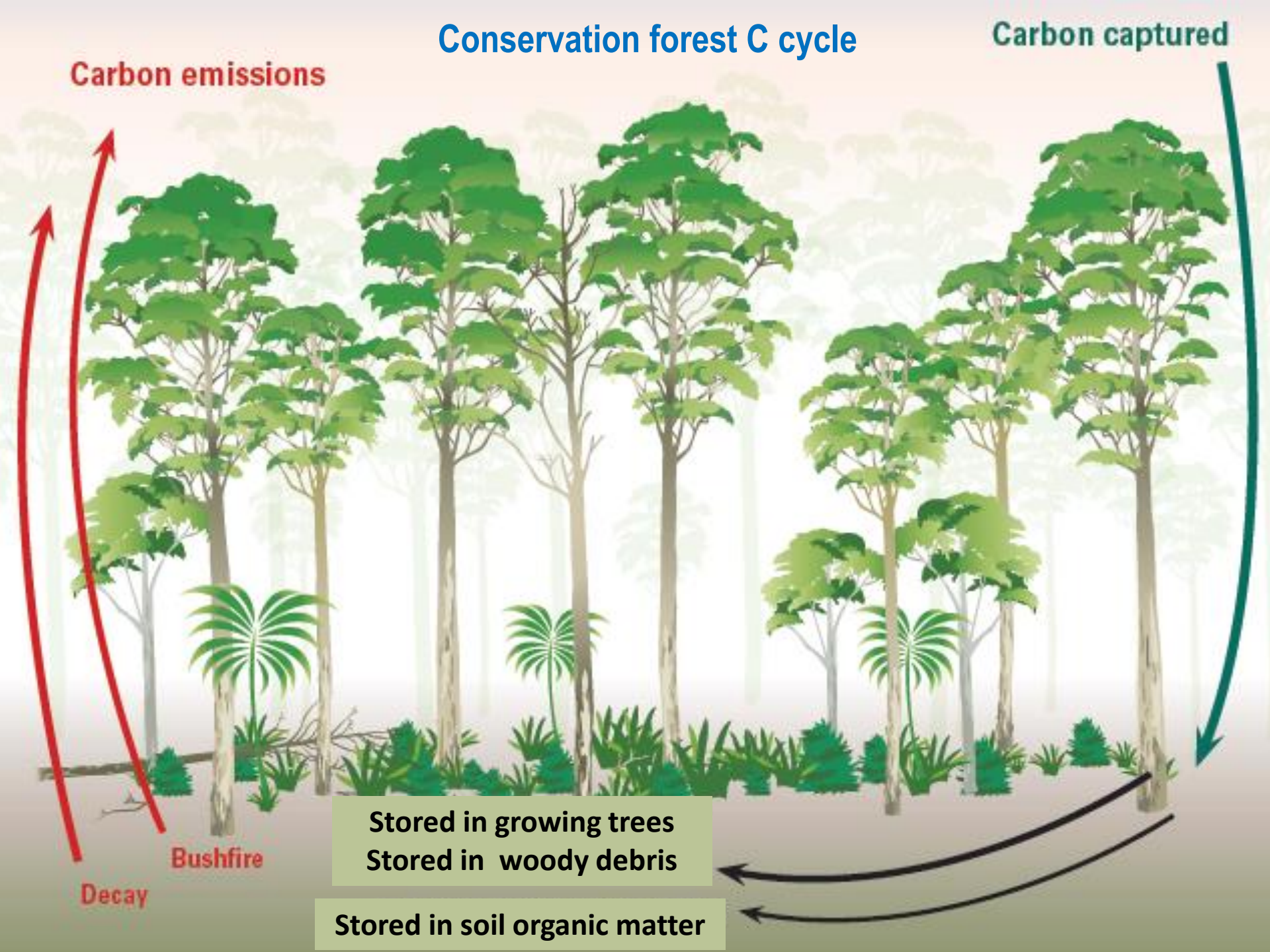


Assessing the climate effects of forestry and bioenergy: Why do different studies get different answers?

Annette Cowie and Göran Berndes, plus colleagues from
IEA Bioenergy Task 38 & NSW Department of Primary Industries

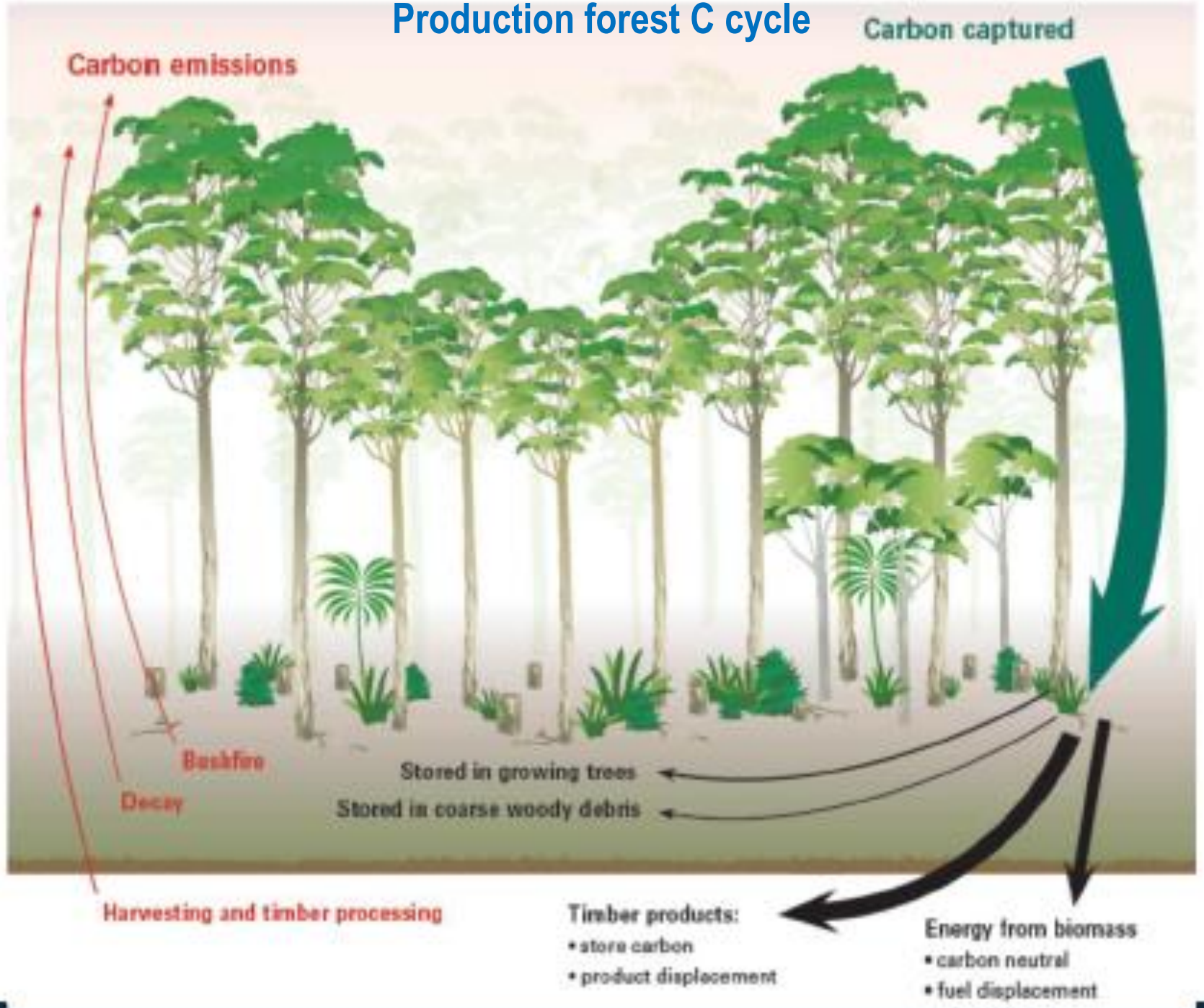
How to manage forests for climate change mitigation?

Conservation forest C cycle



Forest products

Production forest C cycle



Biomass and Bioenergy
Volume 10, Issues 5–6, 1996, Pages 275-300

The role of forest and bioenergy strategies in th global carbon cycle

Bernhard Schlamadinger*, †, Gregg Marland*

Environmental Research Letters

The economic potential of bioenergy for climate change mitigation with special attention given to implications for the land system

Alexander Popp[1], Jan Philipp Dietrich[1], Hermann Lotze-Campen[1], David Klein[1], Nico Bauer[1], Michael Krause[1], Tim Beringer[1], Dieter Gerten[1] and Ottmar Edenhofer[1,2]

Published 16 August 2011 • IOP Publishing Ltd

Energy Policy
Volume 35, Issue 12, December 2007, Pages 5965-5979

Bioenergy expansion in the EU: Cost-eff change mitigation, employment creation dependency on imported fuels

Göran Berndes, Julia Hansson

Show more

Seeing Forests for More than Carbon in the Trees: Incentivizing Actions beyond Carbon Storage to Mitigate Climate Change

Robert Alec Giffen, Chris Schwalm, Robert Perschel, Phil Duffy, Richard A. Houghton, Will Price, Frank Lowenstein

Journal of Forestry, Volume 115, Issue 4, 1 July 2017, Pages 329–331,

Managing Forests for Climate Change Mitigation

Josep G. Canadell*, Michael R. Raupach

Global Carbon Project, CSIRO Marine and Atmospheric Research, GPO Box 3023, Ca

* To whom correspondence should be addressed. E-mail: pep.canadell@csiro.au

– Hide authors and affiliations

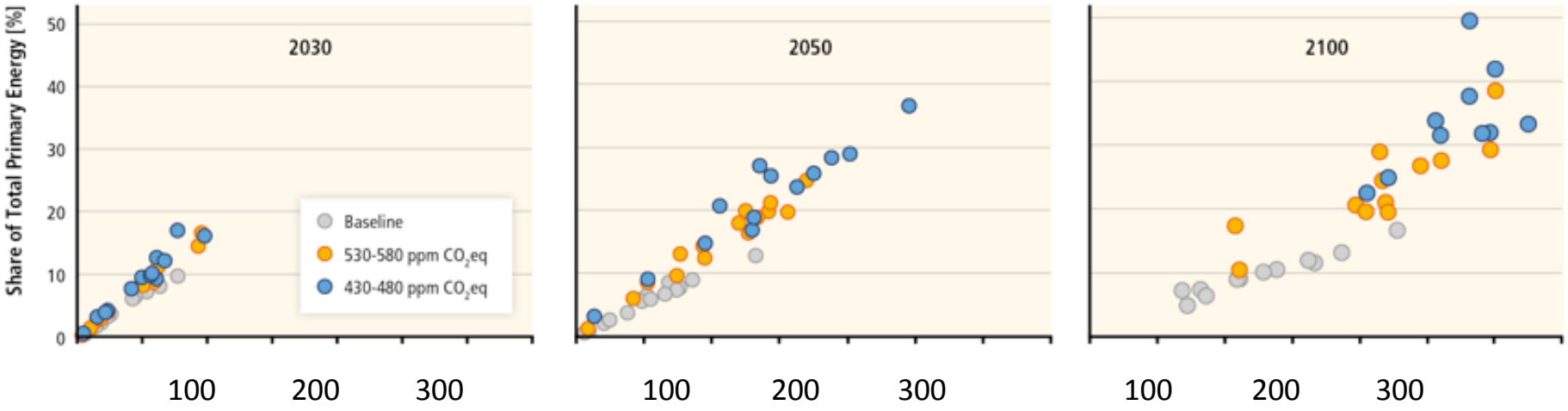
Science 13 Jun 2008:
Vol. 320, Issue 5882, pp. 1456-1457
DOI: 10.1126/science.1155458

BIOENERGY TO MITIGATE FOR CLIMATE CHANGE AND MEET THE NEEDS OF SOCIETY, THE ECONOMY AND THE ENVIRONMENT

RALPH E.H. SIMS
Centre for Energy Research, Massey University, Palmerston North, New Zealand
*(*For correspondence: Tel.: +64 6 3505288; Fax: +64 6 3505604;*
E-mail: R.E.Sims@massey.ac.nz)

Bioenergy for climate change mitigation

Integrated assessment modelling indicates a critical role for bioenergy in order to meet the temperature target of the Paris Agreement.



