Dynamic LCA approach applied to specific bioenergy case studies

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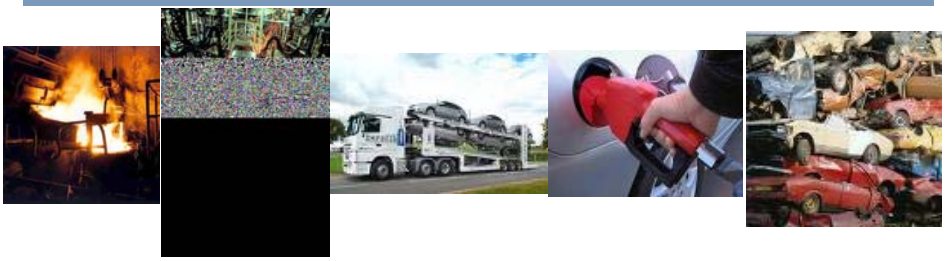
A research unit of the CIRAIG

ÉCOLE POLYTECHNIQUE MONTRÉAL

Dynamic LCA applied to bioenergy case studies

1. Presentation of the dynamic LCA approach
   - Time and LCA: current situation
   - Considering time in LCA
   - Dynamic LCA for global warming
2. Application to specific bioenergy case studies
   - Assessing the replacement of fossil fuels with biofuels while considering LUC emissions
   - Forest bioenergy and the carbon debt
3. Future developments
   - New metric: instantaneous temperature change

Time and LCA - Inventory



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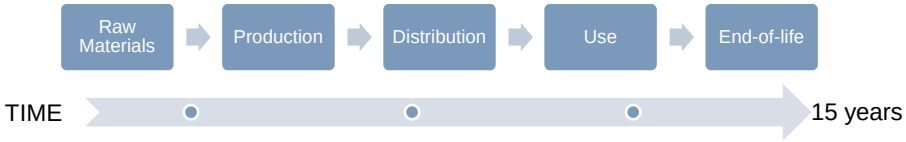
Time and LCA - Impact assessment



Substance	Inventory (kg)	Characterisation factor (kg ref-eq/kg)	Impact score (kg ref-eq)
A	X	1	1 * X
B	Y	2	2 * Y
C	Z	3	3 * Z
...	...	...	...
TOTAL			**X+2Y+3Z**

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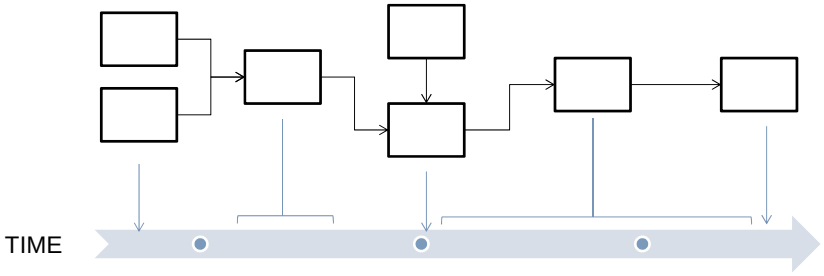
Dynamic LCA – Temporal inventory



Time step	A (kg)	B (kg)	C (kg)	...
1				
2				
3				
4				
...				

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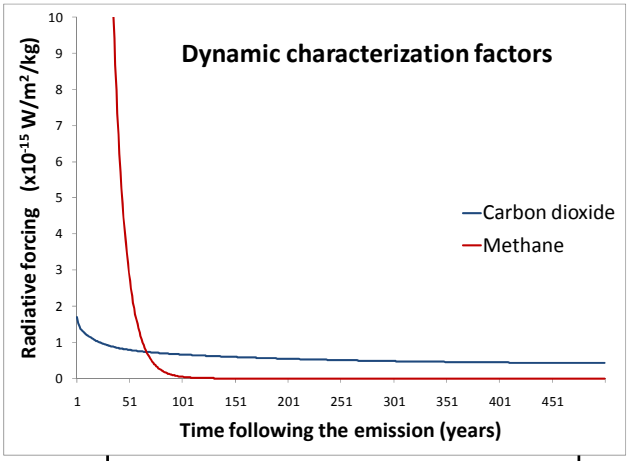
Dynamic LCA – Characterization factors for GW



$$DCF = AGWP(t) = a * \int_0^t C(t)dt$$

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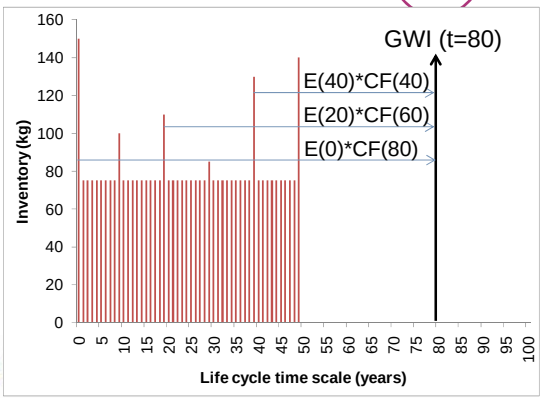
Dynamic LCA computation

