

# Carbon balances of forest bioenergy: State of Science and Methodologies

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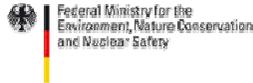
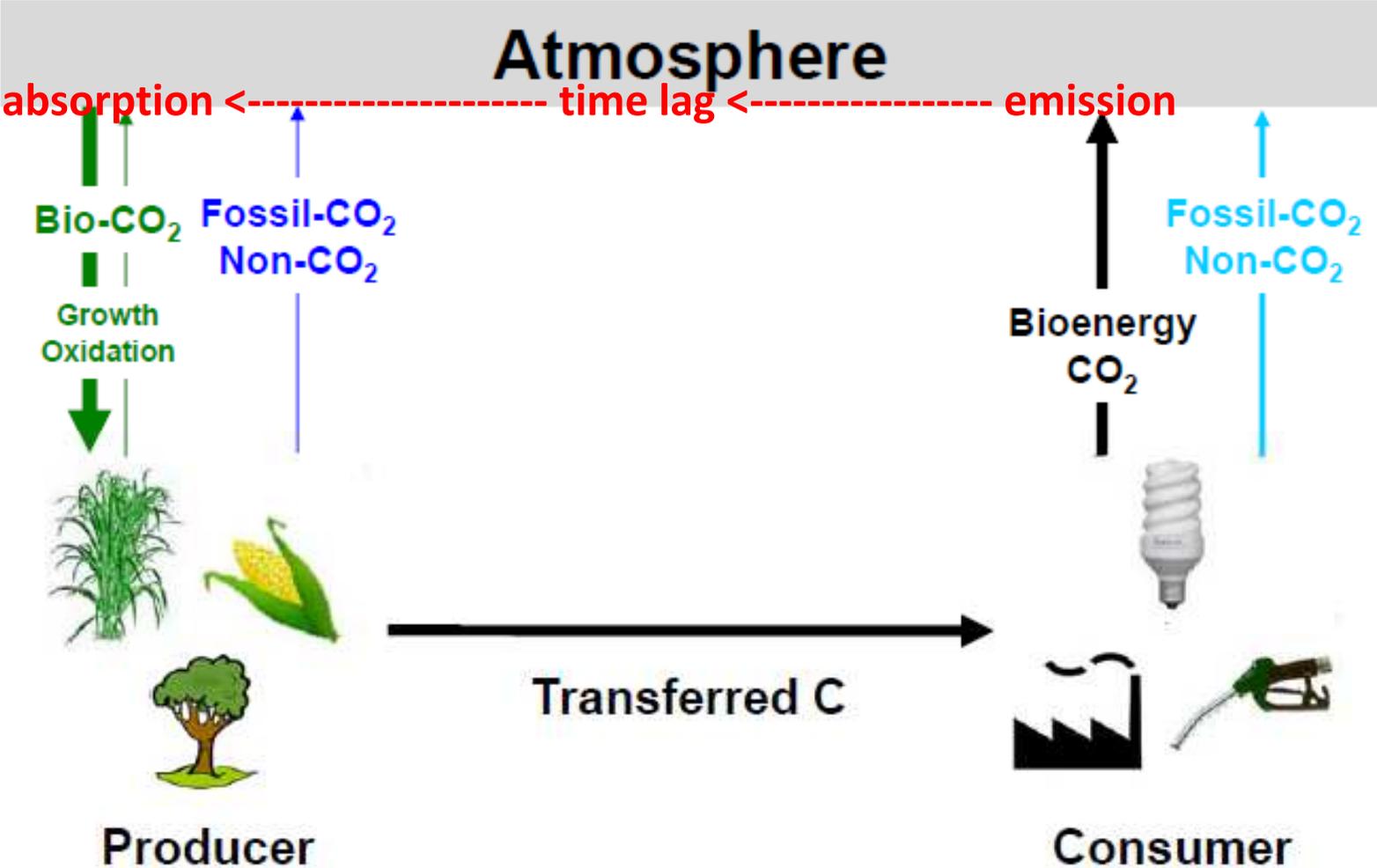
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# GHG Emissions and Time



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Bird et al. (2011)

# Carbon Balance and C Debt

- Bioenergy **is C-neutral** in the **long-term**
- Short- to-medium balance different for (some) forest bioenergy
- **Temporal** atmospheric residence of biogenic C vs. **permanent** residence of fossil C: time lag between bio-C release and re-absorption in forest growth creates “carbon debt”
- **Not** an issue in agriculture: for annual and perennials crops, only minor delay in C cycle



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# Metrics: Emissions = Climate Impacts?

- CO<sub>2</sub> emission difference in a given timeframe: problem for (political) **emission reduction targets** (e.g. by 2020 and 2030)?
- “Budget” approach for 2 °C limit rather **independent** from emission trajectory? Then long-term emission balance most relevant, but sub-targets (0.1 °C per decade, ocean acidification) restrict emission dynamic, imply medium-term reduction preference
- Climate impact = **temperature difference**? Then GTP seems most appropriate (for consequential LCA)

## Scope: Tree, Stand, Landscape

- Analytical scope in LCA should reflect “relevant” system boundaries – for policies targeting forest bioenergy, the “whole forest” (**landscape level**) should be considered
- In **attributorial** LCA (“average” situations), forests can deliver more biomass while increasing C stocks if forests are comparatively young (e.g. DE, SE)
- **Consequential** LCA addresses marginal changes of future scenarios, i.e. **any** C stock change against the baseline (counterfactual) is relevant

## Scope: Reference Systems

- **Forest** side: “unharvested” biomass or change of management (which)?
- **Demand** side: which material use (if any), change of pattern over time (e.g. less pulp & paper)?
- **Energy** side: fossil fuel supply pattern - change over time (marginal fuel)? Consider imports of syncrude (tar sands) or shale gas?
- High uncertainty/variation on forest baseline and material demand levels