Source: IPCC AR5

ECOSPHERE
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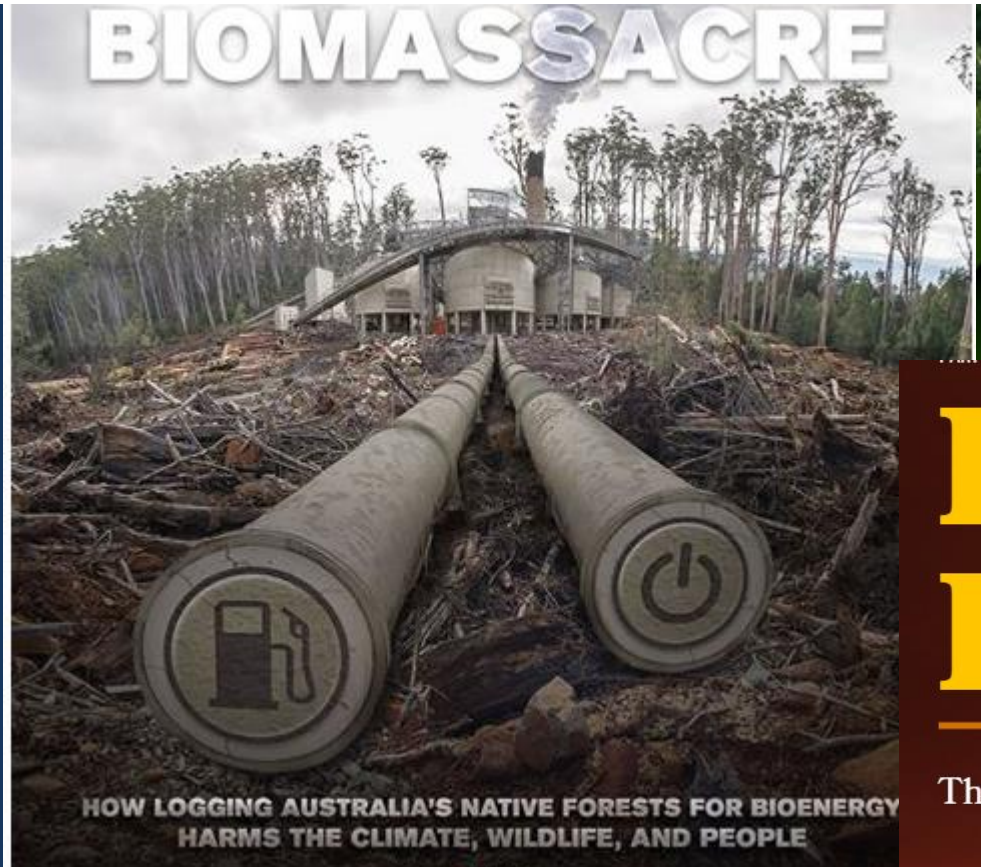
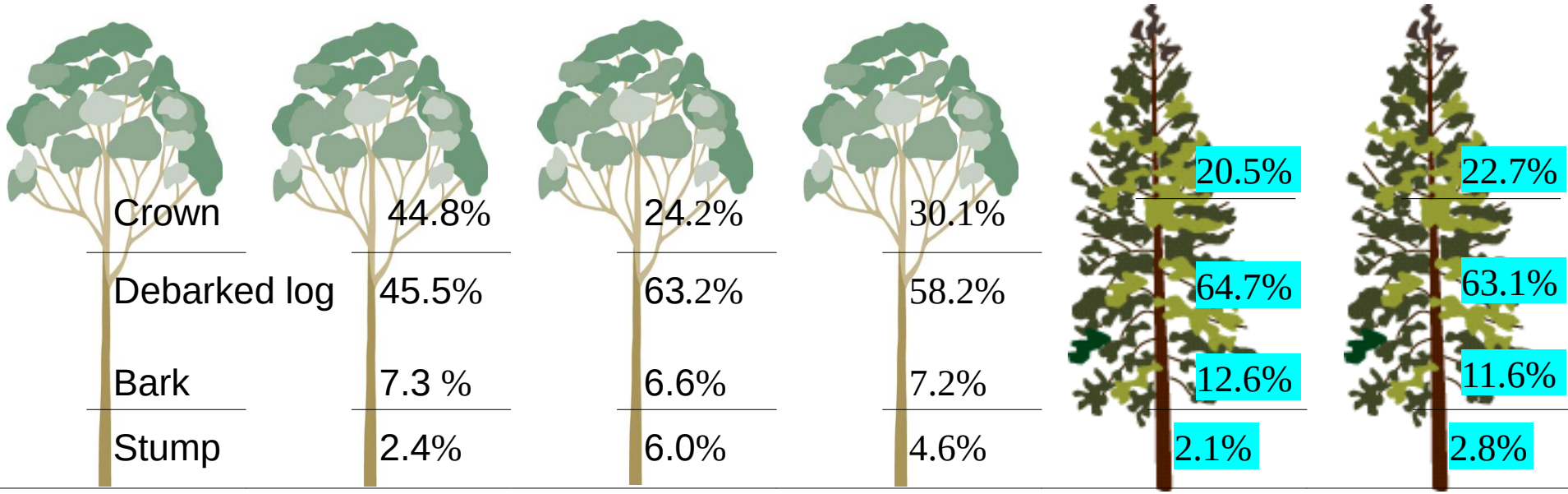
Article

Managing temperate forests for carbon storage: impacts of logging versus forest protection on carbon stocks

Heather Keith ✉, David Lindenmayer, Brendan Mackey, David Blair, Lauren Carter, Lachlan McBurney, Sachiko Okada, Tomoko Konishi-Nagano



Different forest types – different products, recoveries



Species	Blackbutt	Messmate	Spotted gum	Radiata pine	Cypress pine

Ximenes et al



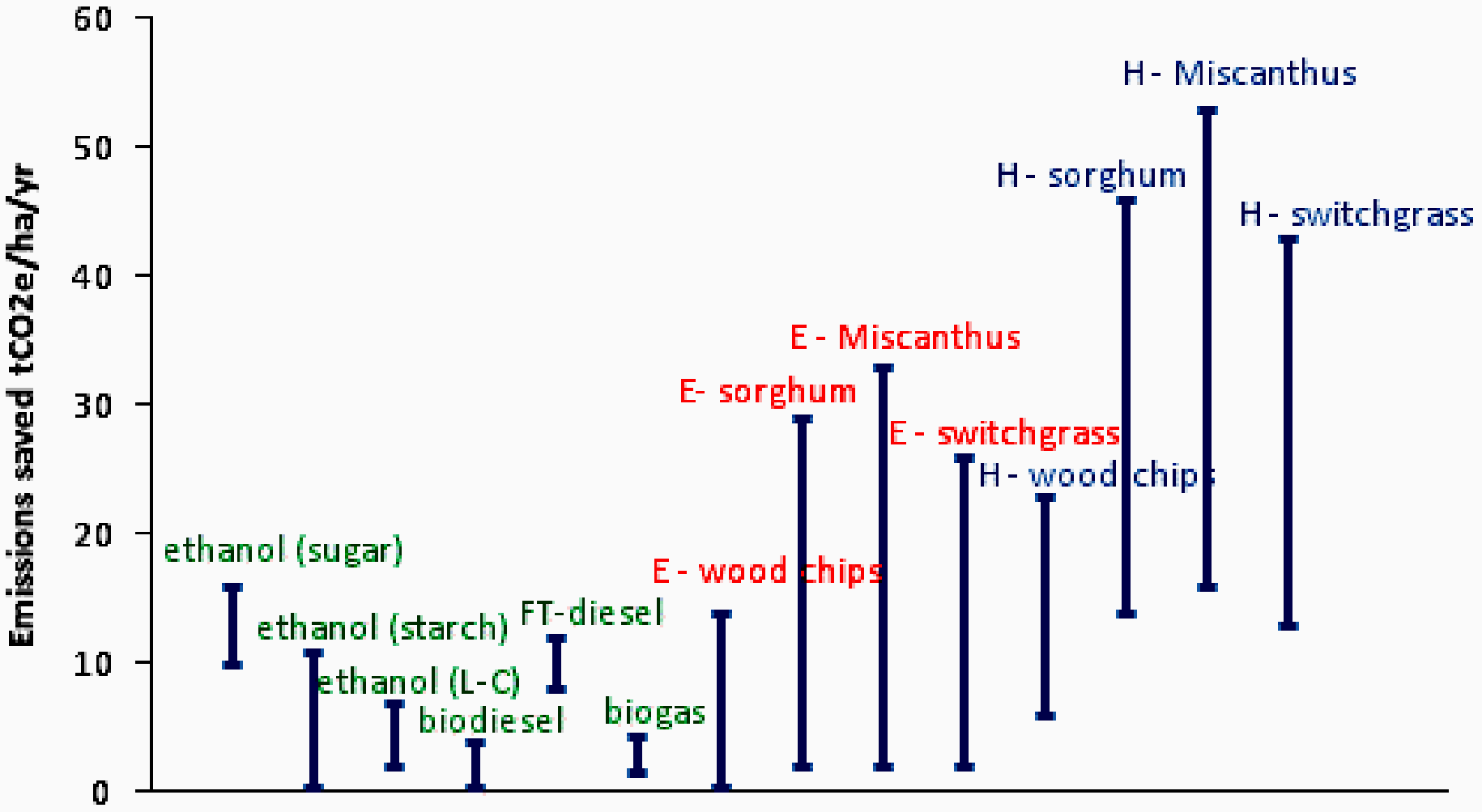
Bioenergy – different feedstocks

- Sawmill residues
- Forest harvest residues
- Construction/demolition waste
- Short rotation woody crops
- Urban green waste