Life cycle time scale

Emissions time scale



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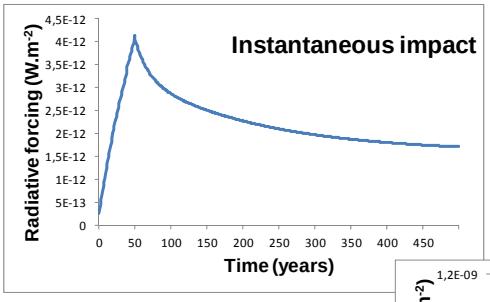
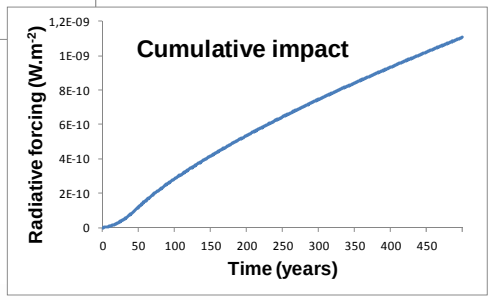
Example of results





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Properties of dynamic LCA for global warming

1. It provides cumulative radiative forcing results over a consistent time frame.
2. It accounts for the specific atmospheric fate of every GHG and for positive and negative CO_2 flux from any source (fossil or biogenic).
3. It allows a consistent assessment of temporary carbon storage activities and delayed GHG emissions.
4. It allows testing the sensitivity of the results to the choice of a time horizon.
5. It can be applied to:
   - Any type of product or project;
   - Any temporal profile;
   - Every impact category.

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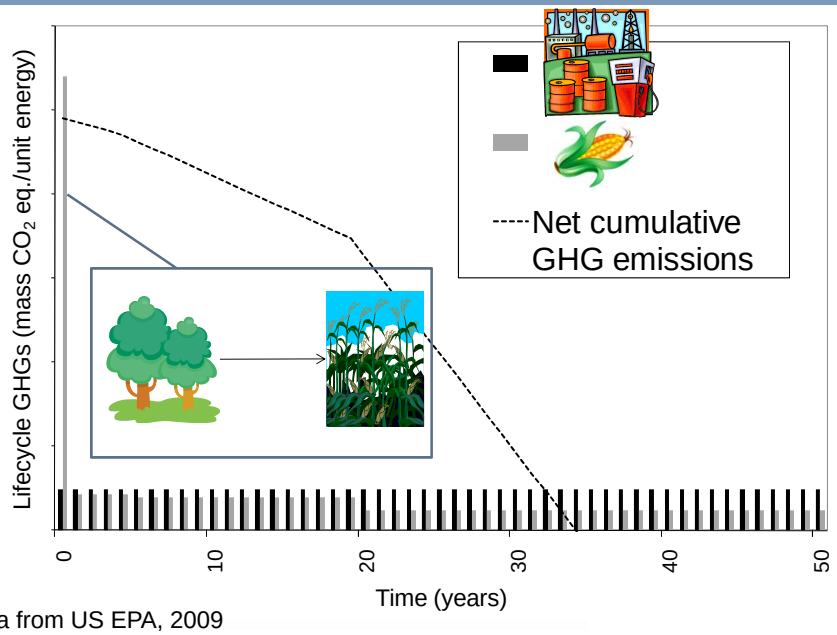
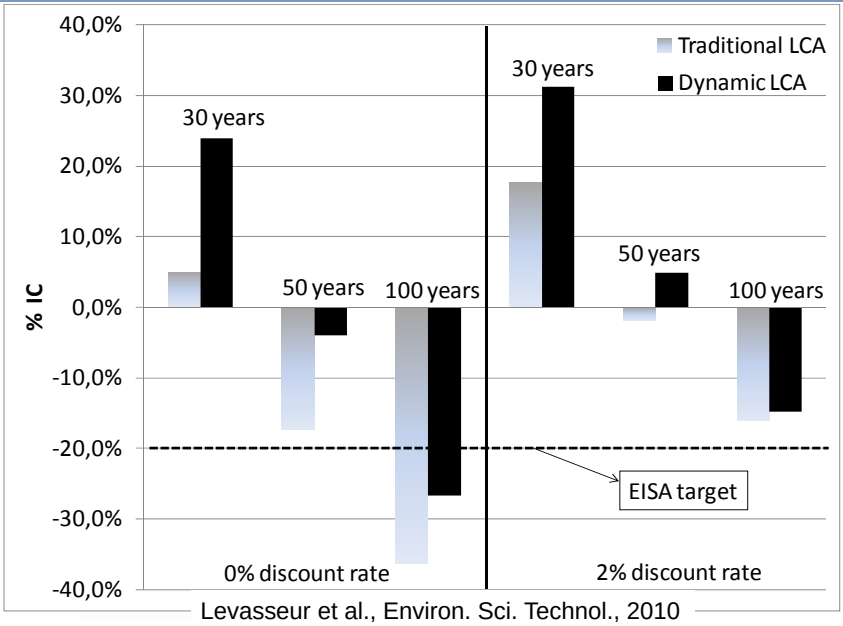
Application to the US EPA LCA on renewable fuels



