Carbon accounting of forest bioenergy using life cycle assessment

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Université du Québec

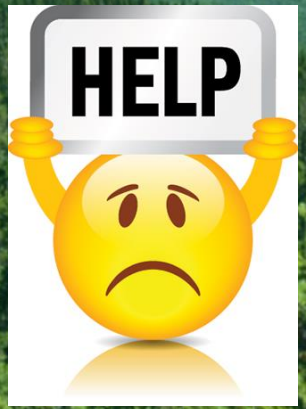
Picture: Sepaq

Picture: Radio-Canada

Picture: L'Écho de La Tuque

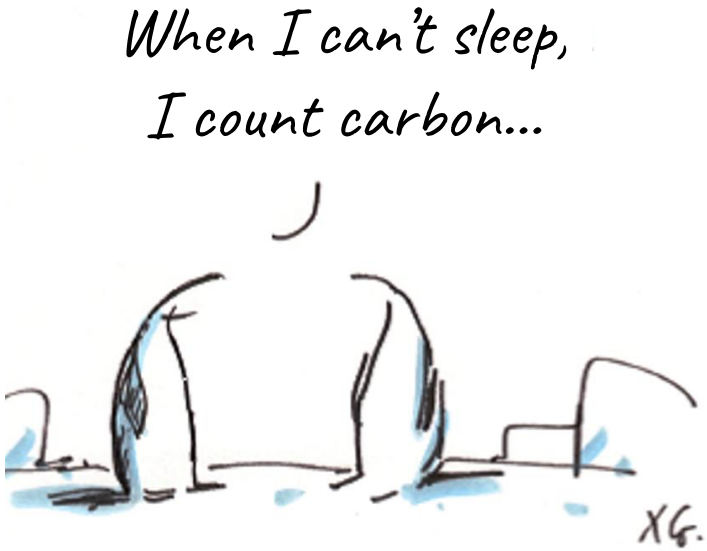
Picture: Radio-Canada

Picture: operationsforestieres.ca



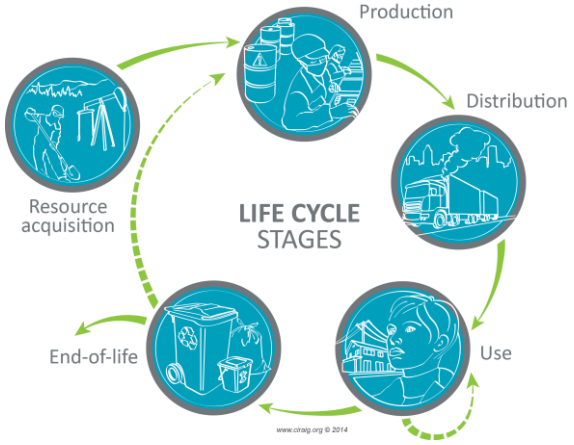
Picture: allianceforetboreale.org

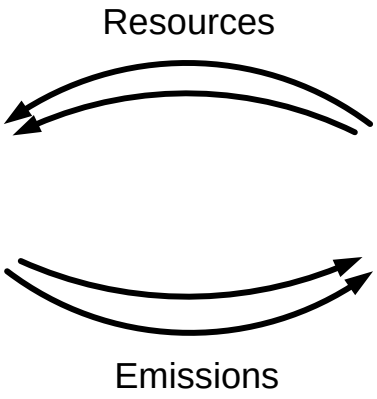
1. Carbon accounting and life cycle assessment