Bioenergy – different technologies

- Combustion
  Co-firing
  CHP
- Pyrolysis, gasification
- BTL

Different energy products



Excludes indirect land use change

Data from Cherubini et al 2009

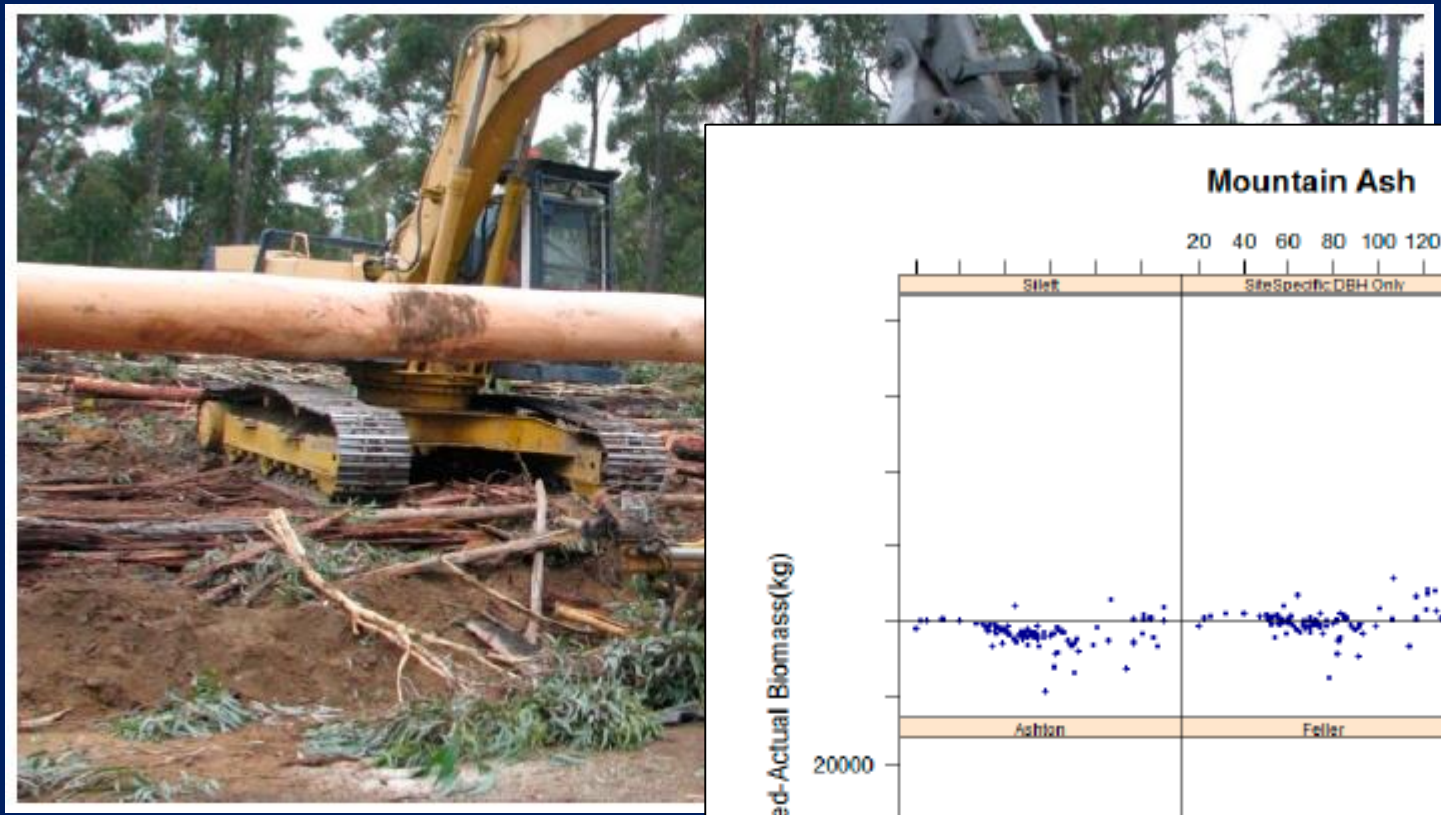
Bioenergy - Different scales

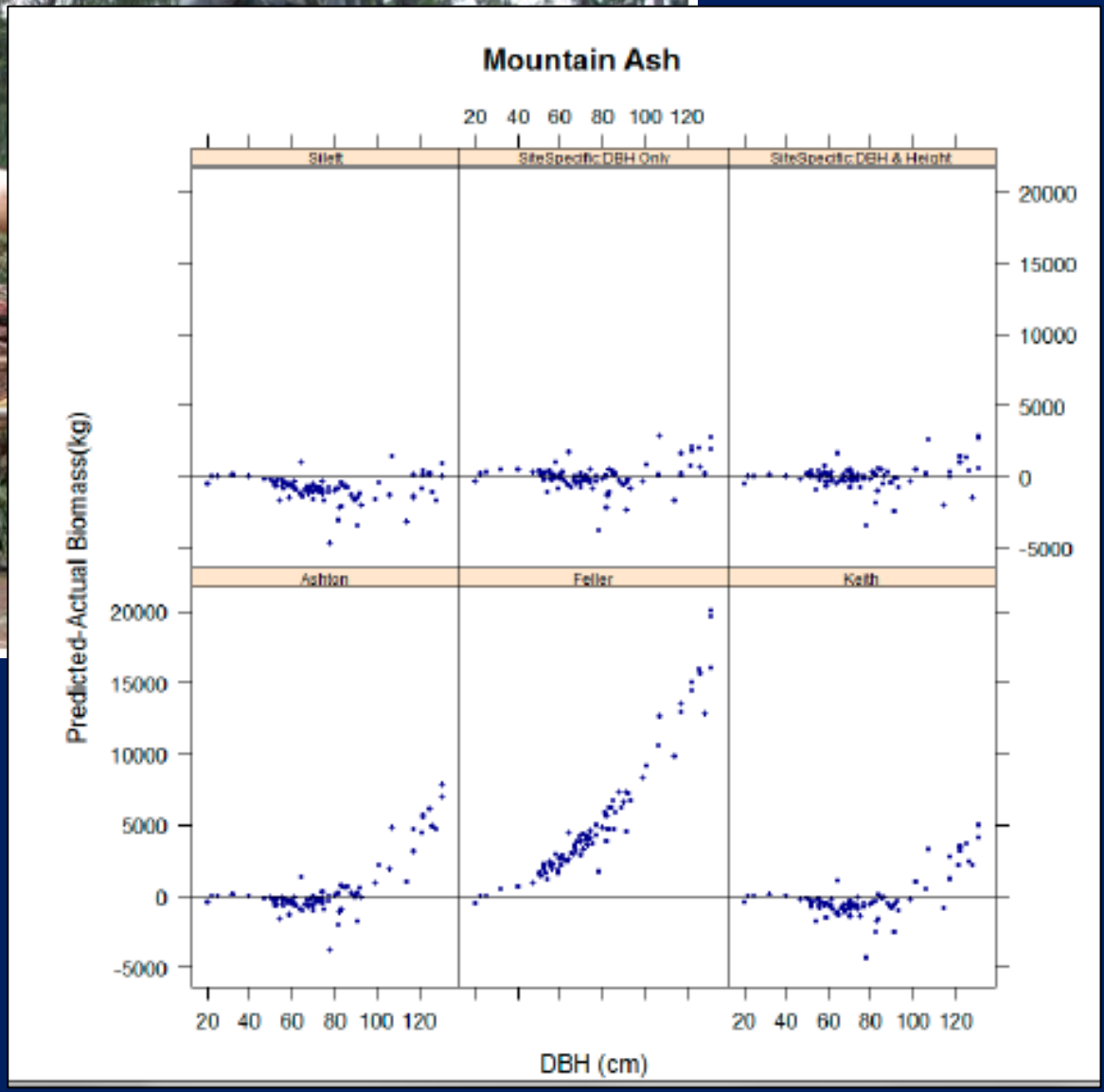

Bioenergy to support
expansion of renewables

Bioenergy - alternative fate of biomass


NIGHTLY AT 8.
COLE PORTER'S
MUSICAL-
VICTOR

Analytical method – data sources

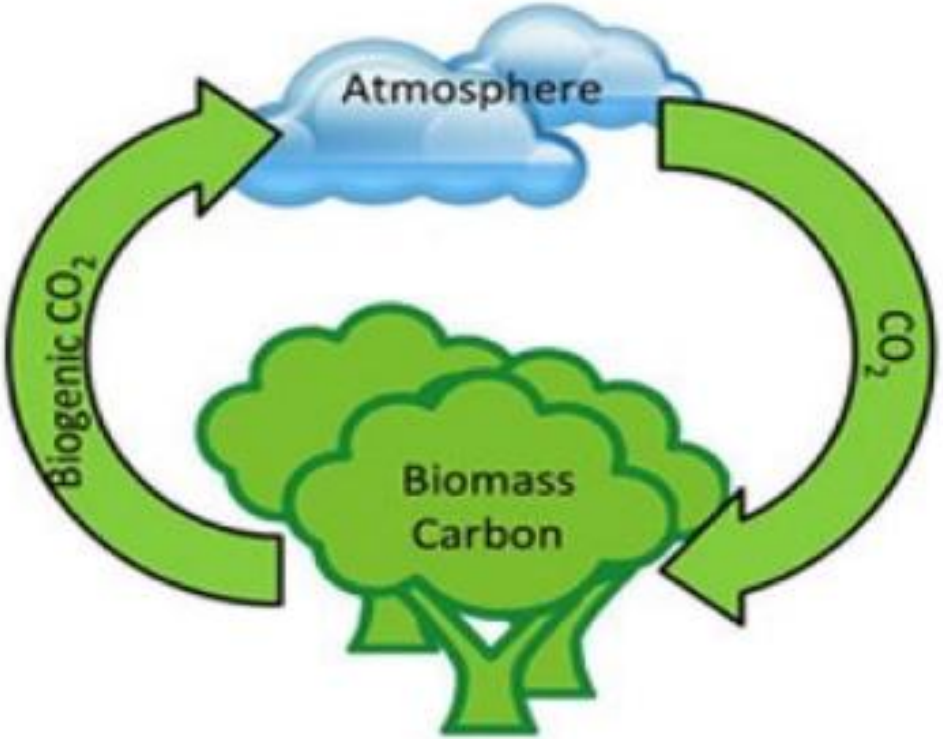




Ximenes et al, 2018


System boundary
Wood worse than coal?

System boundary: Wood vs coal



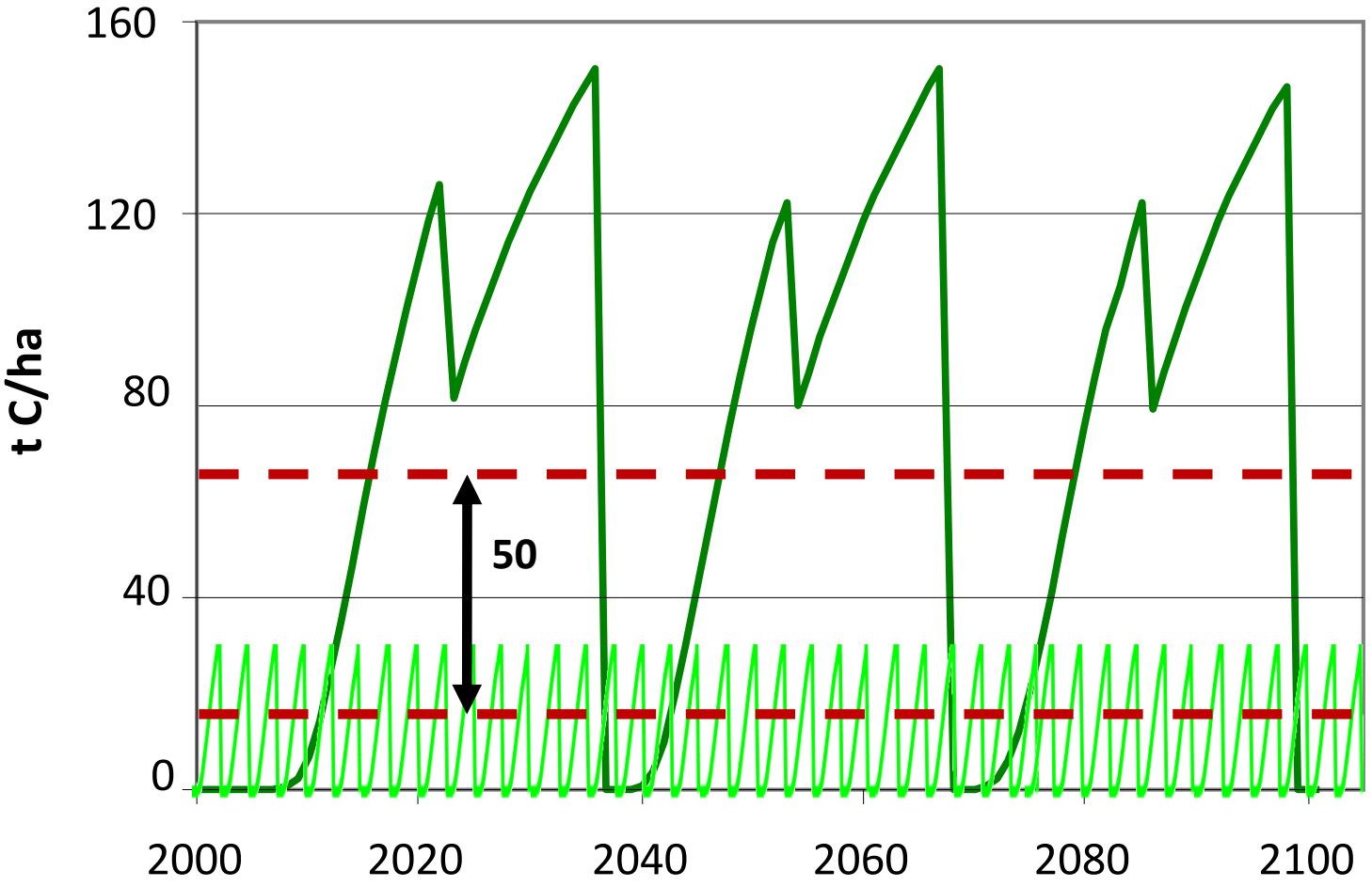
Circular C flow

Linear C flow

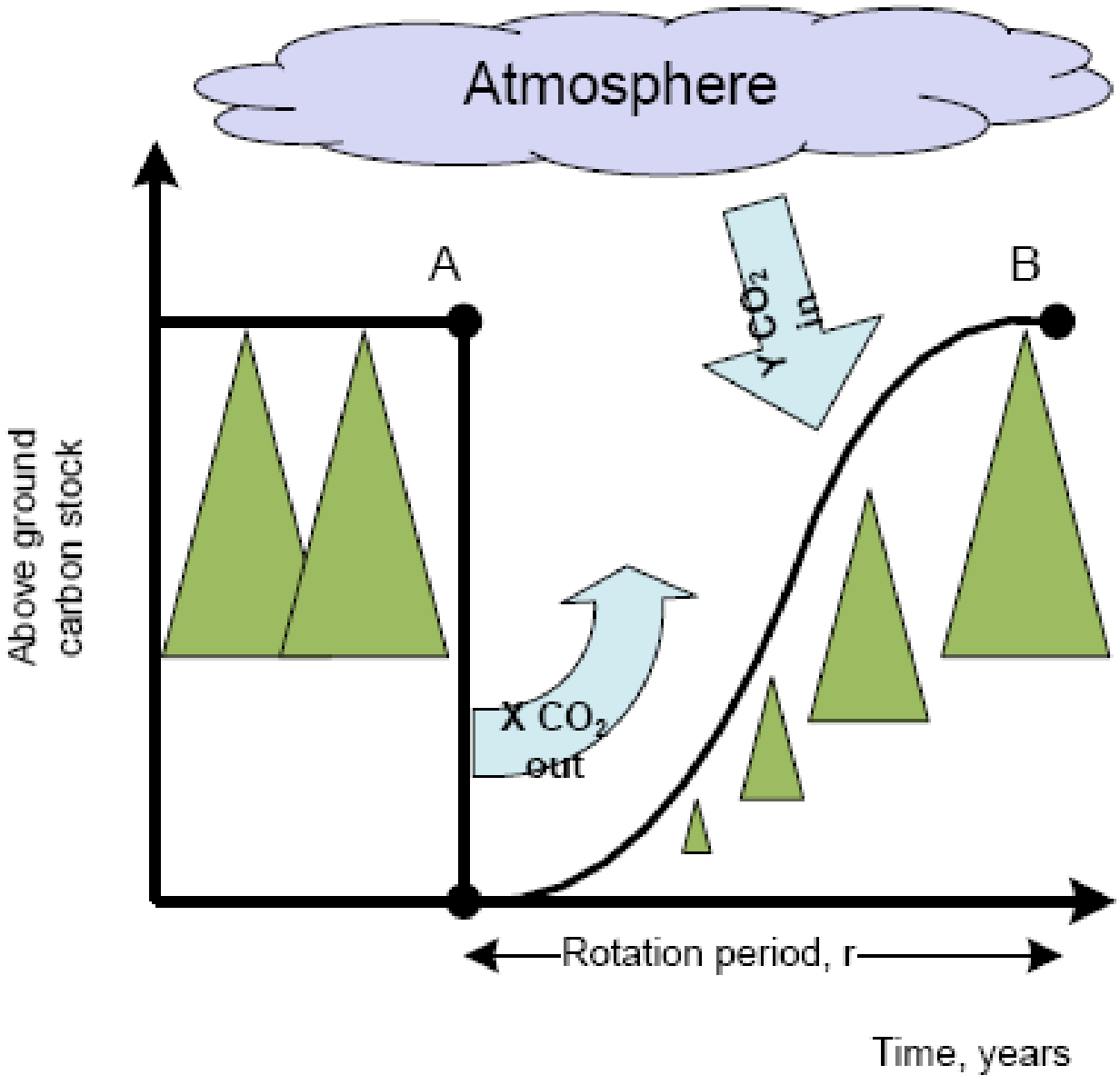
Scope: Forest carbon stock

- C stock change in biomass or soil
- direct land use change - dLUC
- change in management practice