Data from US EPA, 2009

Comparison of dynamic and traditional LCA approaches



Levasseur et al., Environ. Sci. Technol., 2010

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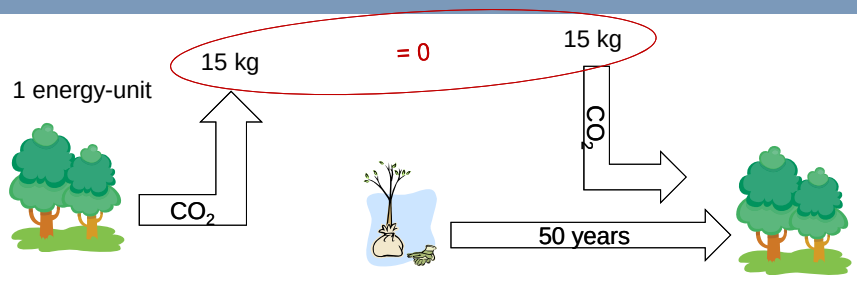
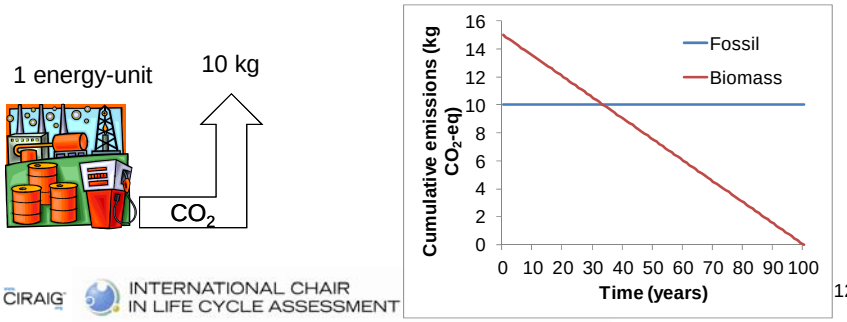
Application to forest bioenergy





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Hypothetical case study

	Biomass (kg CO_2-eq)	Fossil (kg CO_2-eq)
2010	15	10
2020	-1,5	0
2030	-1,5	0
2040	-1,5	0
2050	-1,5	0
2060	-1,5	0
2070	-1,5	0
2080	-1,5	0
2090	-1,5	0
2100	-1,5	0
2110	-1,5	0
TOTAL	**0**	**10**

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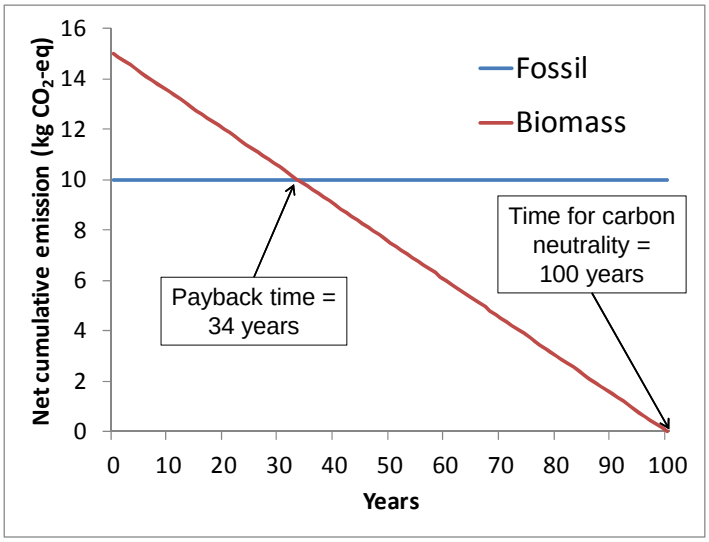
Carbon debt of forest bioenergy