Adapted from Xavier Gorce

Life cycle assessment





Climate Change

Ecotoxicity

Human Toxicity

Acidification

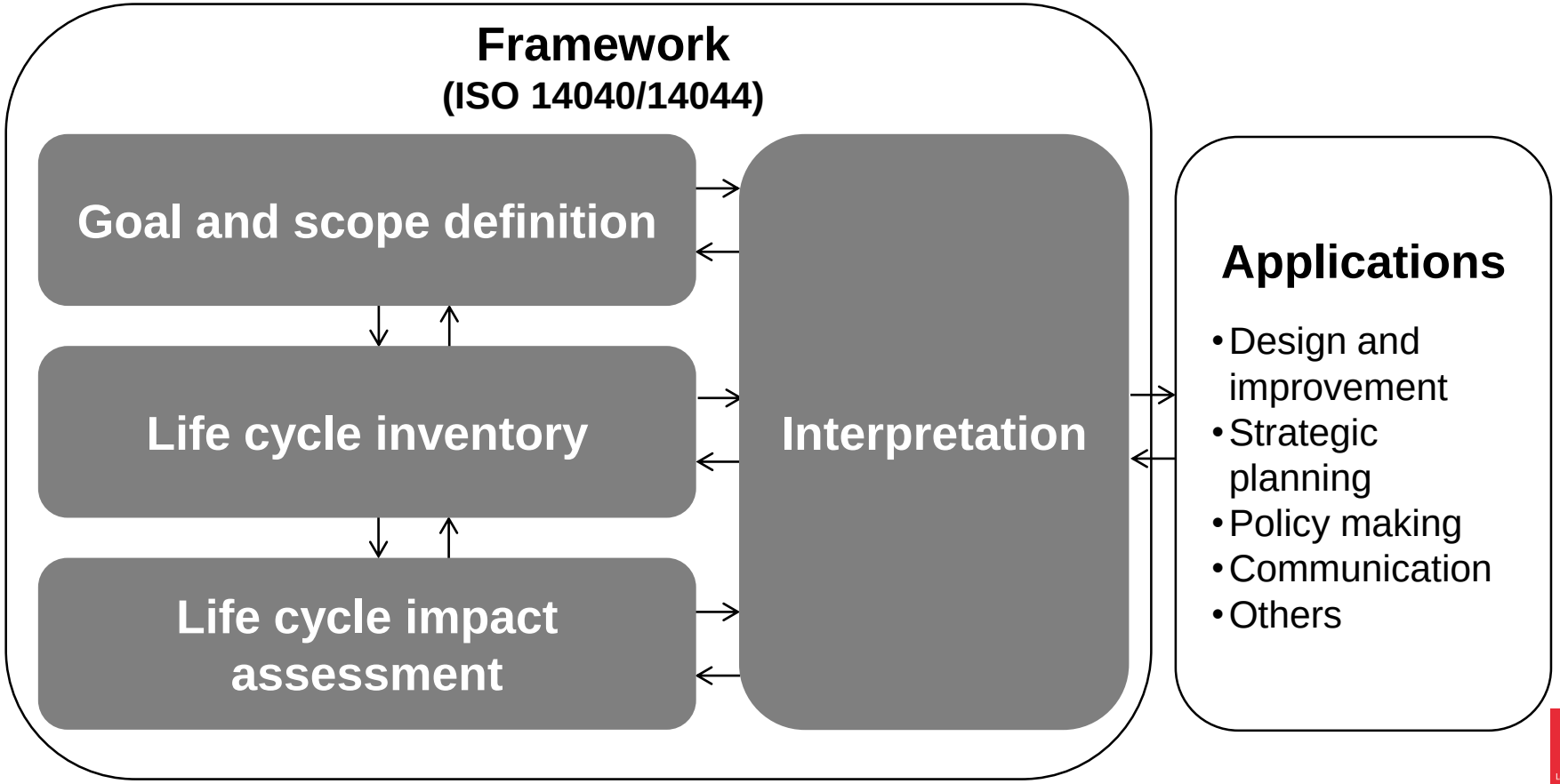
Resource Depletion