Forest C stock change

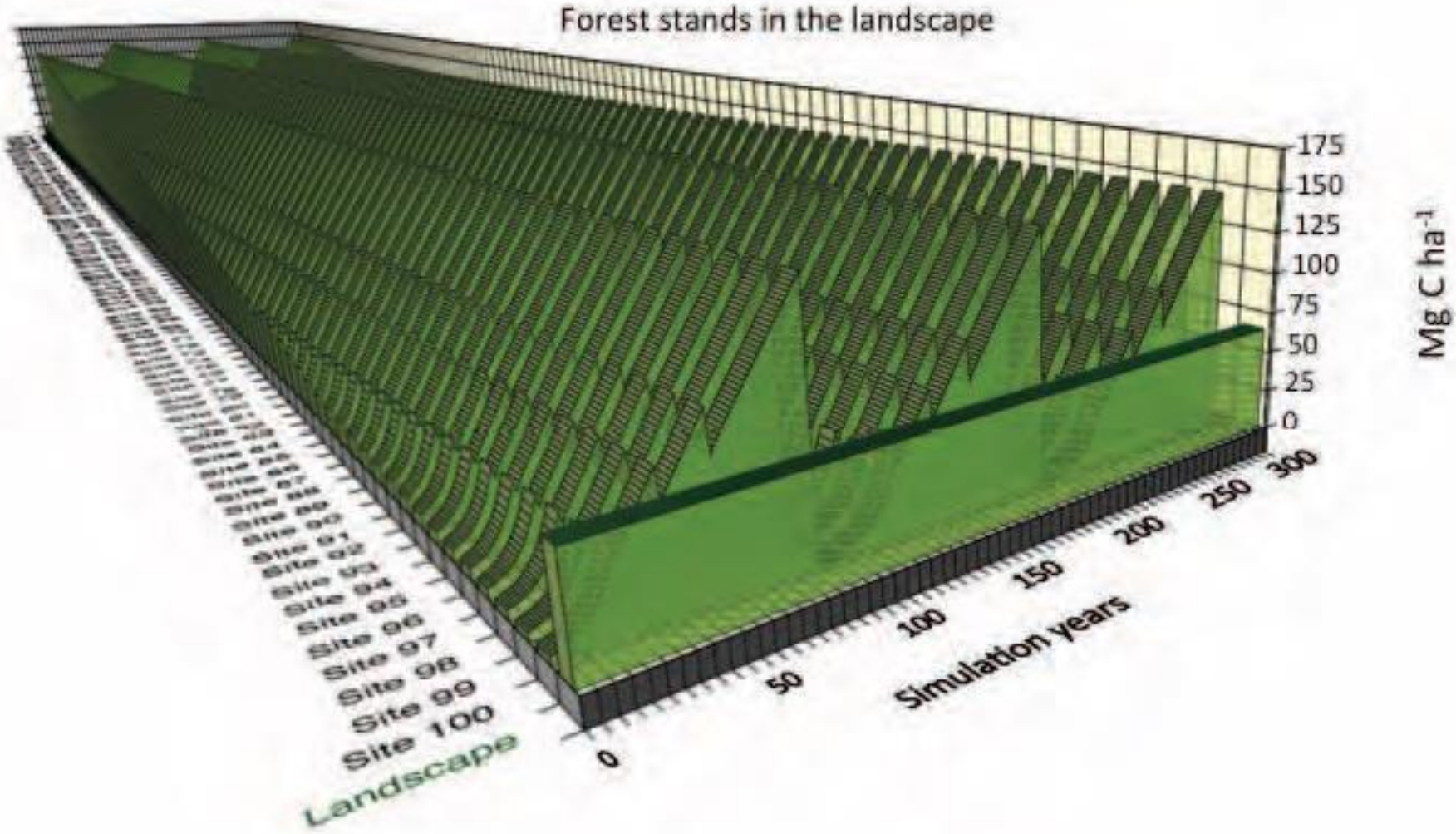


Spatial scale - stand



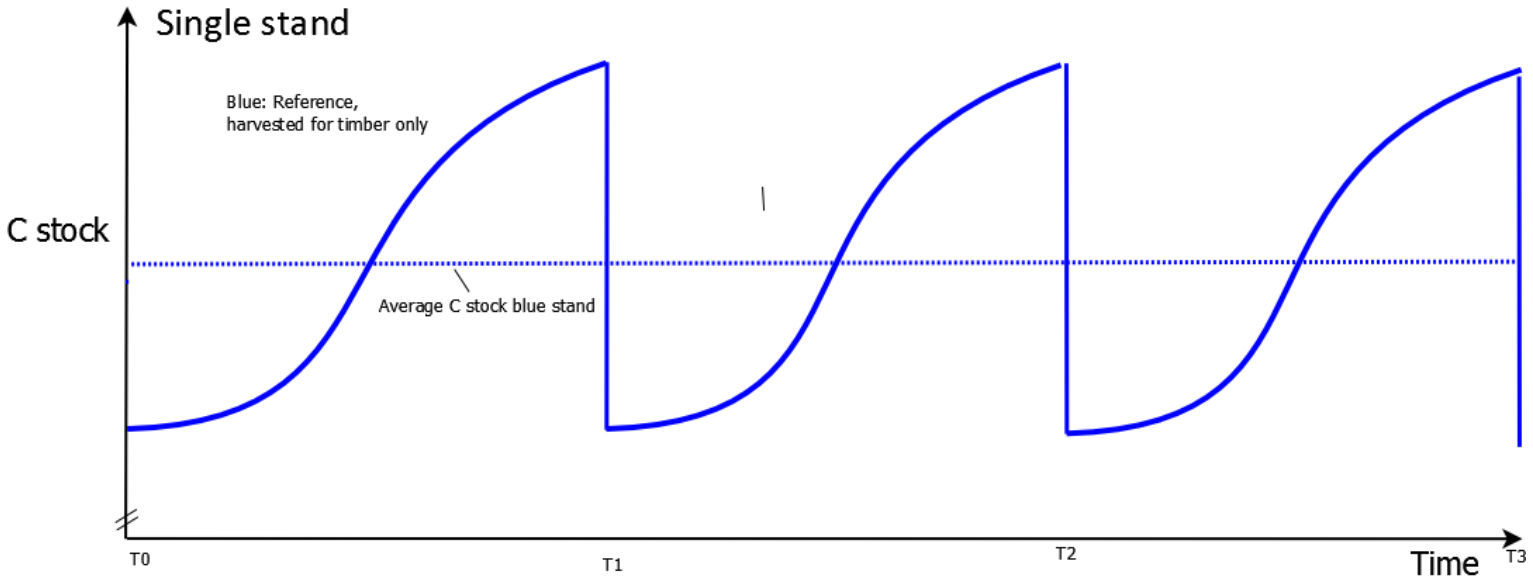
F Cherubini NTNU

Spatial scale - landscape

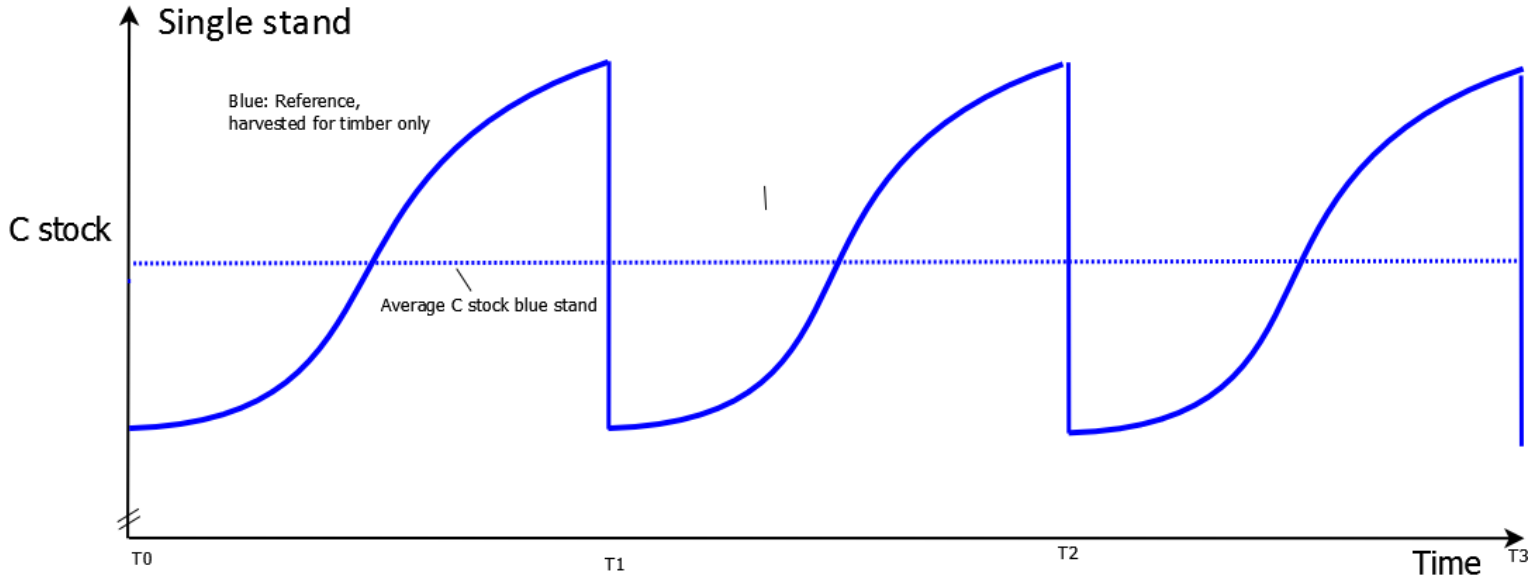


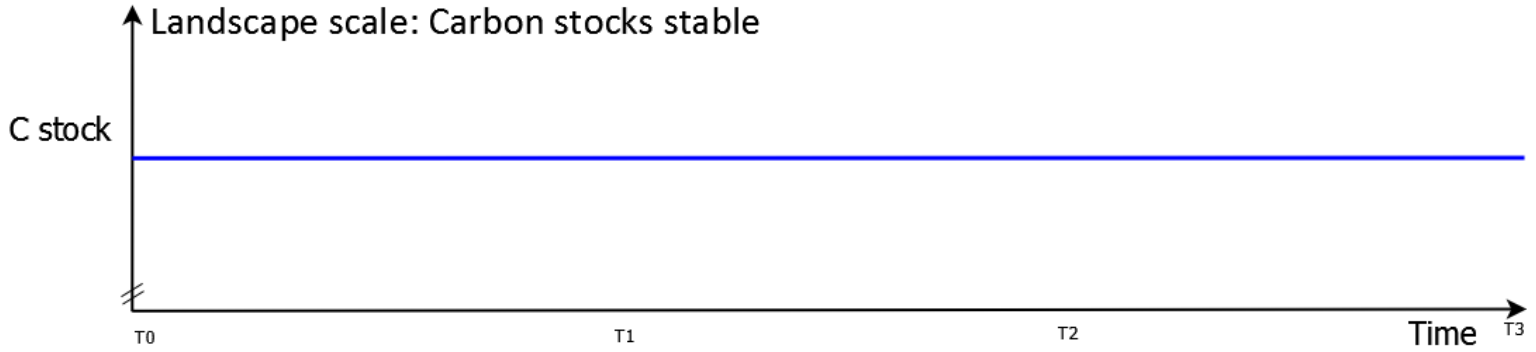
Berndes et al 2011

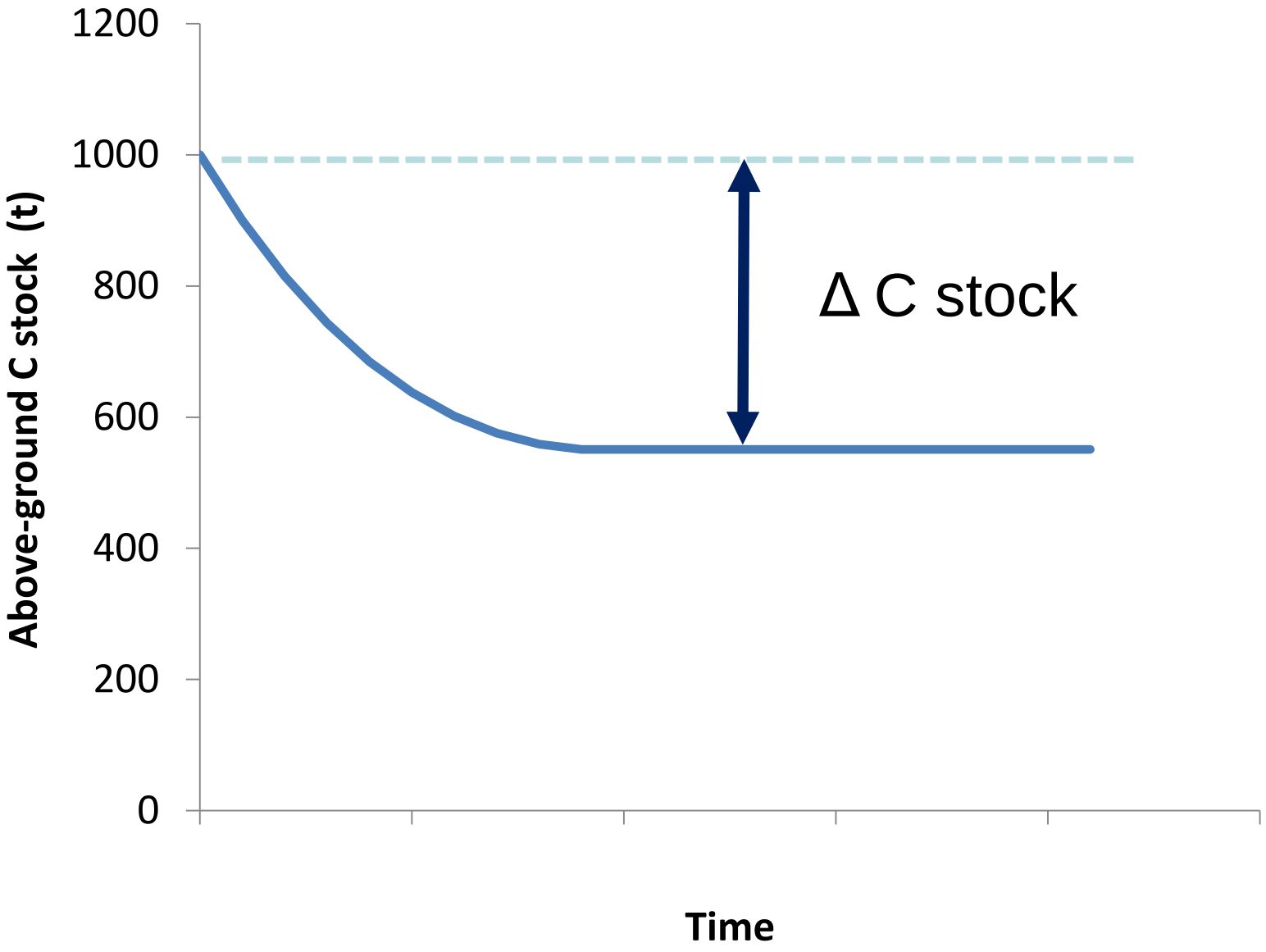
Spatial scale – stand vs landscape



Spatial scale – stand vs landscape

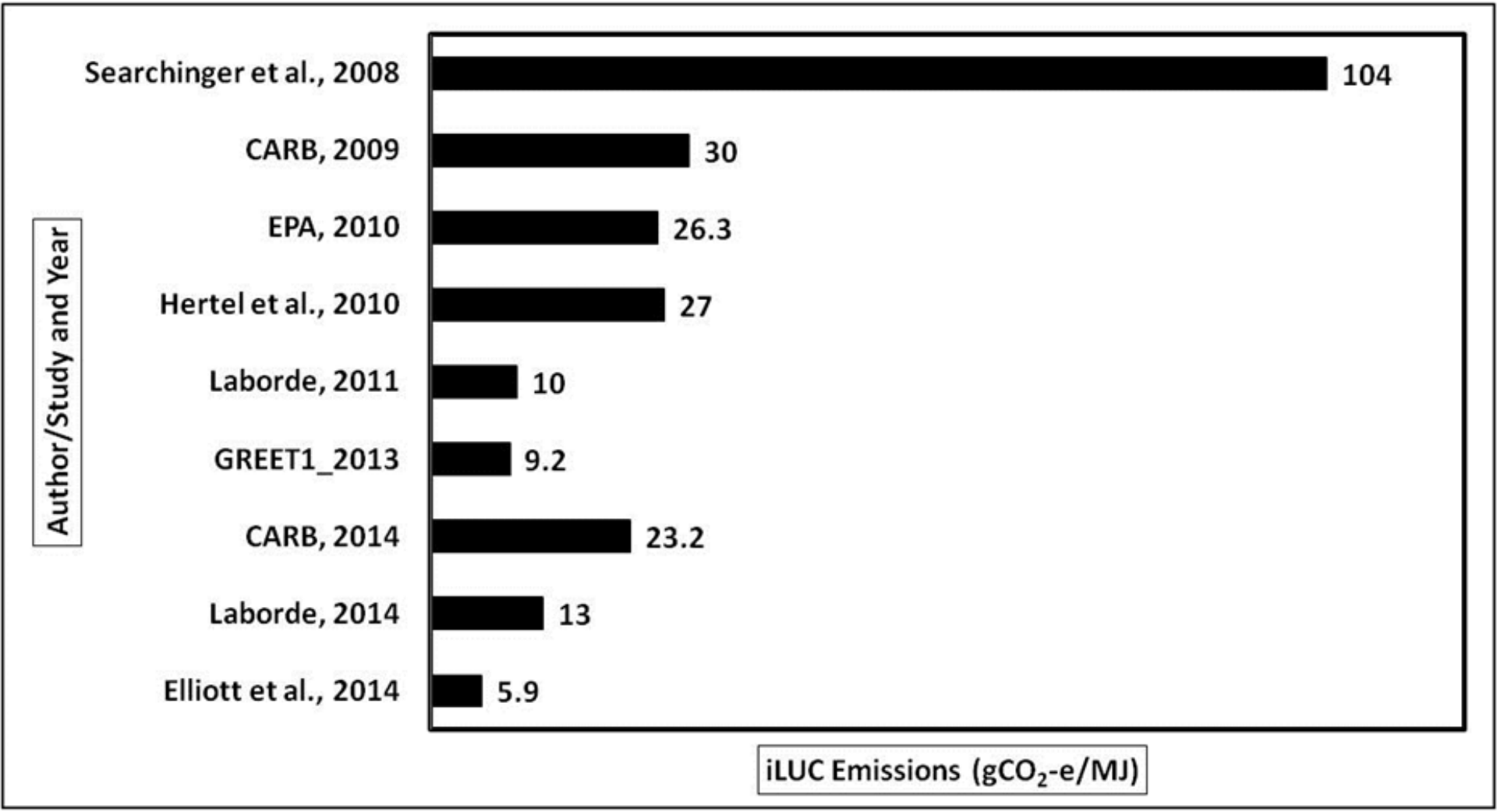





1200
1000
800
600
400
200
0
Above-ground C stock (t)
Δ C stock
Time

Indirect landuse change

iLUC - corn-based ethanol



Counterfactual reference: energy system

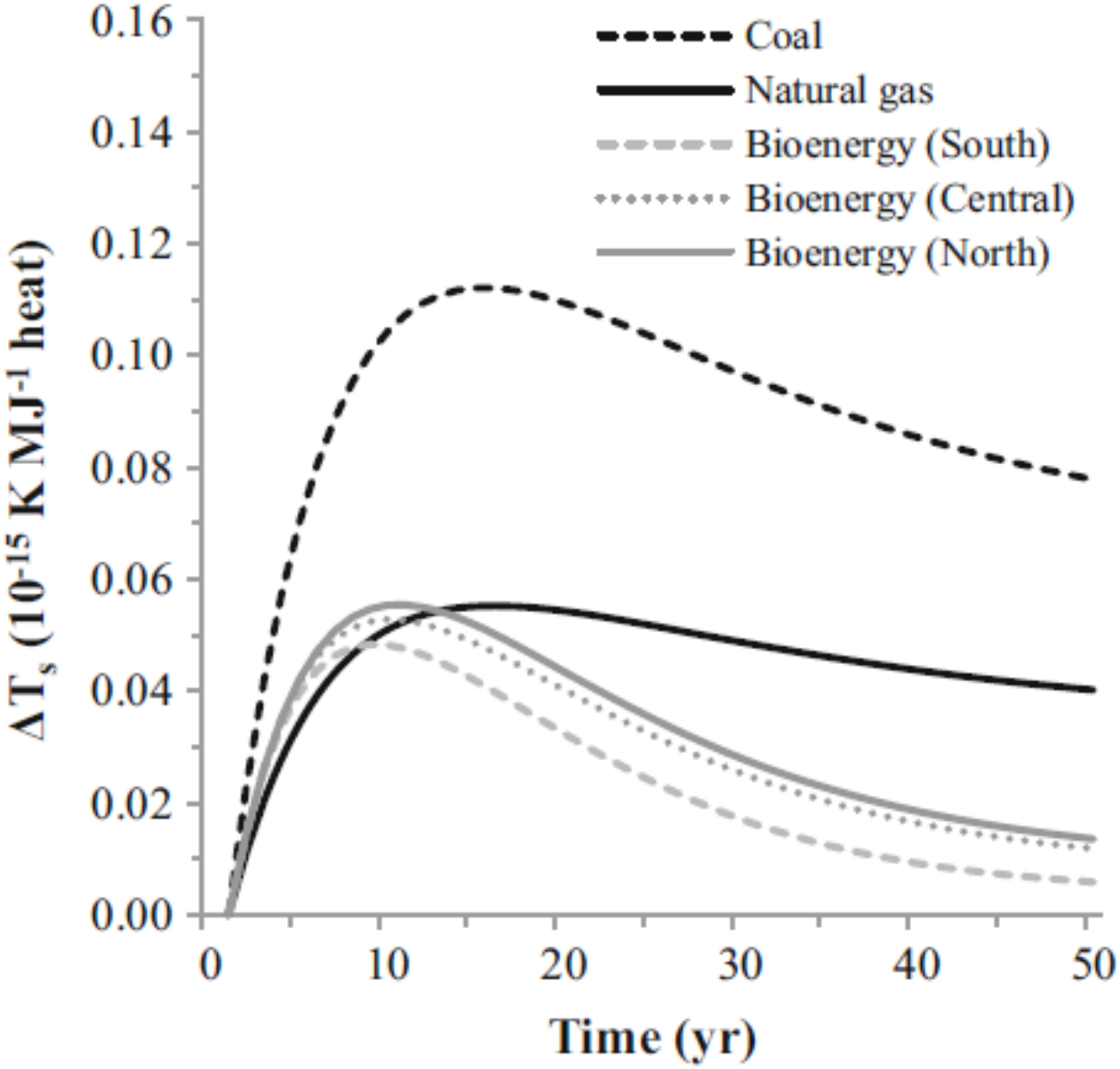
- Fossil energy reference
- Conversion efficiency
- CO_2/MJ

Displacement factor

= $efficiency_{bio}$ /$efficiency_{ref}$ x $CO2_{ref}$/$CO2_{bio}$

- Nearly always <1

Reference energy system



Hammar et al

Reference: land use

