Carbon Impacts of Burning Bioenergy

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Biofuelwatch and Friends of the Earth
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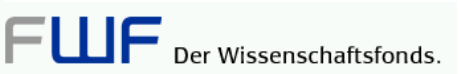
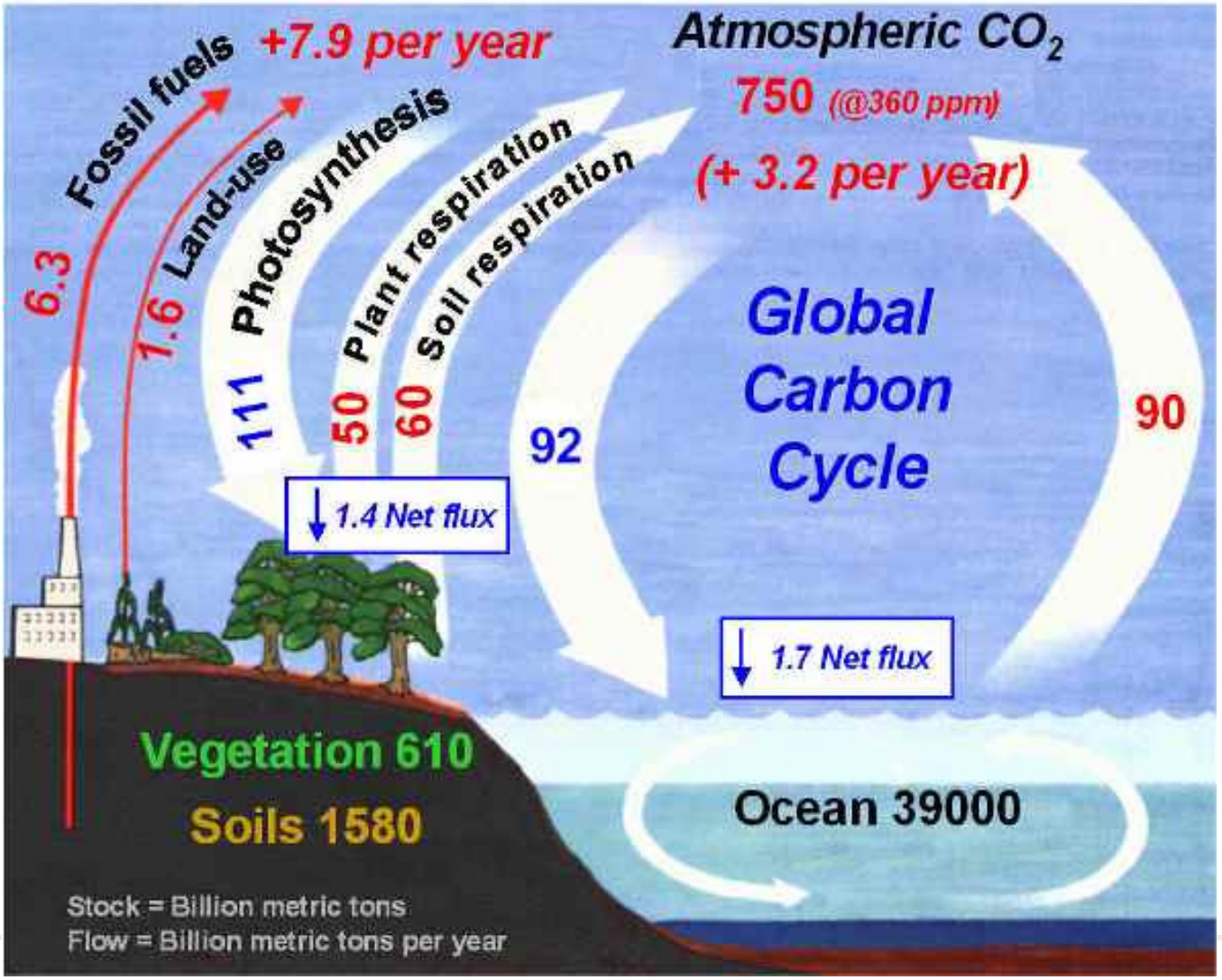


