

Timing of Emission Reduction through Forest-based Bioenergy Substituting for Fossil Energy

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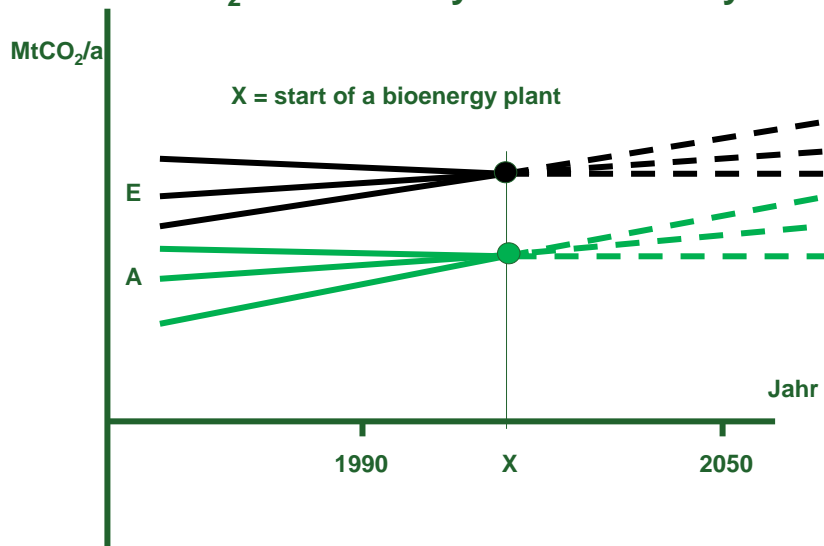
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Background

- **“Secondary” processes in bioenergy systems analyzed in detail: (d/i)LUC, fossil auxiliary fuel, conversion efficiency, socio-economy, “general” environmental benefits, forest management schemes**
- **“Timing” of emission reduction addresses the assumption of zero emissions when burning biomass substituting for fossil fuels; it is independent of the above**

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Examples for Emissions (E) and Absorptions (A) of CO₂ within the System Boundary



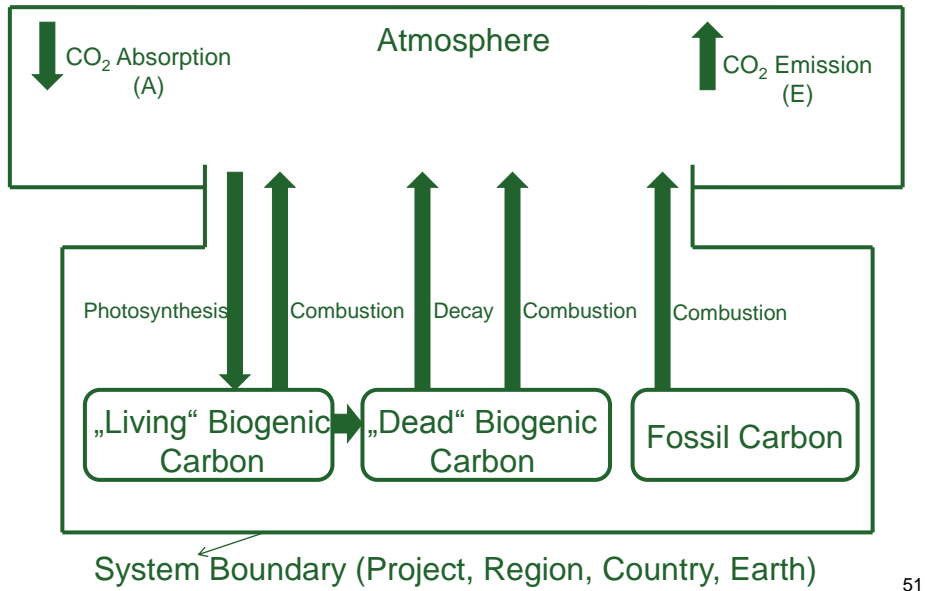
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What happens to A and E after a Forest-based Bioenergy Plant Has Started Operation?