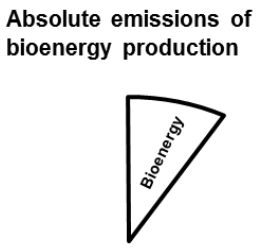
- Timber without bioenergy?
- Conservation forests?
  - with natural disturbance?
- Purpose-grown crop?

- Grown on marginal or degraded land?

Integrated biomass production with agriculture

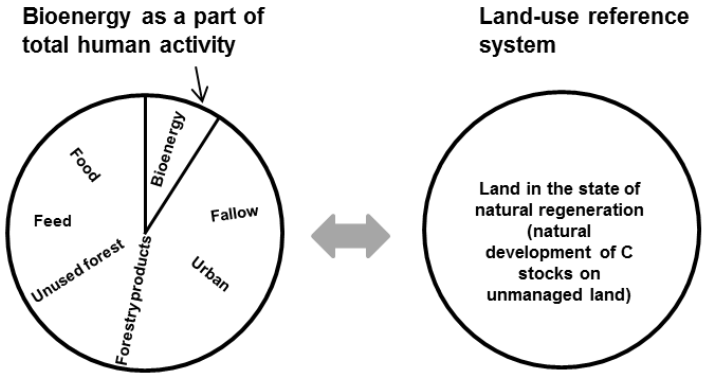
Choosing the reference land use:

Absolute emissions of bioenergy production?



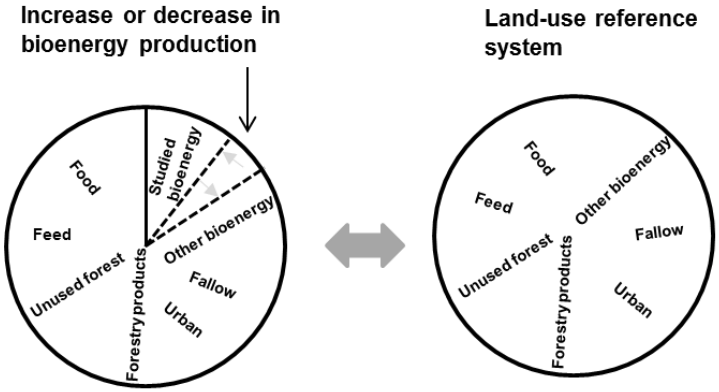
No land reference system
- The total climate effect not captured

Climate effect of bioenergy as it occurs?



Natural regeneration reference
- No need to include indirect impacts
- Uncertainty on what happens in natural regeneration

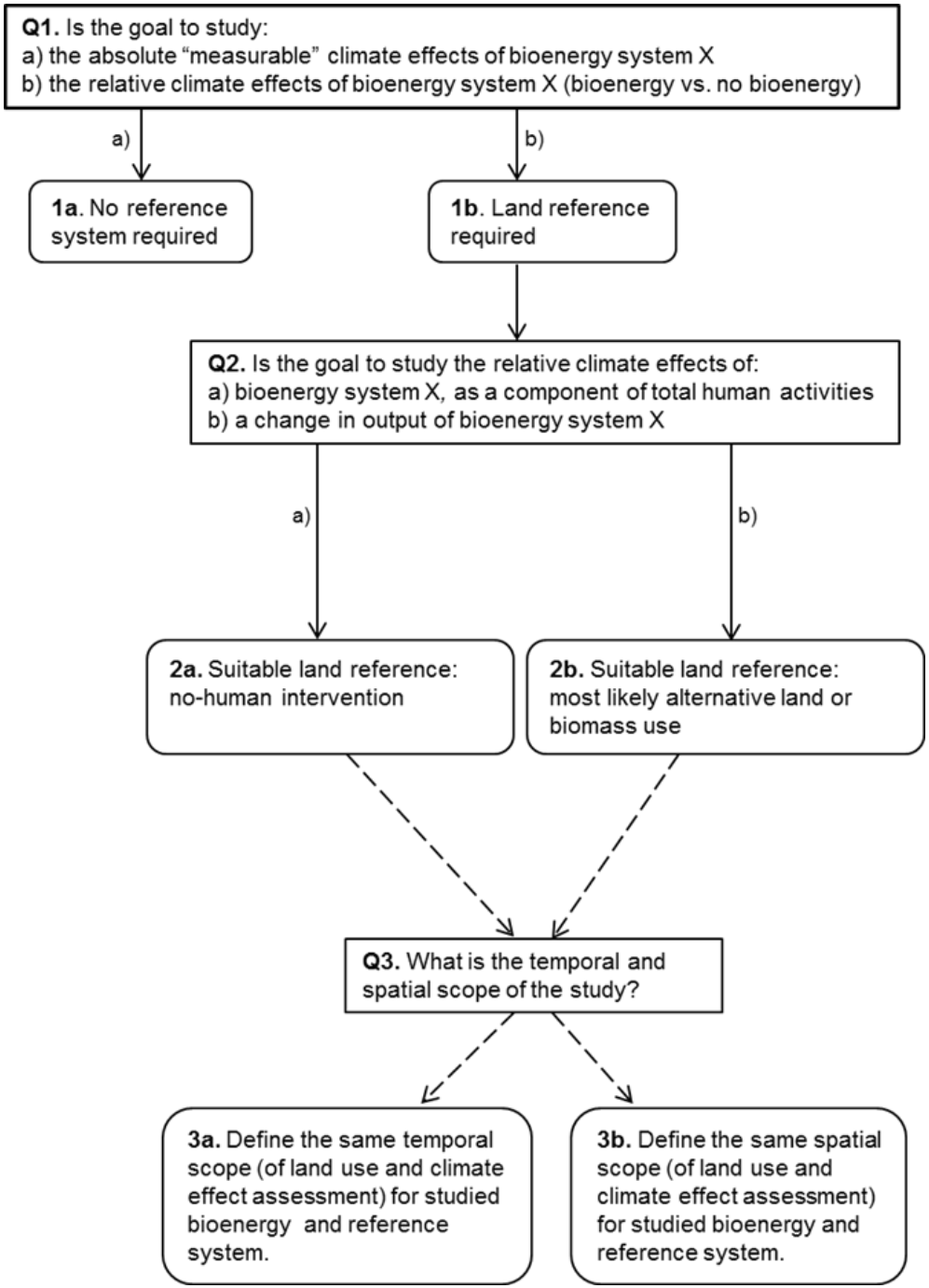
Climate effect due to a change in bioenergy production?



The most likely land use reference, BAU
- Most common research question asked, e.g. for decision making
- Indirect impacts need to be included (e.g. ILUC)