The global carbon cycle



Source: umich.edu

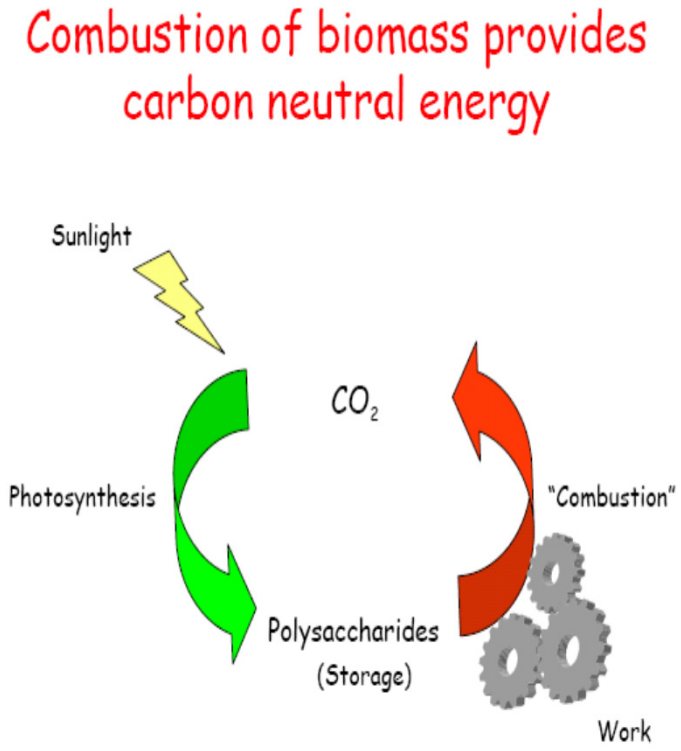
CO_2 emissions from combustion per unit of energy

Coal	0.35-0.40 kg CO_2 / kWh
Oil products	0.26-0.30 kg CO_2 / kWh
Natural gas	0.20-0.22 kg CO_2 / kWh
Biomass	≈ 0.40 CO_2 / kWh

If C absorption during plant growth is neglected, CO_2 emissions of biomass combustion are higher than those of fossil fuel combustion.

‚Conventional wisdom‘

CO_2 emissions of biomass combustion need not be counted because plants absorb CO_2 when they regrow



But …

Land grows plants, whether it is used for bioenergy or not

→ Assuming that CO_2 emitted during biomass combustion is offset through plant growth results in many cases in double-counting of carbon.

Biomass combustion can only help to reduce CO_2 if

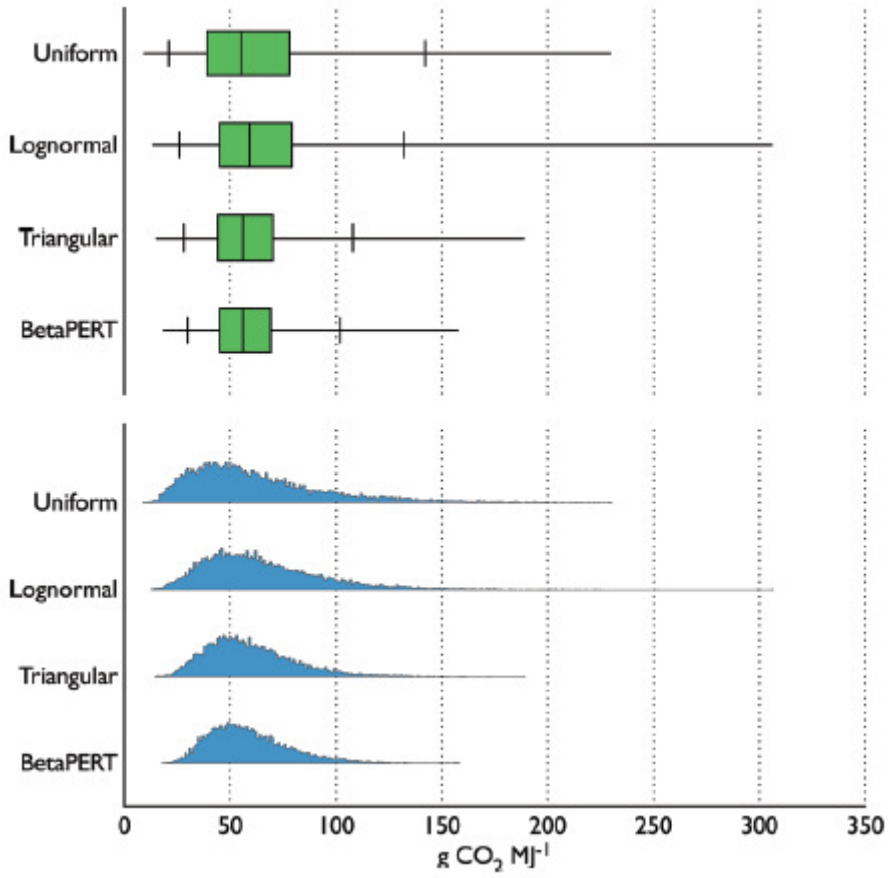
(1) The biomass stems from additional plant growth or