Eutrophication

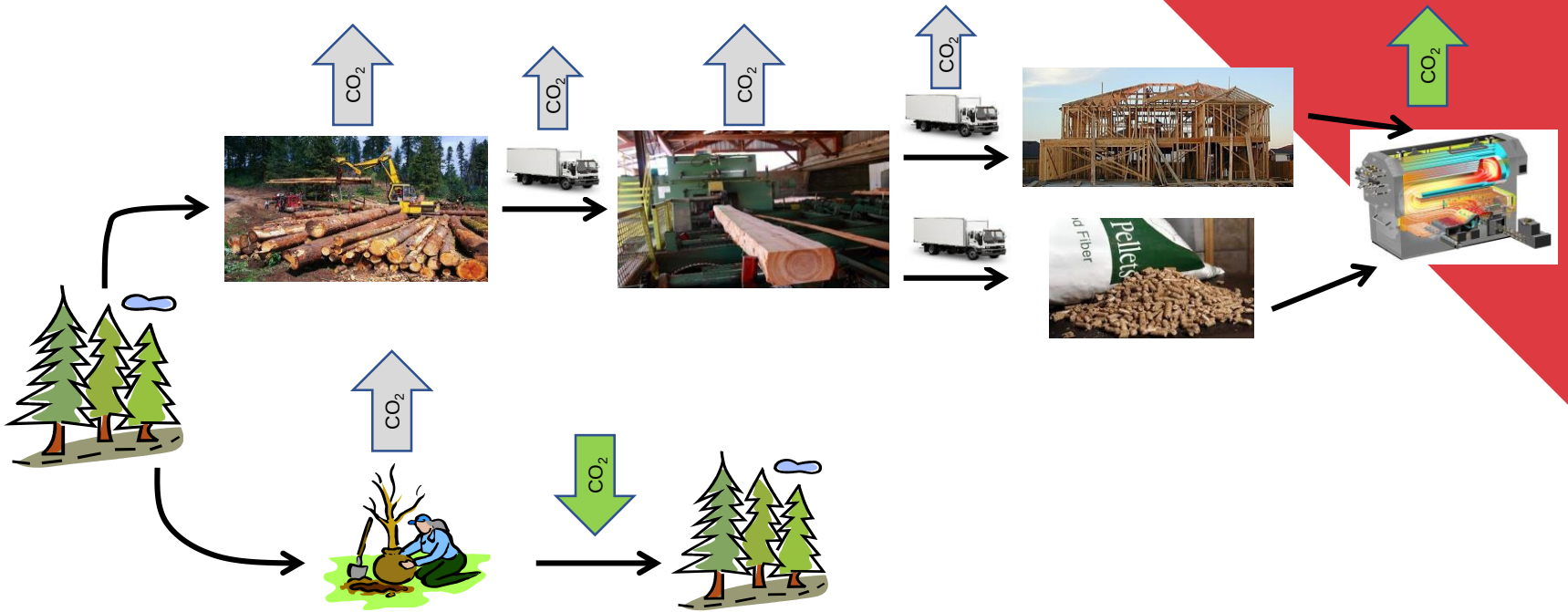
Smog

Ozone Layer Depletion

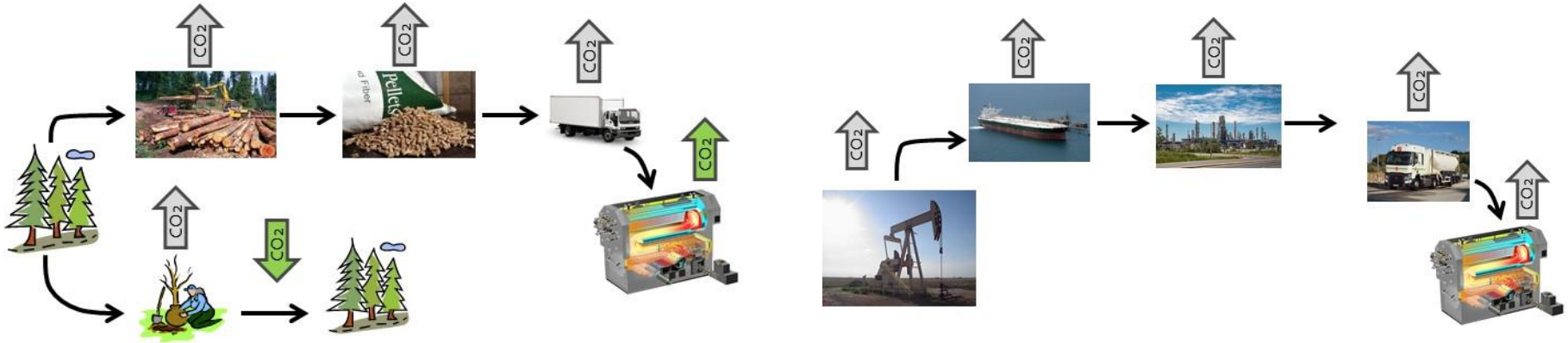
Life cycle assessment according to ISO standards