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# C Balance of Forest Bioenergy

- **Differentiation** needed:
  - Type of forest biome (boreal, temperate, tropic)
  - Type of forest product (residues, thinnings, low- or high quality stemwood)
  - Type of material displacement (short-lived paper/packaging, low-quality wood products, high-quality construction wood)
  - Energy displacement (efficiency, emission factor)
- **Models and simplified approaches: 5-20 years payback time for residues = nearly C neutral**

# Low-Risk Feedstocks?

Woody biomass source for energy use	Time horizon for CO <sub>2</sub> emission reduction					
	short (10 years)		medium (50 years)		long (centuries)	
	Coal	gas	coal	gas	coal	gas
Boreal, stems final harvest	---	---	-	--	+	+
Temperate, stems final harvest	---	---	+/-	-	++	+
Harvest + thinning residues, landscape care & salvage wood*	+/-	+/-	+	+	++	++
SRC on marginal agricultural land	+++	+++	+++	+++	+++	+++
SRC replacing forest	-	-	++	+	+++	+++
industrial residues, wastes	+++	+++	+++	+++	+++	+++

-; --; ---: **bioenergy system emits more** CO<sub>2</sub>eq than reference fossil system **in given time frame**

+/-: GHG emissions of **bioenergy and fossil are comparable** in given time frame

+, ++, +++: **bioenergy system emits less** CO<sub>2</sub>eq than reference fossil system **in given time frame**

\*For harvest/thinning residues & salvage wood, balance depends on alternative use (burning) and decay rates

Source: own compilation based on JRC (2013)



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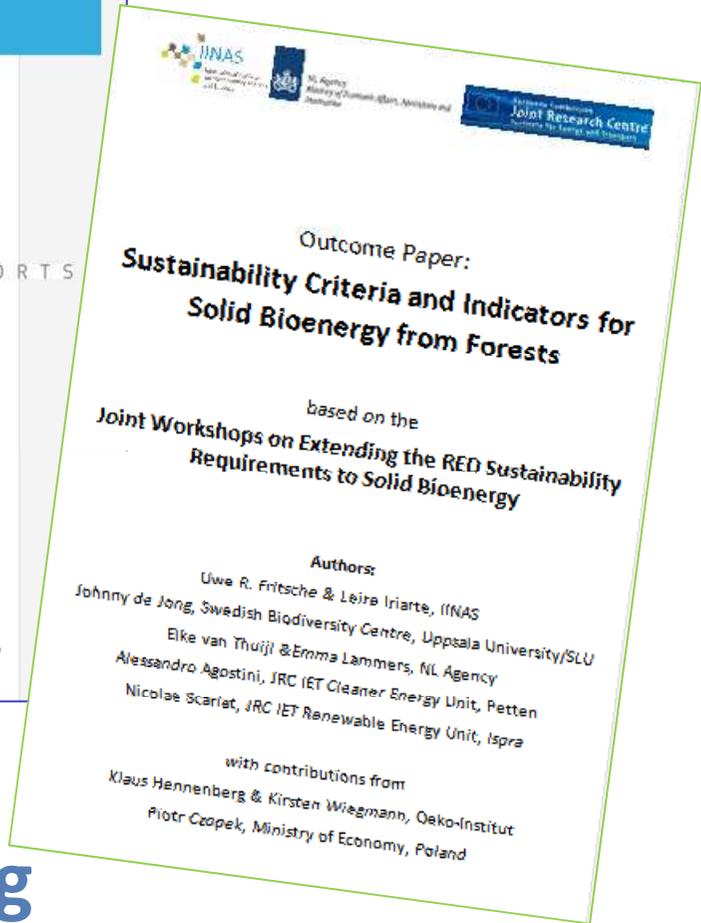
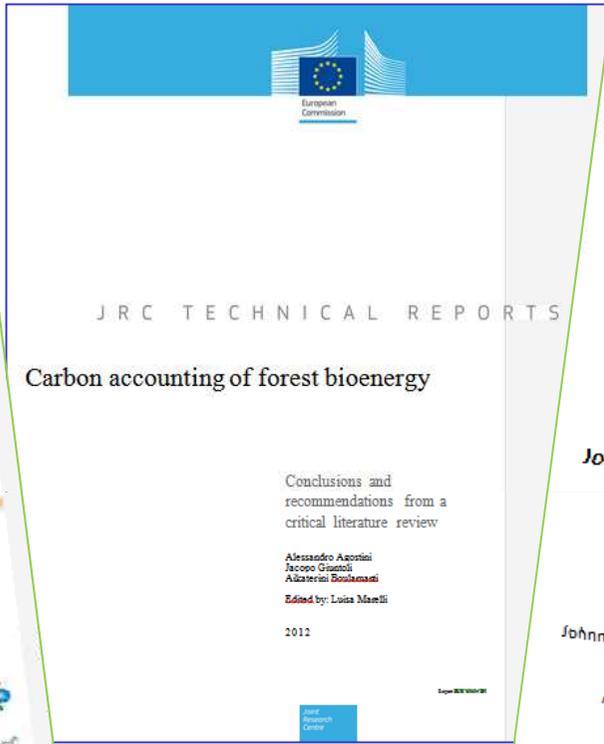


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## Conclusion & Perspective

- Feedstock **is** relevant: **where** from, and **which** forest products (especially for imports)
- Waste and woody residues: good, but possible biodiversity and displacement effects (better analysis!)
- **Metrics**: no agreement yet between scientists, but needed for policy:
  - **Define “low-risk”** options (e.g. forest residues, woody wastes vs. coal)
  - **Clarify role of metrics**: GHG reduction, limit temperature increase

# More Information & Contact



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