(2) The biomass would have decomposed rapidly if not used for energy

Critical issues determining the C balance of biomass combustion

- Purpose-grown biomass
  - What would have happened on the land if not used to grow bioenergy crops? C sequestration, food or energy crops, etc.?
  - If food or feed crops are replaced: are they replaced? If so, how: intensification (increased yields = more plant growth) and/or land-use change (e.g. deforestation elsewhere -> iLUC)?
- Residues
  - What would have happened with the residue if not used for bioenergy? (burning, use as fertilizer)
  - Reduced use of residues as fertilizer may deteriorate soils and result in C loss from cropland soils

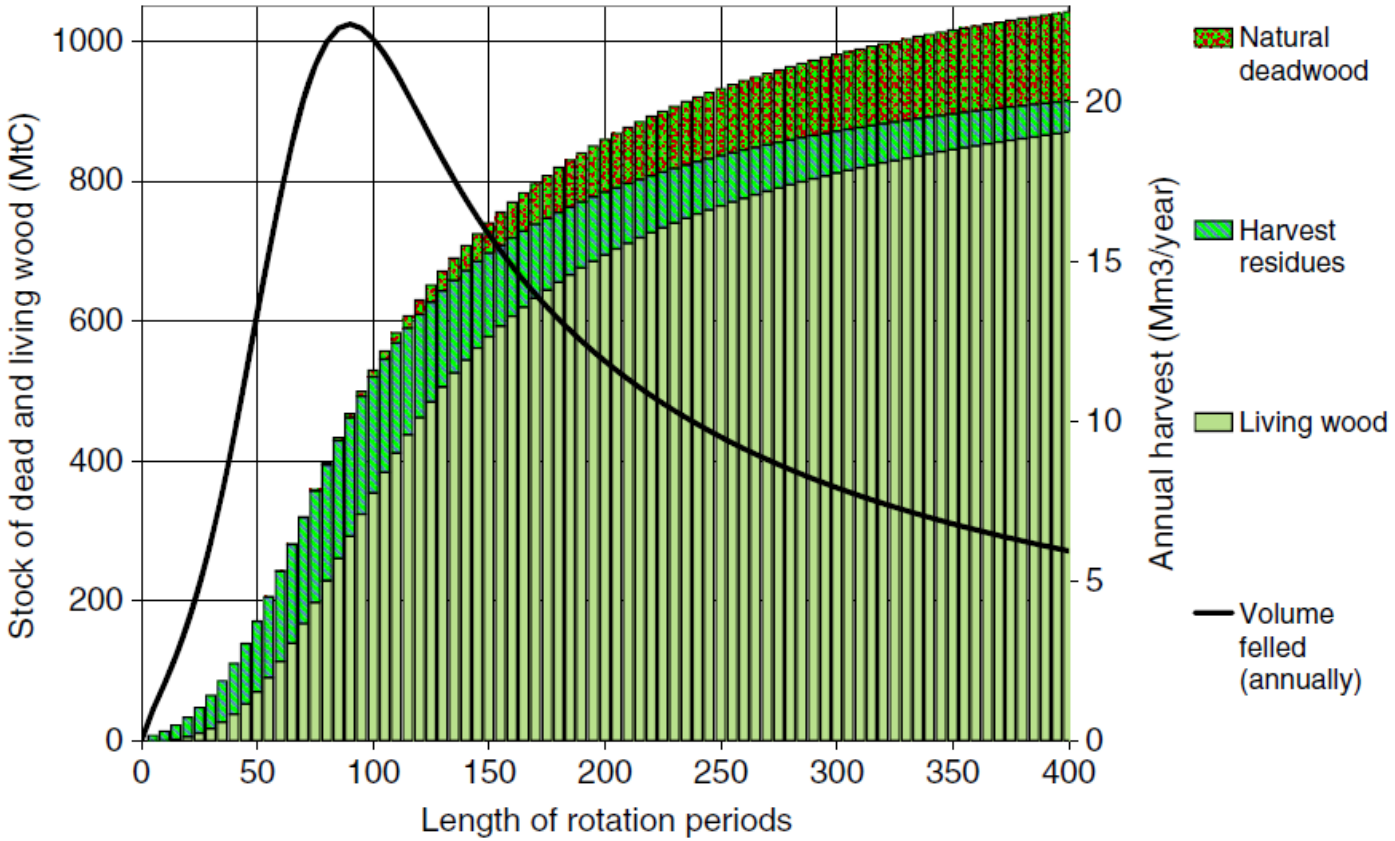
Probabilistic analysis of iLUC emissions of US corn ethanol