Koponen et al, 2018

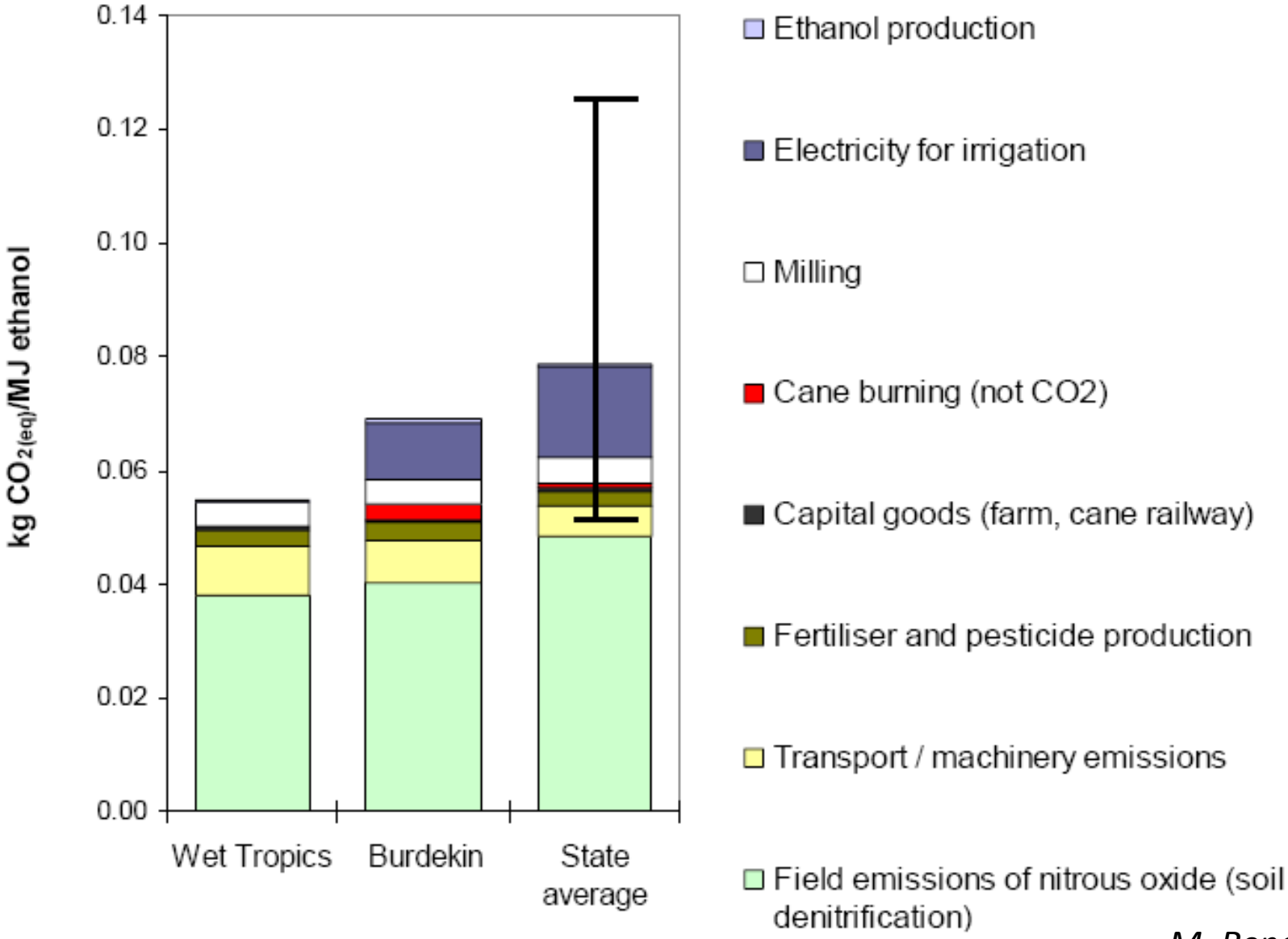
Choosing the land use reference system



Koponen et al, 2018

Scope: GHGs included

Carbon footprint of cane ethanol



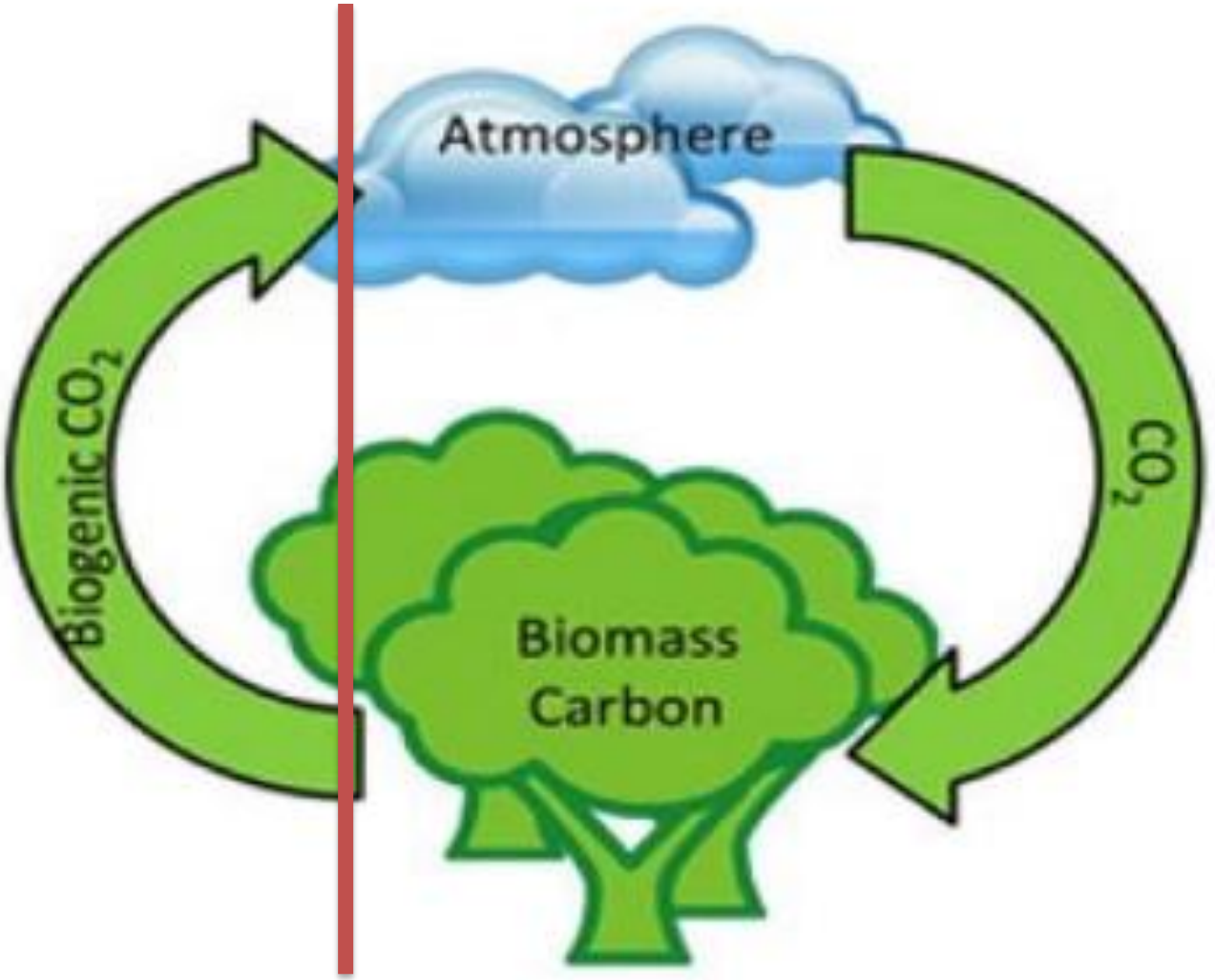
M. Renouf 2007

Assumptions: Products displaced

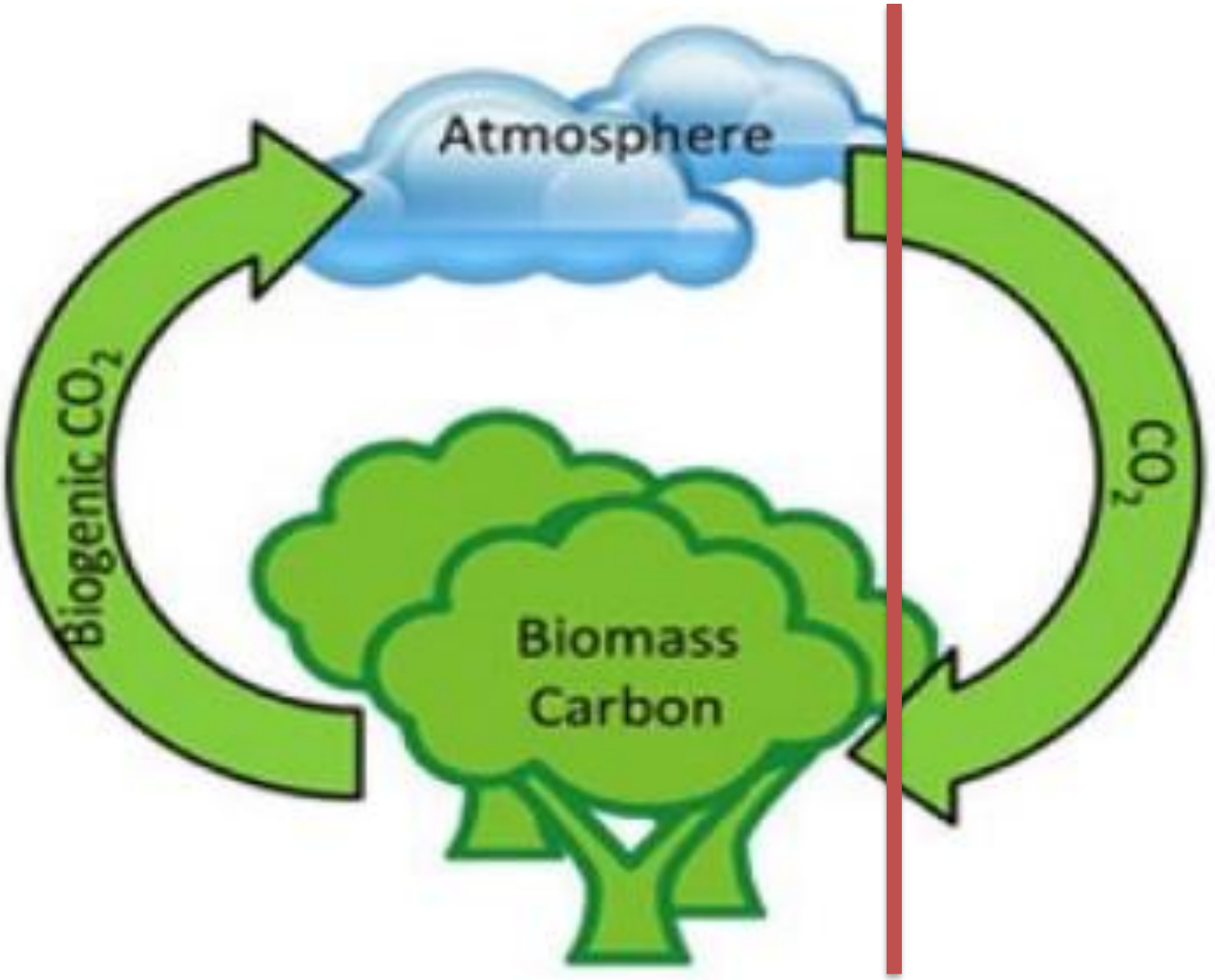
For each t C in wood products:

GHG emission reduction of 1 - 3 t C

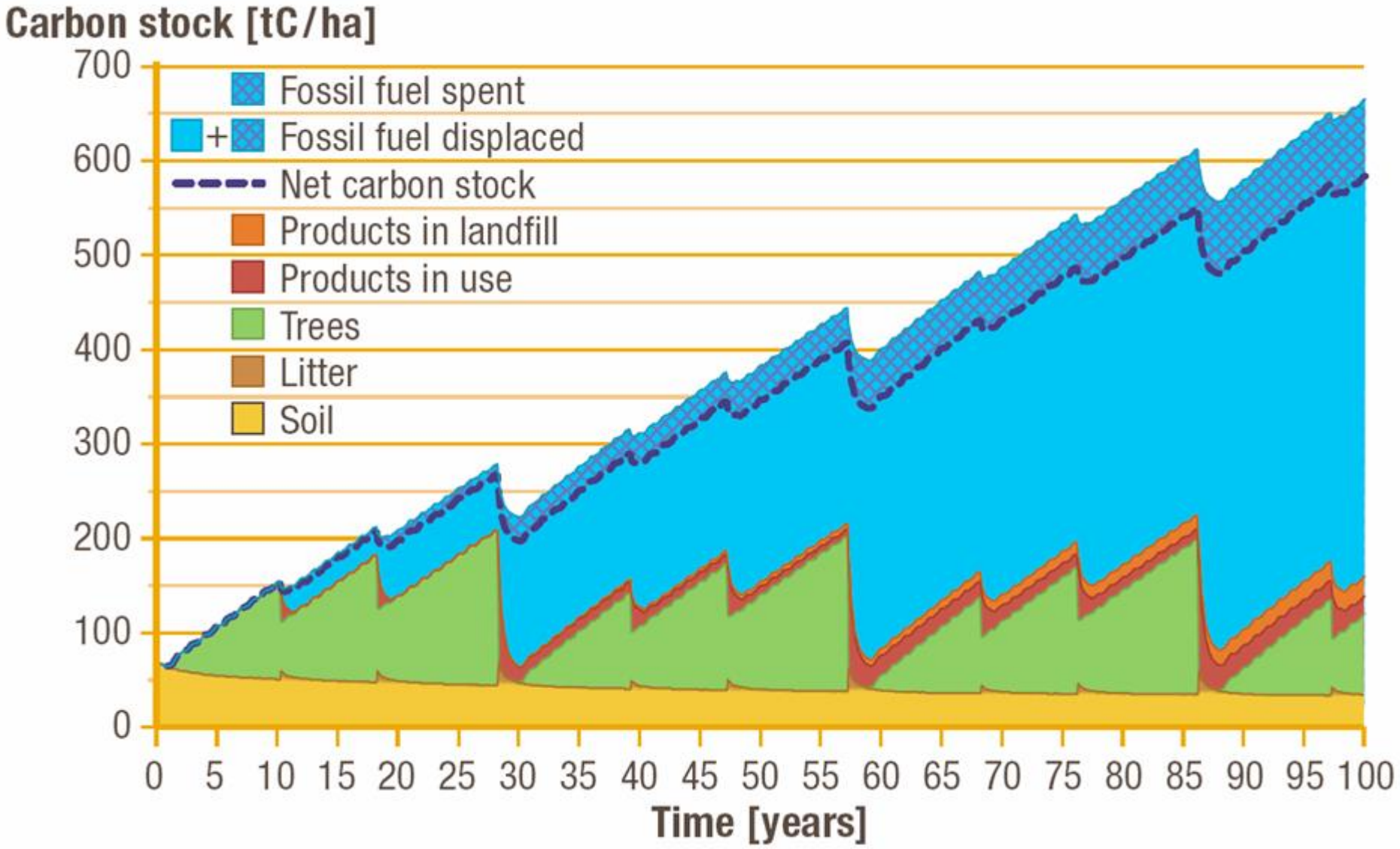
Time: When to start counting?



Time: When to start counting?