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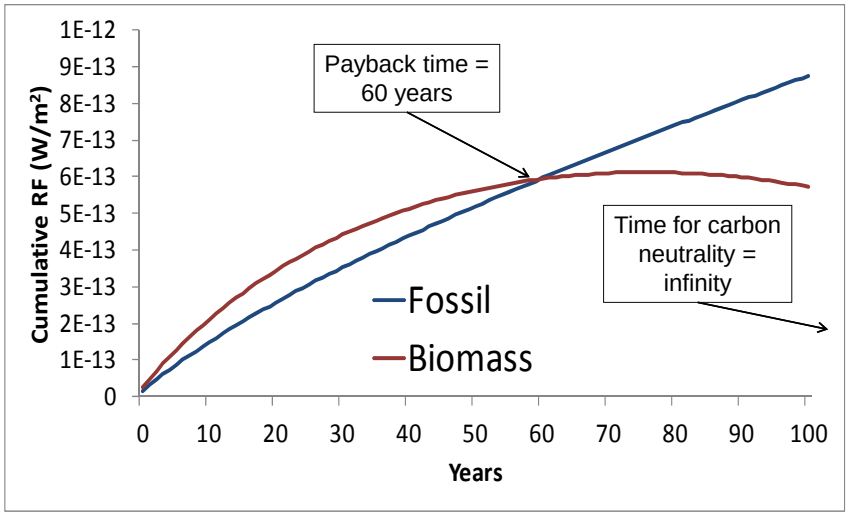
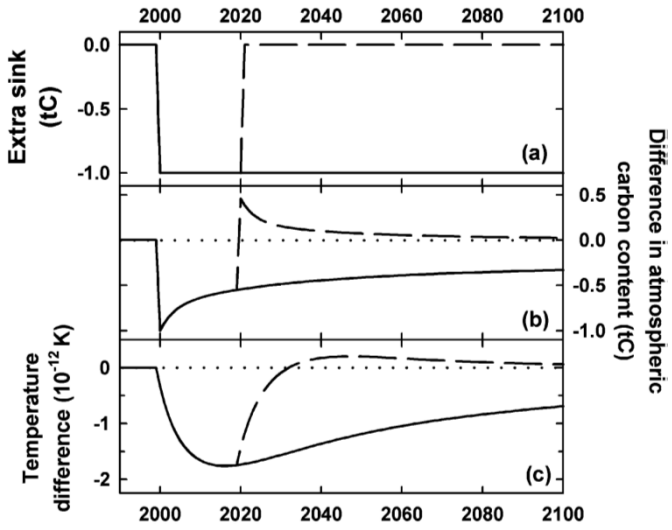
Climate debt of forest bioenergy

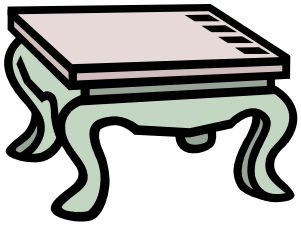


What about other metrics?



Kirschbaum, Mit. Adapt. Strat. Gl. Change, 2006

Hypothetical case study



		Wood	Other material
Year 1	kg CO_2	50	50
Year 2 to 50	kg CO_2/yr	-20	0
Year 51	kg CO_2	980	0
TOTAL	kg CO_2	**50**	**50**

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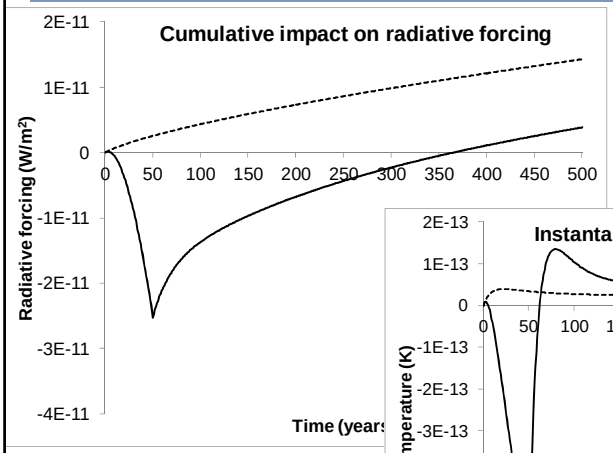
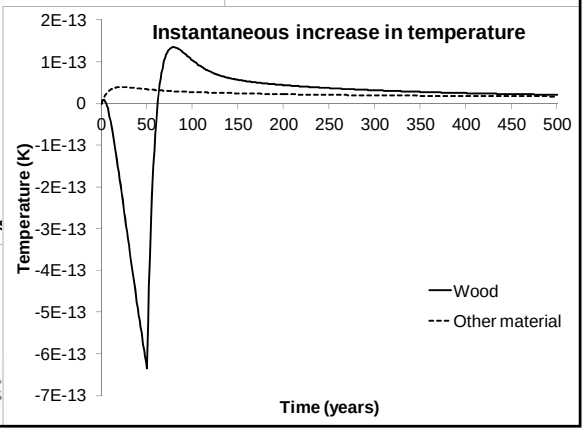
Dynamic LCI using two metrics





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Questions ?

Thank you for your attention