Life cycle of forest products

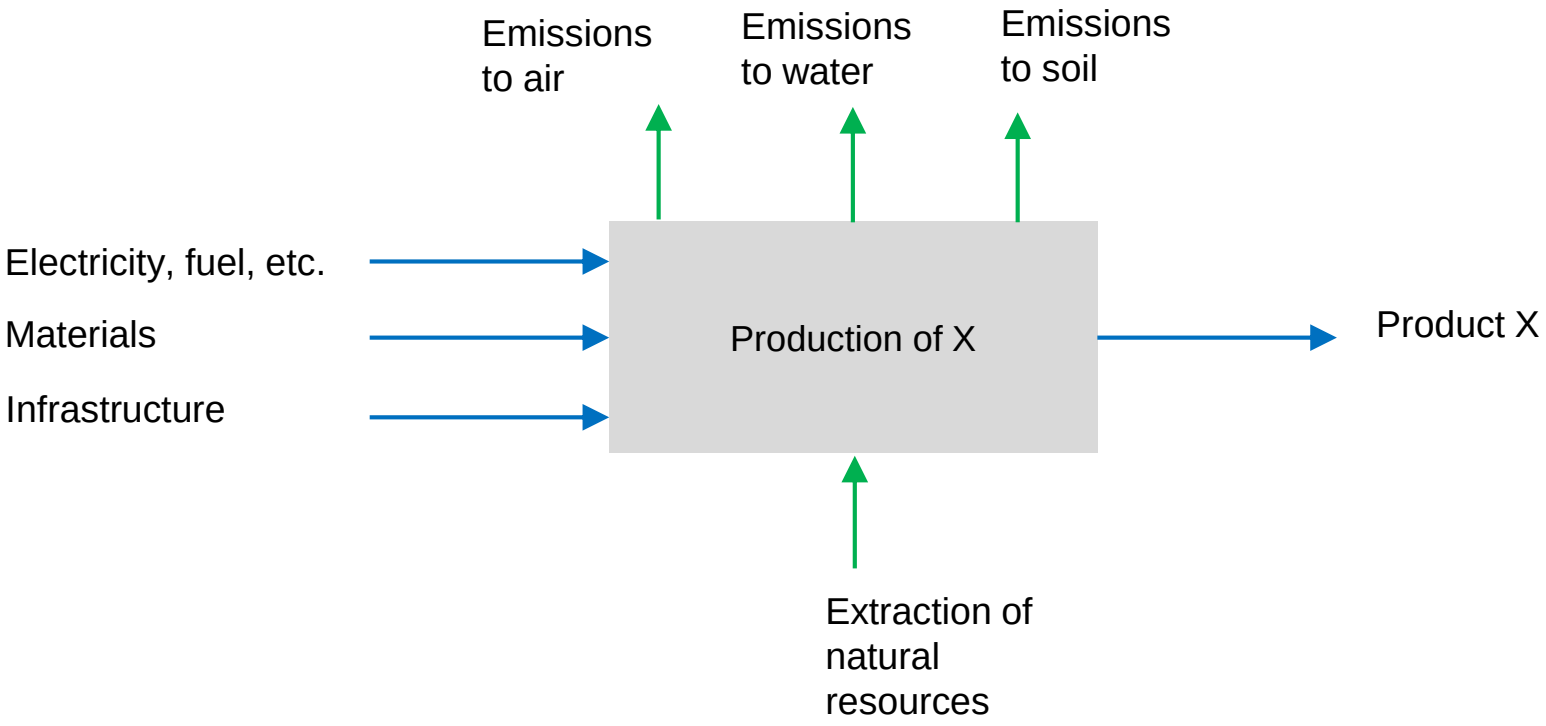


Comparing functionally equivalent systems

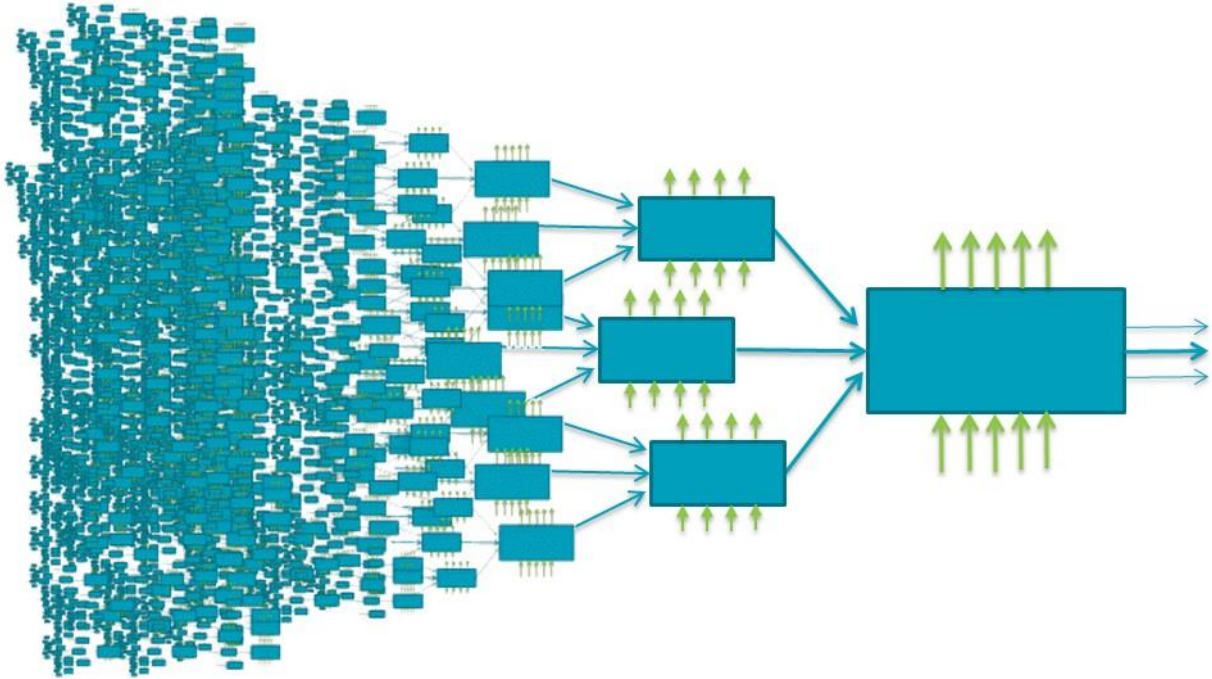


Production of 1 MJ heat for an institutional building

Accounting for emissions and resource extractions



Life cycle inventory



Data sources

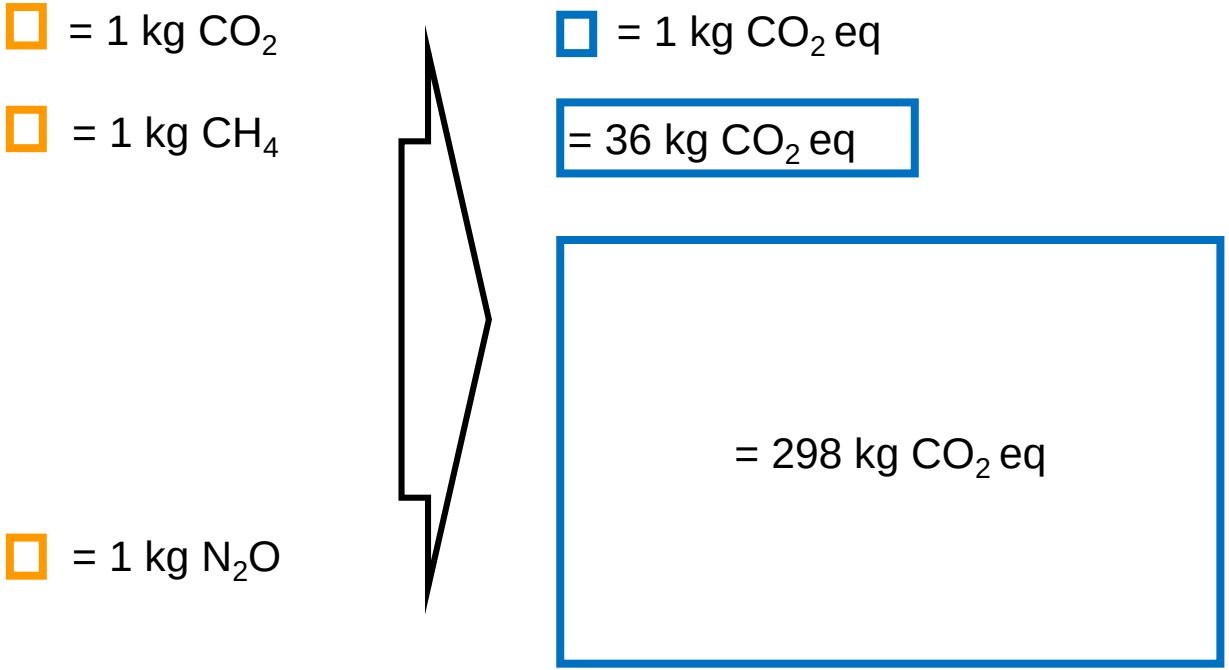
Primary (or specific) data:

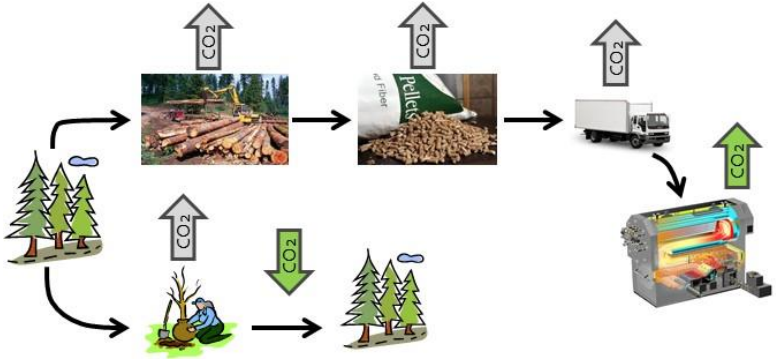
- Data from the forest industry, plants, energy providers, etc.;
- Usually available for foreground processes;
- Data regarding key parameters, conditions of use, etc.

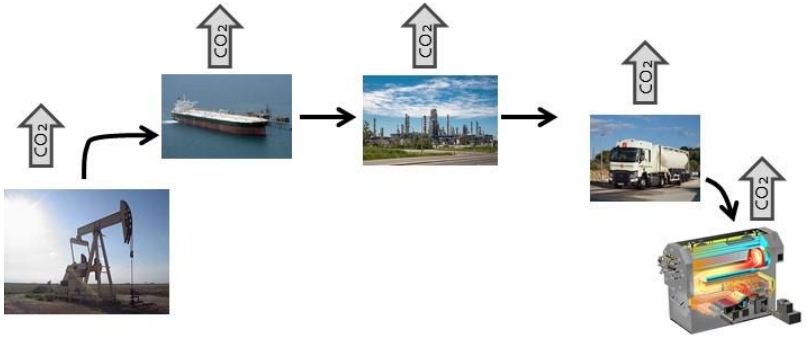
Secondary (or generic) data:

- Literature;
- Statistics;
- Modeling;
- Life cycle inventory databases.