Time period of assessment

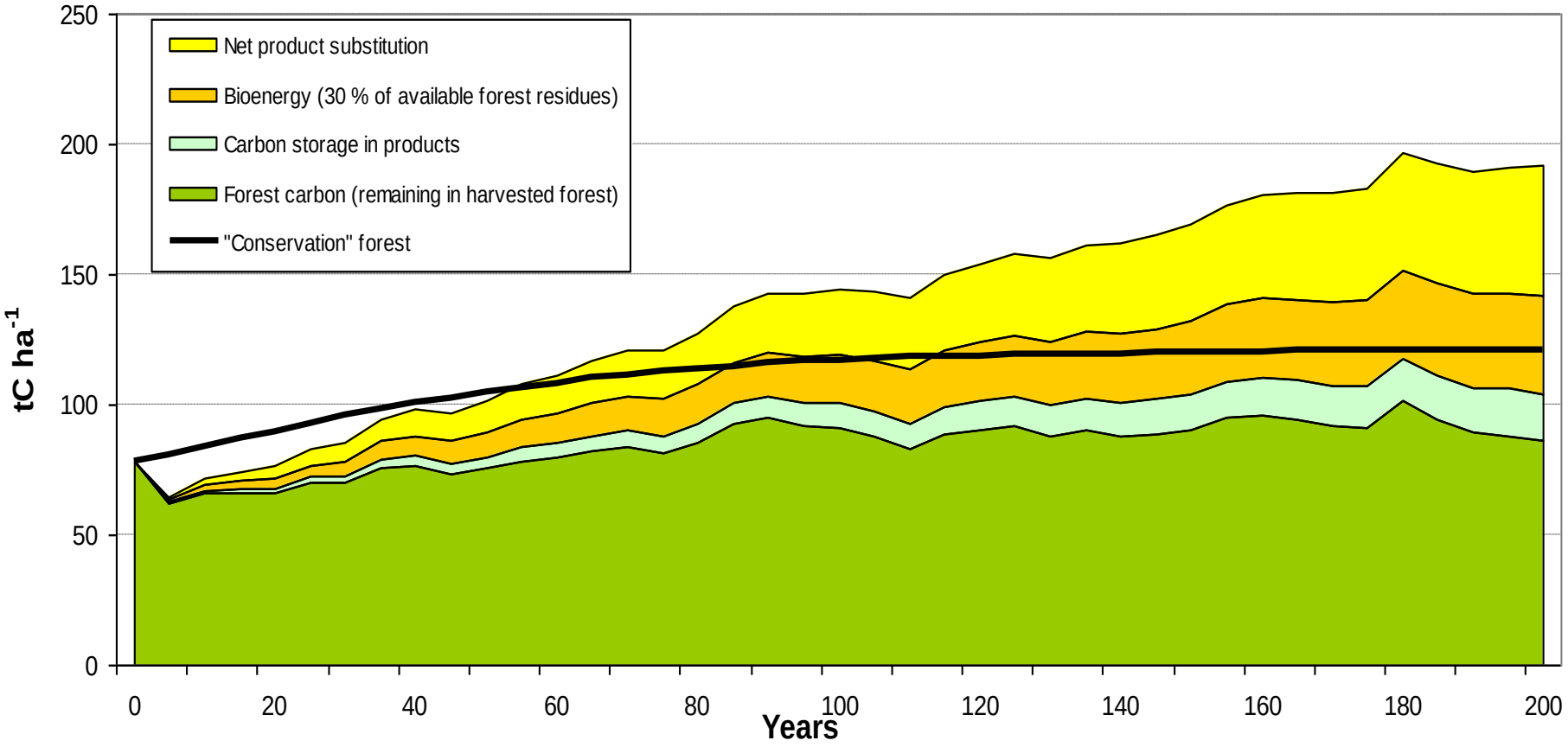


Cowie, 2007

Conservation vs managed forest

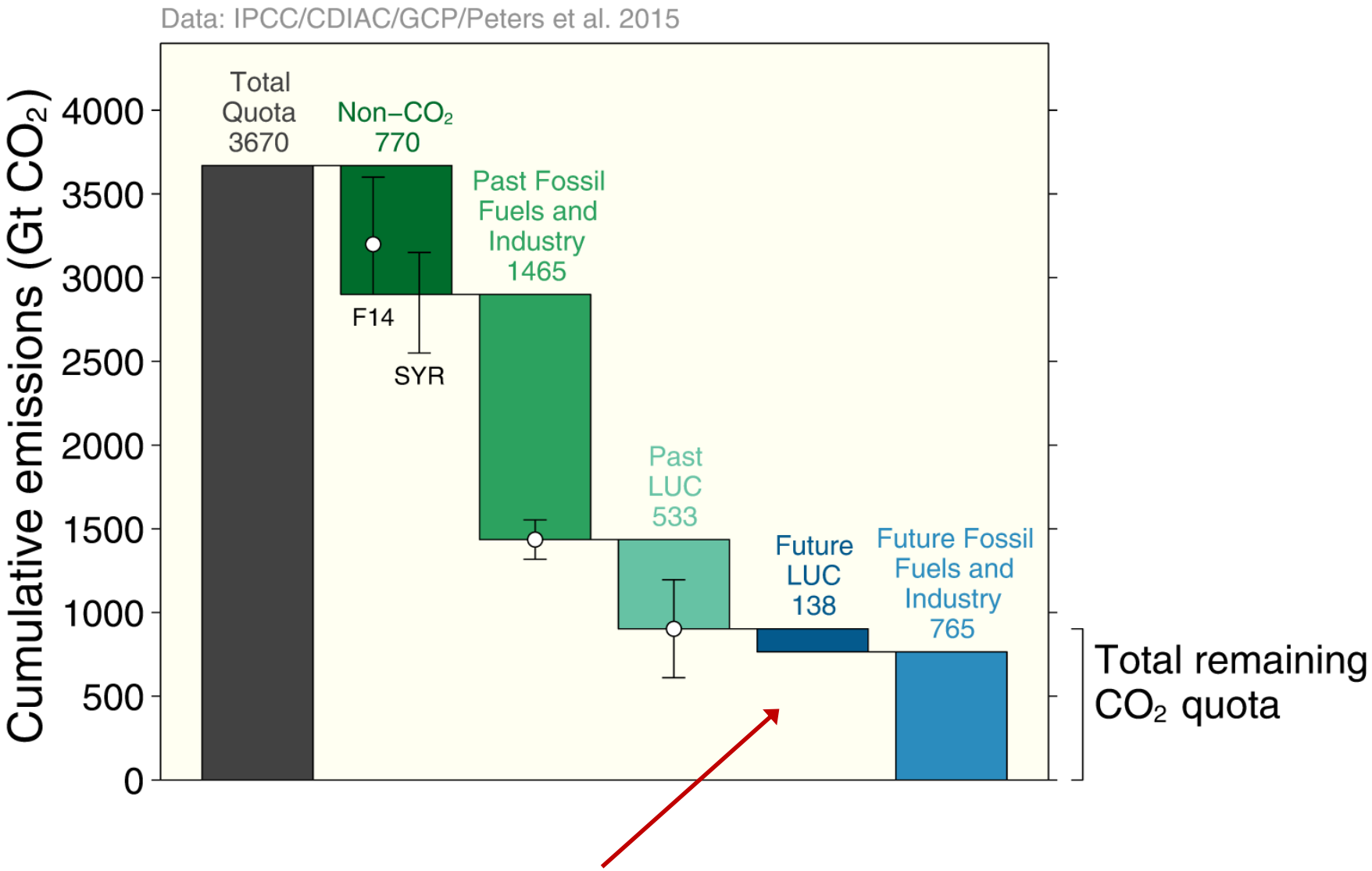
South Coast NSW

After 50 years, managed forest gives greater mitigation



Ximenes et al, 2012

Global carbon budget

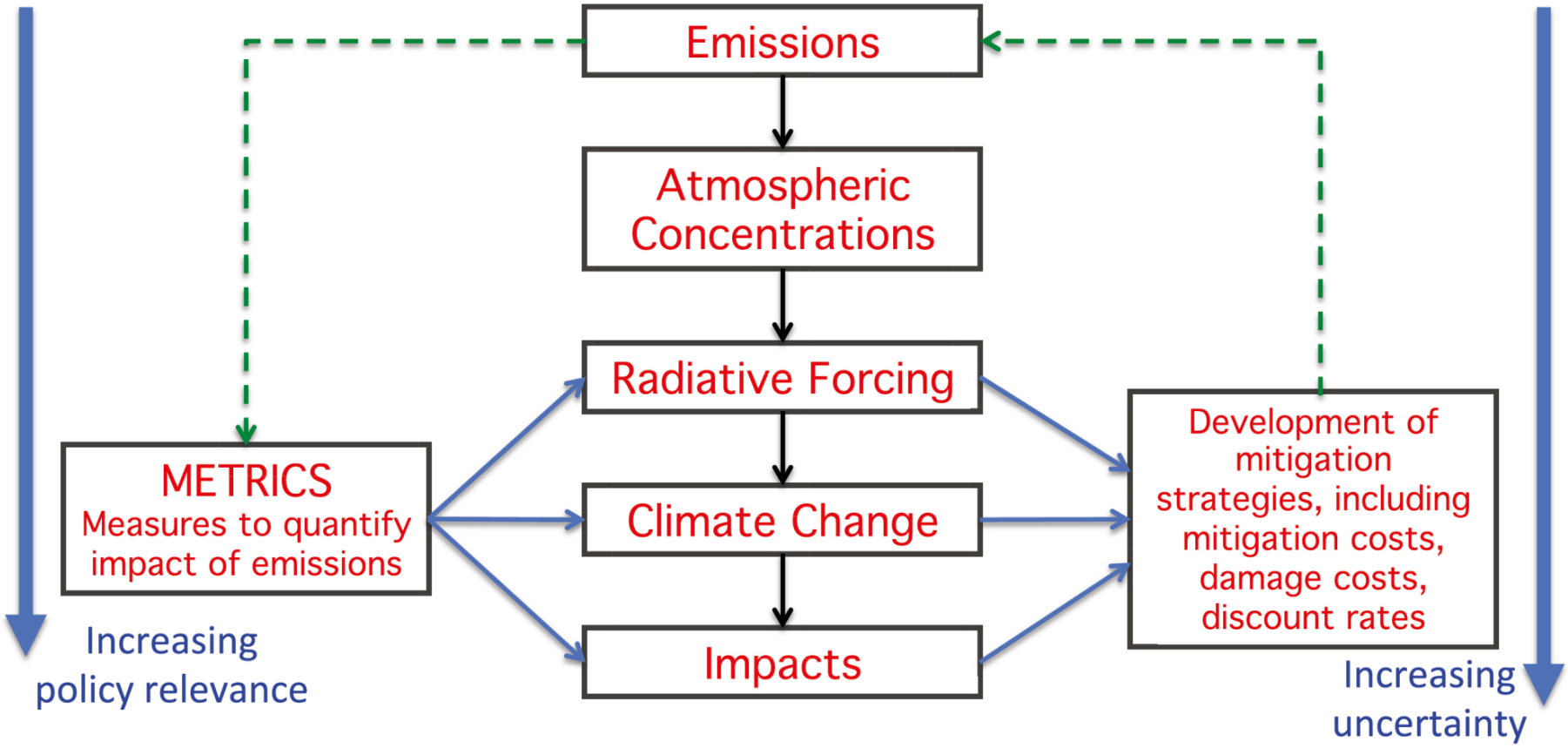


Is it ok to use some of the quota for expanding bioenergy systems?

How to measure climate effect?

- Units
  - Emissions CO_2-e per MJ?
  - Emission reduction per unit biomass /land area?
- Metrics – GWP, GTP
- Impact assessment method
  - Include effect of time?
- Climate change mitigation
  per unit biomass / land area/ nationally/globally
  per dollar invested?

How to measure climate effect?