- Types of forest-based biomass
 - “Dead” biomass: Products of forest/wood industry (Residues from logging and wood processing, wood products after the end of their use); these products would decay if they were not burned for energy production
 - “Living” biomass: Additional felling and thinning in forests; these materials will re-grow, harvesting will initially lead to reduced absorption
- Development of A and E
 - “Dead” biomass: Absorption remains unchanged, biomass combustion emissions are of the same magnitude as the fossil emission avoided (typically somewhat higher), decay emissions become zero. The “avoided” decay emissions usually are very small initially and it takes considerable time until they accumulate to a full compensation of the biomass combustion emissions.
 - “Living” biomass: Absorption decreases by the amount absorbed by the trees prior to harvest and increases by the re-growth of the trees. Biomass combustion emissions are of the same magnitude as the fossil emission avoided (typically somewhat higher). It takes considerable time until re-growth accumulates to a full compensation of the combustion emissions.
- The relevant processes (decay and re-growth) extend over time periods of between 5 to 100 years and are independent of forest management practices prior to and after the start of the bioenergy plant

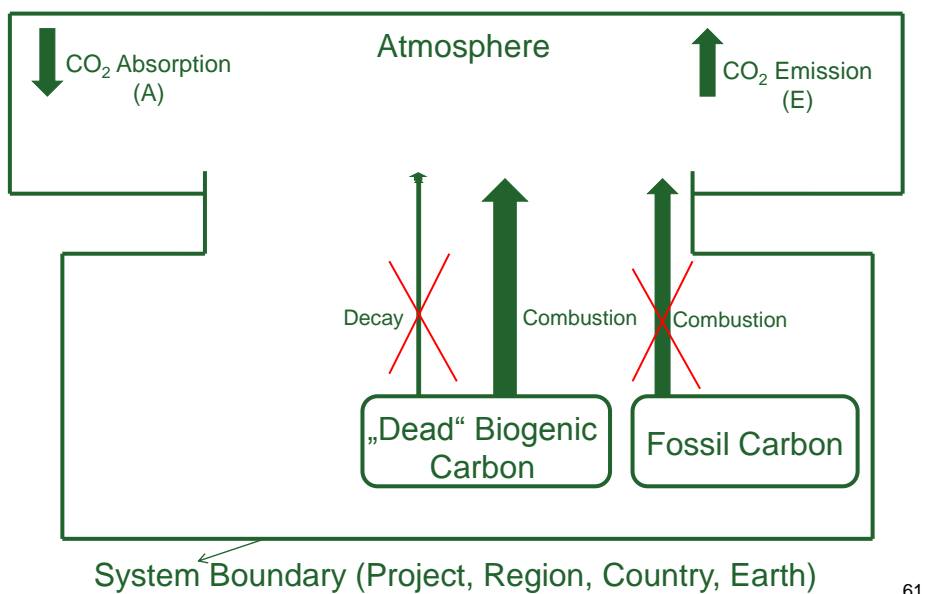
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Carbon Flows in Forest-based Bioenergy Systems



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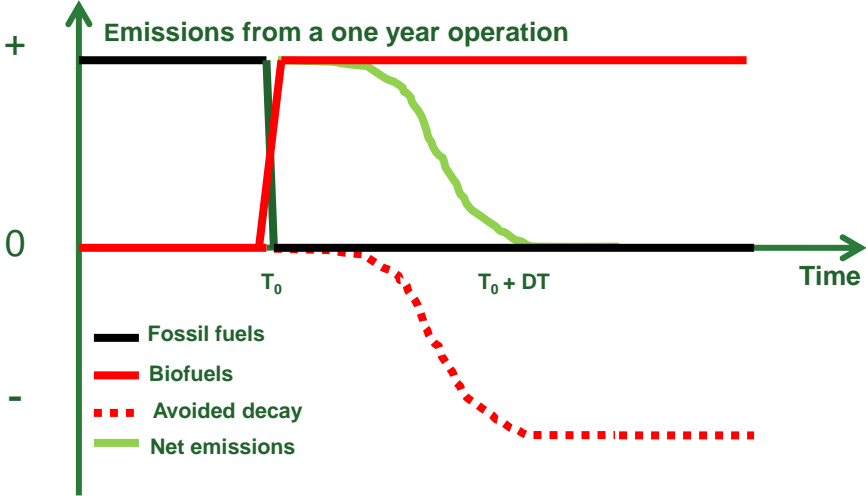
Example: Biofuels from forest and wood industry products/residues (“dead” biomass)