Life cycle impact assessment



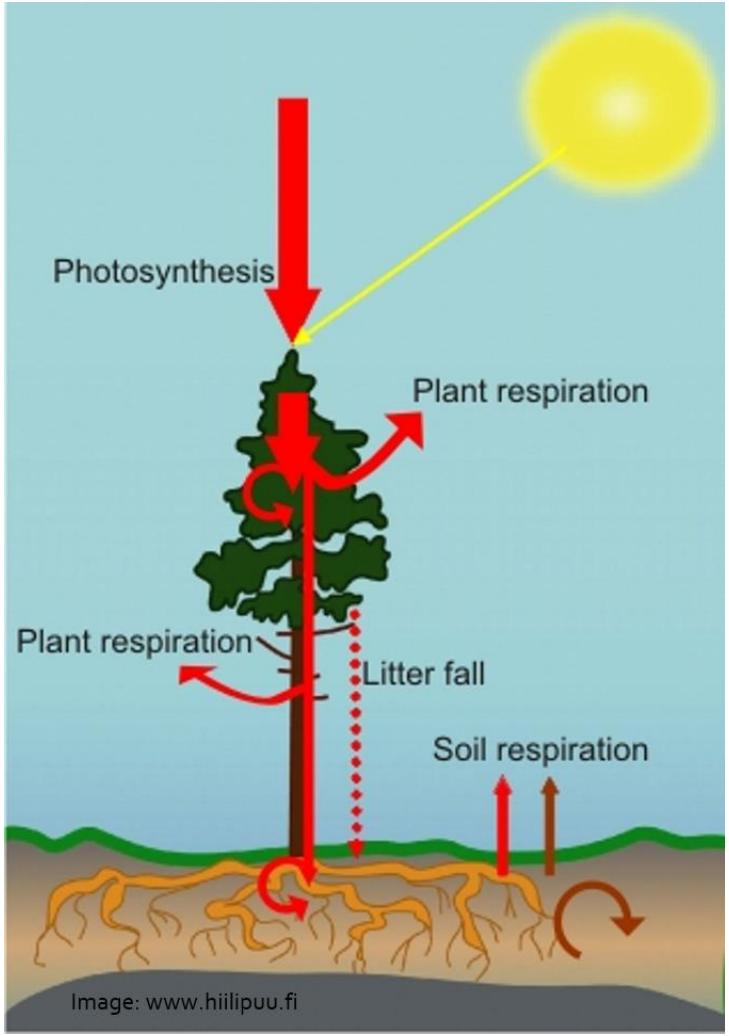




Potential for GHG emissions reductions

- Lower supply chain GHG emissions?
- GHG emissions from combustion compensated by biological carbon sequestration?
- Would forest conservation be better than harvesting to store carbon?

2. Accounting for biogenic carbon



Biogenic carbon neutrality

Is the amount of carbon released from biomass combustion and decay equivalent to the amount of carbon uptaken from the atmosphere?

Δ Carbon = 0 ???