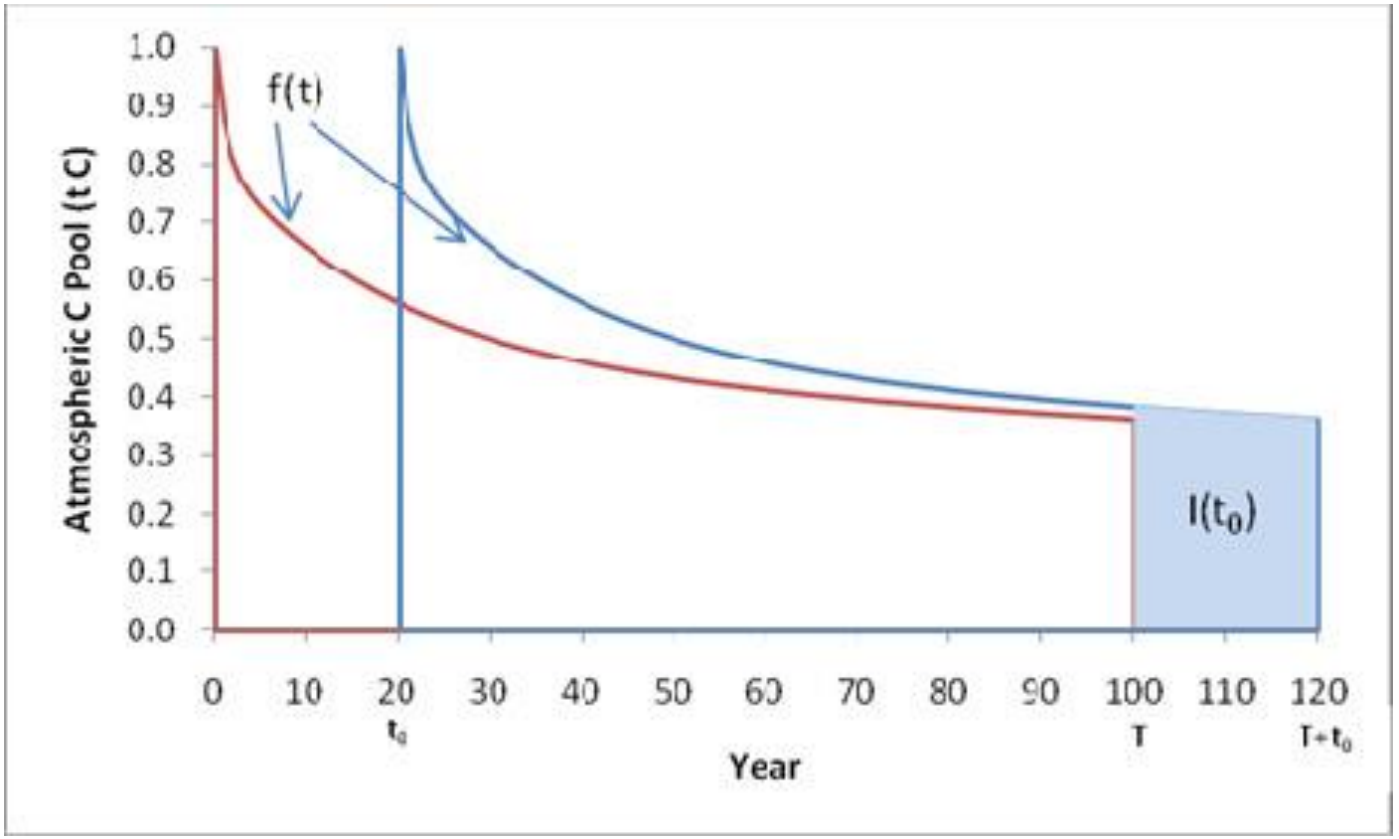


F. Cherubini, NTNU

Time in Life Cycle Assessment

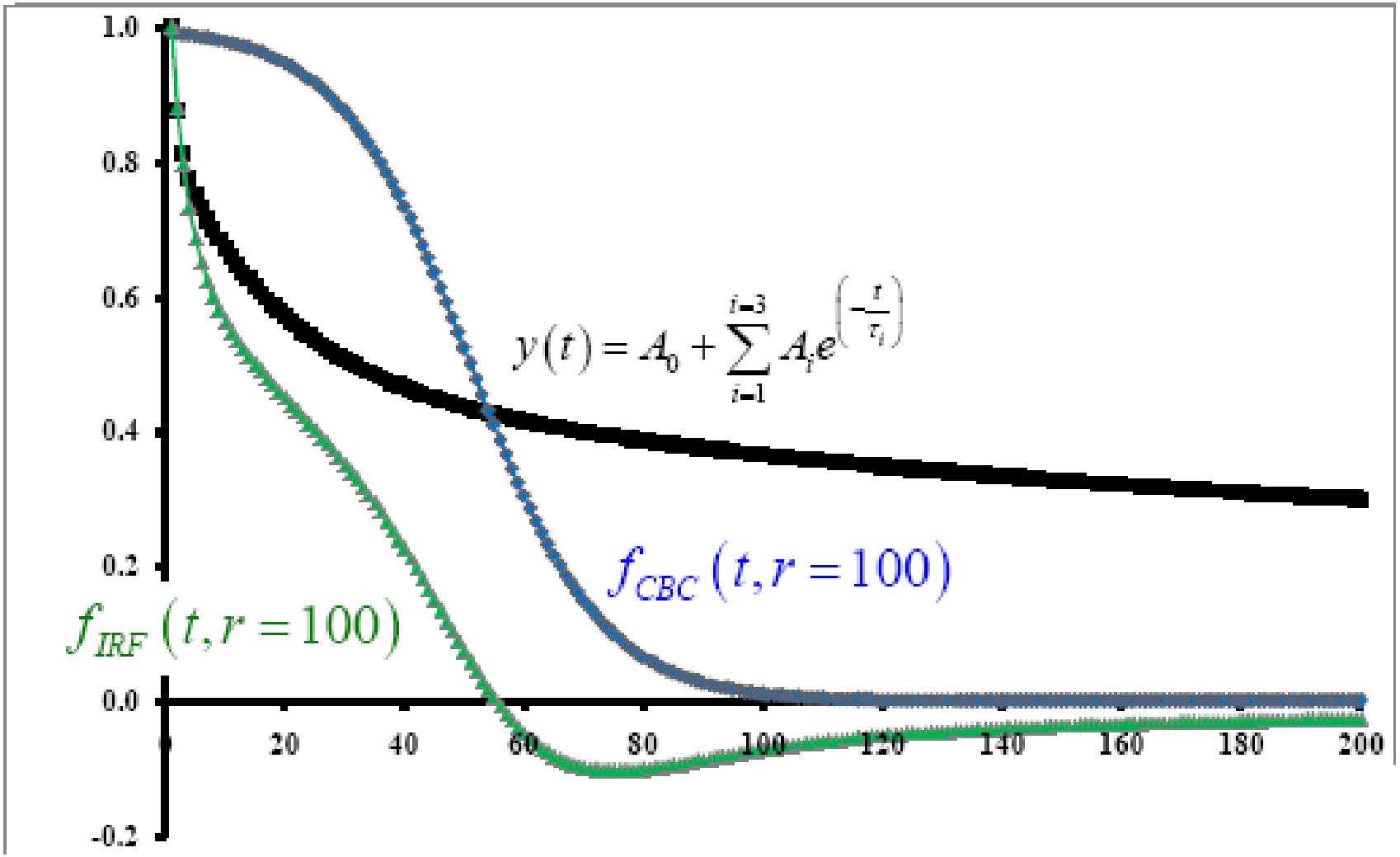
- GHG emissions/removals summed across life cycle
- Timing of fluxes ignored in ISO 14040, 14044 (LCA standards)
- ISO TS14067 (Carbon footprint of products) allows for timing in supplementary value – no method provided
- Does time matter?
  - Credit for temporary storage?
  - Is there a value in delaying emissions?
  - Buys time for technology development
  - Avoids tipping points?
  - Includes value judgment
    - ➢Assumes next generation better able to cope

Credit for delayed emissions: Lashof approach



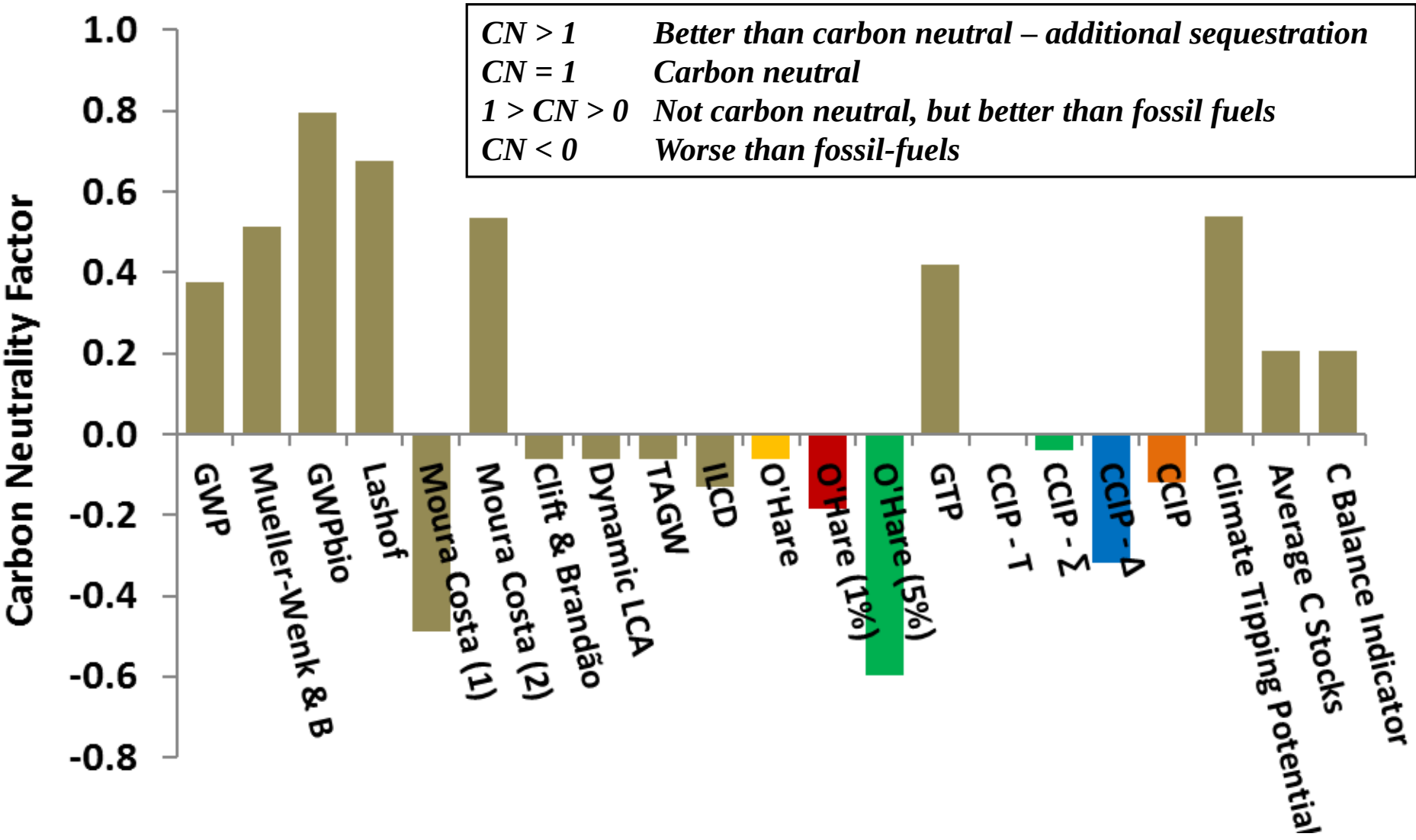
Brandão, 2012. based on P.M. Fearnside, D.A. Lashof and P. Moura-Costa (2000).

GWP_{bio} - Adjust for regrowth period



F Cherubini NTNU

Impact assessment method

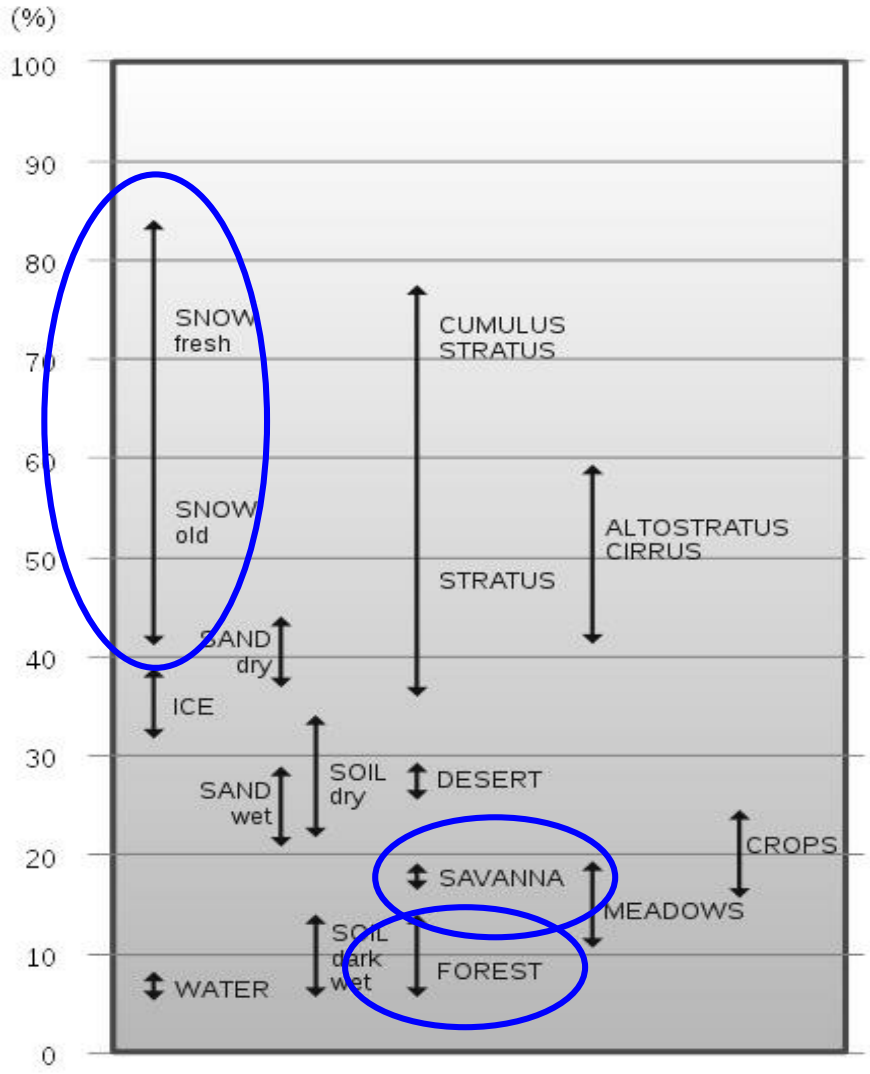


Scenario: High C stock unharvested forest replaced with forest managed on 25 year rotation, biomass used for bioenergy. *Brandão et al, in preparation*

Alternative modelling approaches

- Life cycle assessment (LCA)
  - Attributional vs consequential
- Integrated assessment models (IAM)
- Energy systems modelling
- Economic modelling in each of these

Scope: Non-GHG climate forcing - Impact of albedo



Coniferous forest and snow
High latitudes (Austria)

Pine plantations and savanna
Low latitudes (South Africa)

Neil Bird, 2009

Different results - many reasons

Many analytical choices

- ➔ Stand vs landscape scale
- ➔ Reference: Natural vs managed system; energy system
- ➔ Start calculation at planting vs at harvest
- ➔ Short term vs long term
- ➔ Direct vs indirect effects
- ➔ Biomass only vs integrated forest product system
- ➔ Climate forcers
- ➔ Impact assessment metrics

Different perspectives

- ➔ Individual operator vs government vs research
- ➔ Policy development vs implementation

Purpose of calculation?

Quantify emissions/abatement

Inform policy development vs implementation

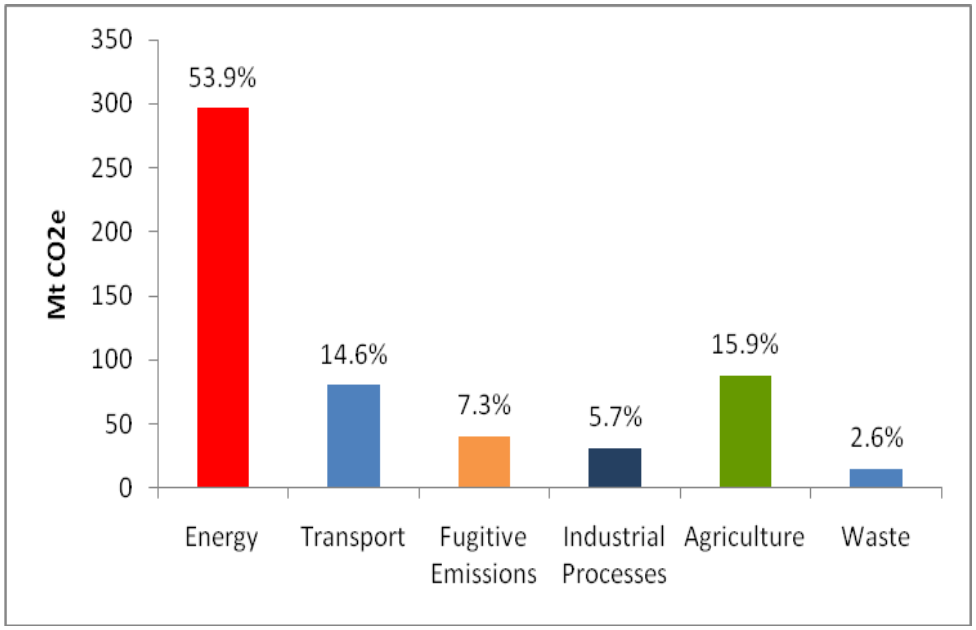
Assess compliance with targets,
calculate credits

Change behaviour

Why? Inventory context

- Inventory reporting
- UNFCCC
- All parties

- GHG accounting
- Kyoto Protocol
- Annex I parties



Sectoral boundaries
National scale
IPCC Guidelines

Annual emissions / removals

Why? Industry context

- Offsets
- Project credits
- Businesses

- LCA
- Carbon labels
- Products or organisations

Cradle to grave boundaries
Farm/forest scale
Schemes, Guidelines, Standards

Emissions reduction, removal enhancement

Science - Policy gulf

Policymakers want

- Quick answers
- Clear, unequivocal statements
- Short messages
- Guidance, recommendations

Scientists provide

- Knowledge gaps
- Hypotheses
- Caveats - it depends
- Technical jargon
- Emphasis on complexity, uncertainty

How can science help?
Development of good practice,
for range of applications

Scientists should work with policymakers and other stakeholders to define the important questions. These might include:

- Across the full life cycle, what is the best use of biomass resources?
- How can land be used to provide energy, products, and meet other needs?
- How can forests be used to support energy system transition?
- How can policies and accounting methods distinguish and promote systems with highest mitigation value?