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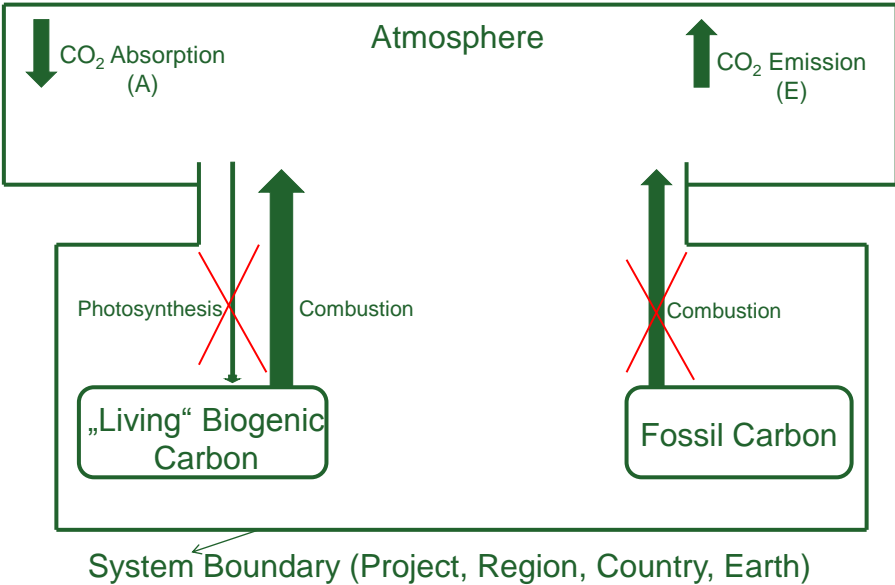
Example: Biofuels from forest and wood industry products/residues (“dead” biomass)

The products replace fossil fuels beginning at T_0 . DT represents the „Decay Time“ (decay period for the products if they had not been burned), which is in the order of 5 to 100 years.



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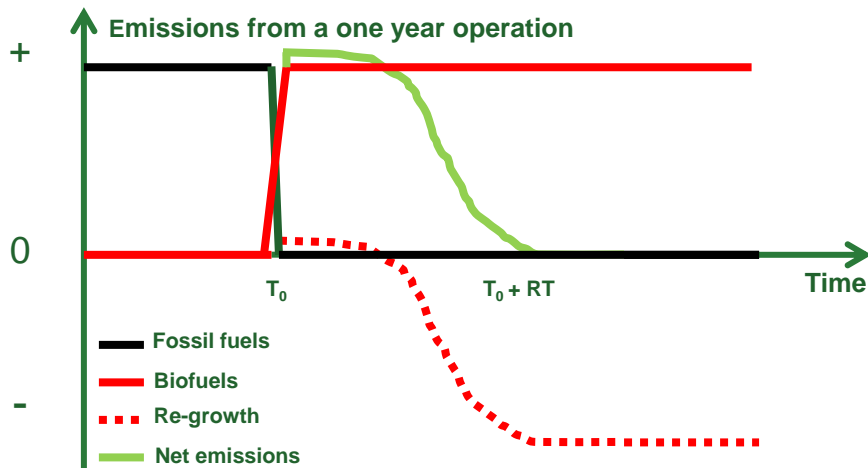
Example: Biofuels from logs and forest thinning (“living” biomass)



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Example: Biofuels from whole trees and forest thinning (“living” biomass)

The biomass replaces fossil fuels beginning at T_0 . RT represents the „Re-growth Time“, which is in the order of 30 to 100 years. The initially reduced absorption results in an increase of the net emissions, which will be compensated by an enhanced growth in the vicinity of the trees harvested and/or in the area of the thinning.



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Conclusions

- The significance of the time delay is, that the emission reduction benefit assumed in most accounting schemes does not happen immediately („zero emission“) but is spread over a certain period of time . Therefore reduction goals set within that period (Kyoto 2012, EU 2020, 2°C limit by 2050) are only partially supported by forest bioenergy schemes.
- The time delay discussed here is not caused by a deviation from a sustainable forestry operation, it occurs under sustainability conditions including situations where a net increase of stock is occurring within the system boundary.

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„Living“ Biogenic Carbon

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„Dead“ Biogenic Carbon

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Fossil Carbon