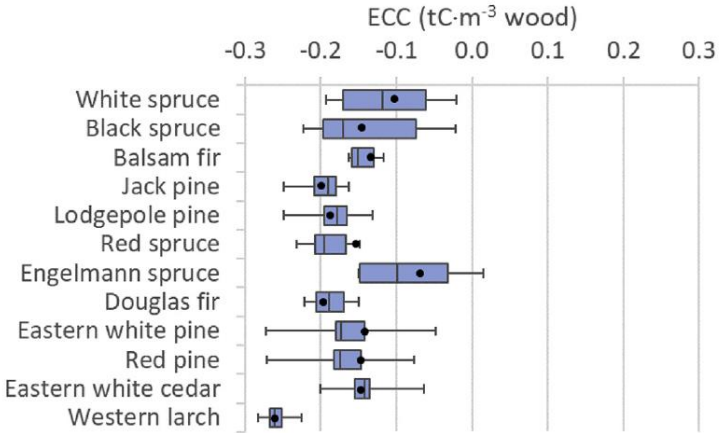
Natural forest

Managed forest

Forest carbon neutrality

YES

Canada – Steady state after 100 years of harvest

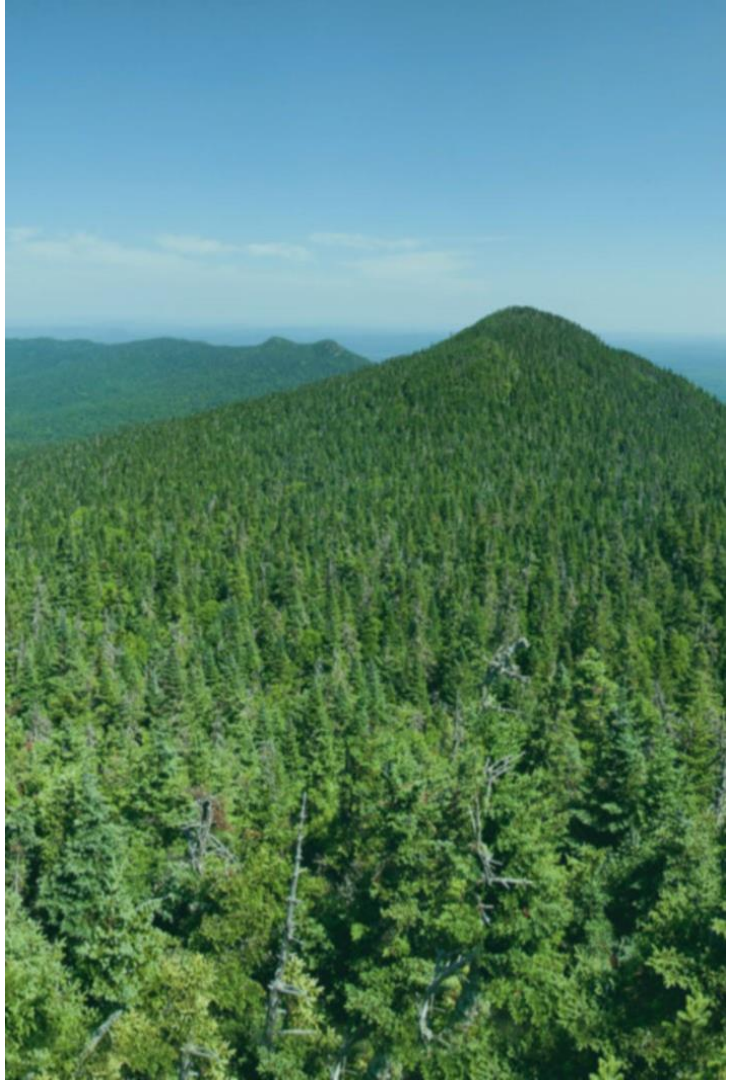


Head et al. (2019) Journal of Cleaner Production

NO

Since 1990, it is estimated that 420 million hectares of forest have been lost through conversion to other land uses, although the rate of deforestation has decreased over the past three decades. (FAO)

Equivalent to fossil carbon emissions

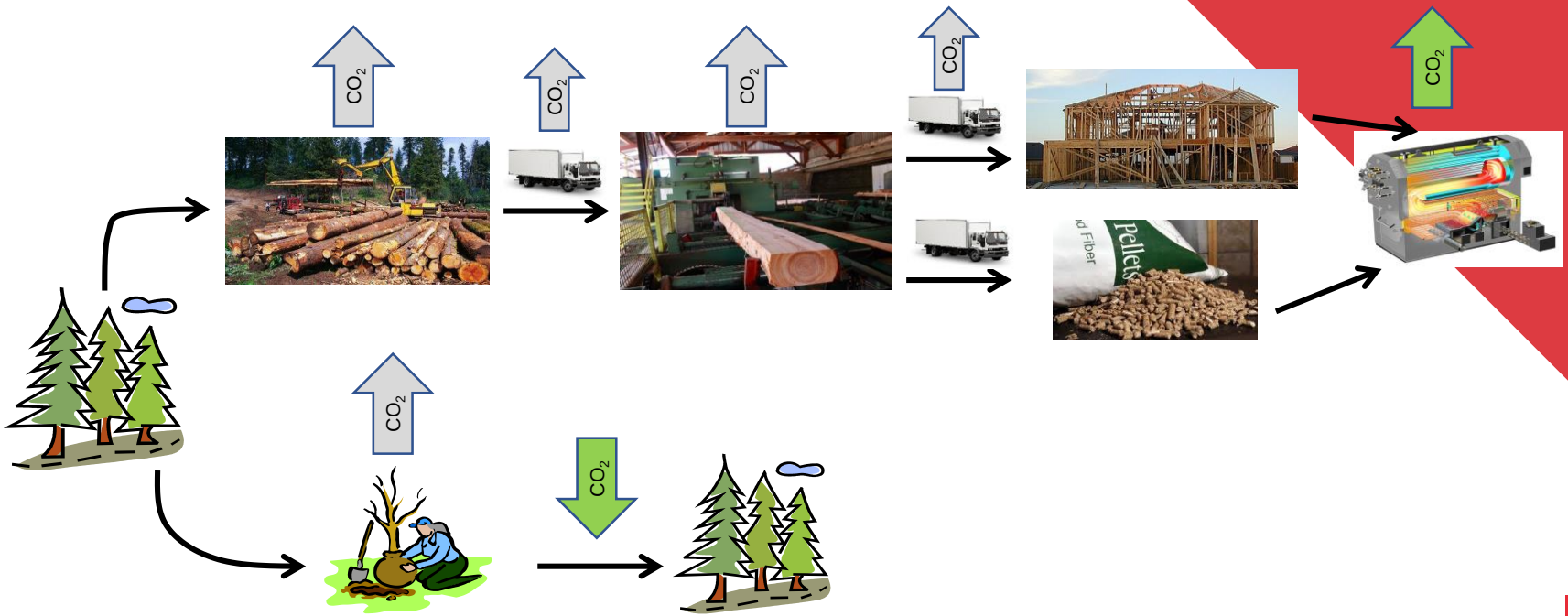


Why is quantification a challenge?

- Depends on local parameters (climate, species, soil, etc.) and on forest management practices;
- Complex modelling;
- Definition of a baseline scenario required:
  - To estimate the « without human intervention » carbon stock and compare it to that of the managed forest to quantify anthropogenic carbon flows to be included in the LCA.

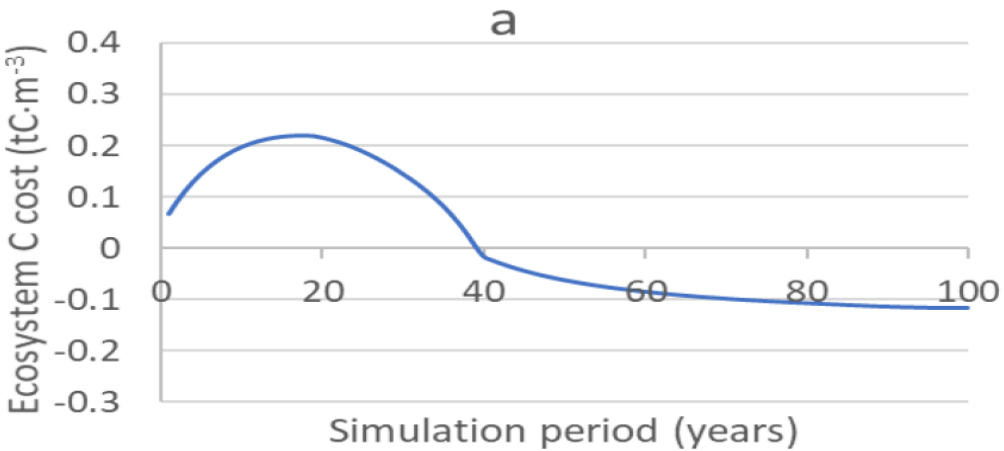
3. Timing

Decades-long processes



What if we increase harvest?

Balsam fir – Boreal forest in Québec



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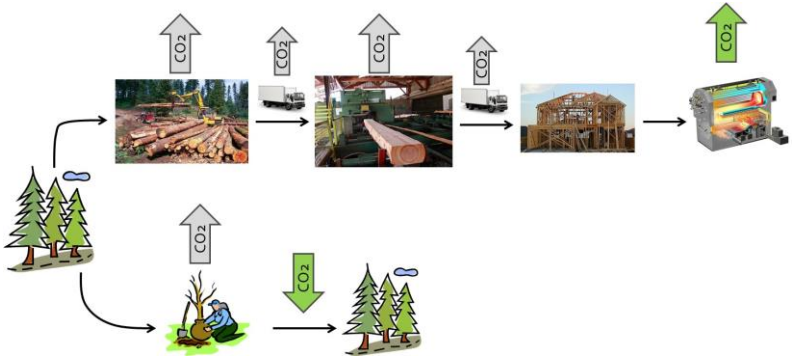
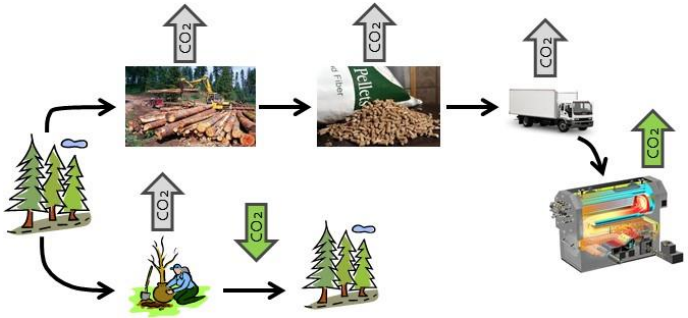
Forest bioenergy carbon debt





Compensated by temporary carbon storage in wood used as material

Debt (years)	Type of biomass	Energy produced	Fossil fuel substituted	Reference
4	Branches	Heat	Natural gas	Repo et al. 2010
6	Forest residues	Heat	Fuel oil	Berner & Paré, 2012
22	Stumps	Heat	Natural gas	Repo et al. 2010
70-75	Commercial stems	Heat	Fuel oil	Manuilova & Johnston, 2011
74	Forest residues	Ethanol	Gasoline	McKechnie et al. 2011
90	Whole trees	Heat	Fuel oil	Bernier & Paré, 2012
> 100	Whole trees	Ethanol	Gasoline	McKechnie et al. 2011

Adapted from Beauregard et al. 2012

Take-home messages

- The forest sector plays an important but complex role in the global climate;
- There is no magic solution to fight climate change, but a package of solutions;
- Life cycle carbon accounting is essential to identify the best strategies and avoid bad ideas.

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