- Emissions of petroleum-based gasoline are ≈ 100 gCO_2-eq MJ^{-1}
- Life-cycle emissions of corn-based ethanol excluding iLUC are 30-70 gCO_2-eq MJ^{-1}
- Neglecting iLUC is equivalent to assuming that iLUC emissions were zero

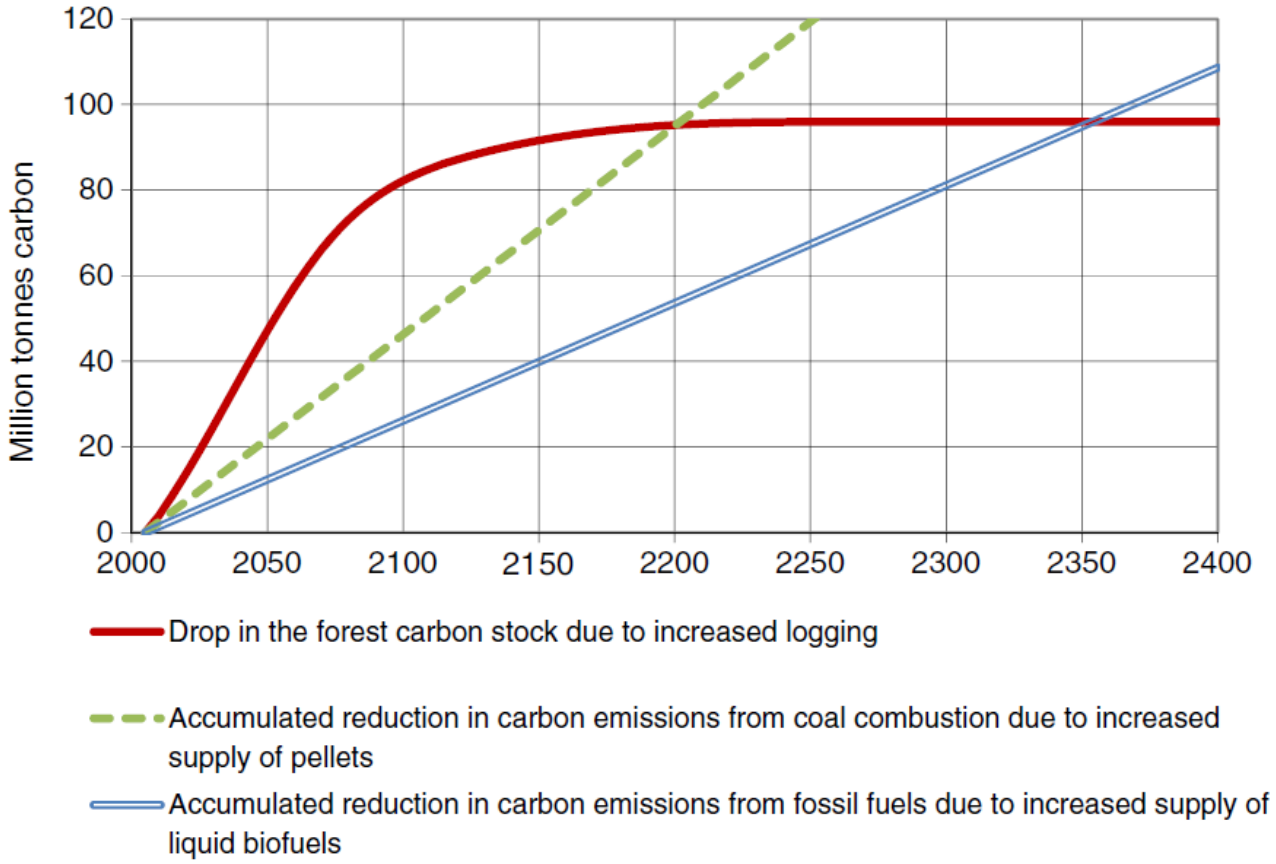
Figure: Plevin et al., 2010, Env Sci Tech 44, p. 8019
Other emission data: Chum et al., 2011, in: IPCC-SREEN

Annual wood harvest versus carbon stocks in Norwegian forests



Holtsmark, 2011 Climatic Change
DOI 10.1007/s10584-011-0222-6

Payback time of the C debt resulting from increased wood harvest, Norway



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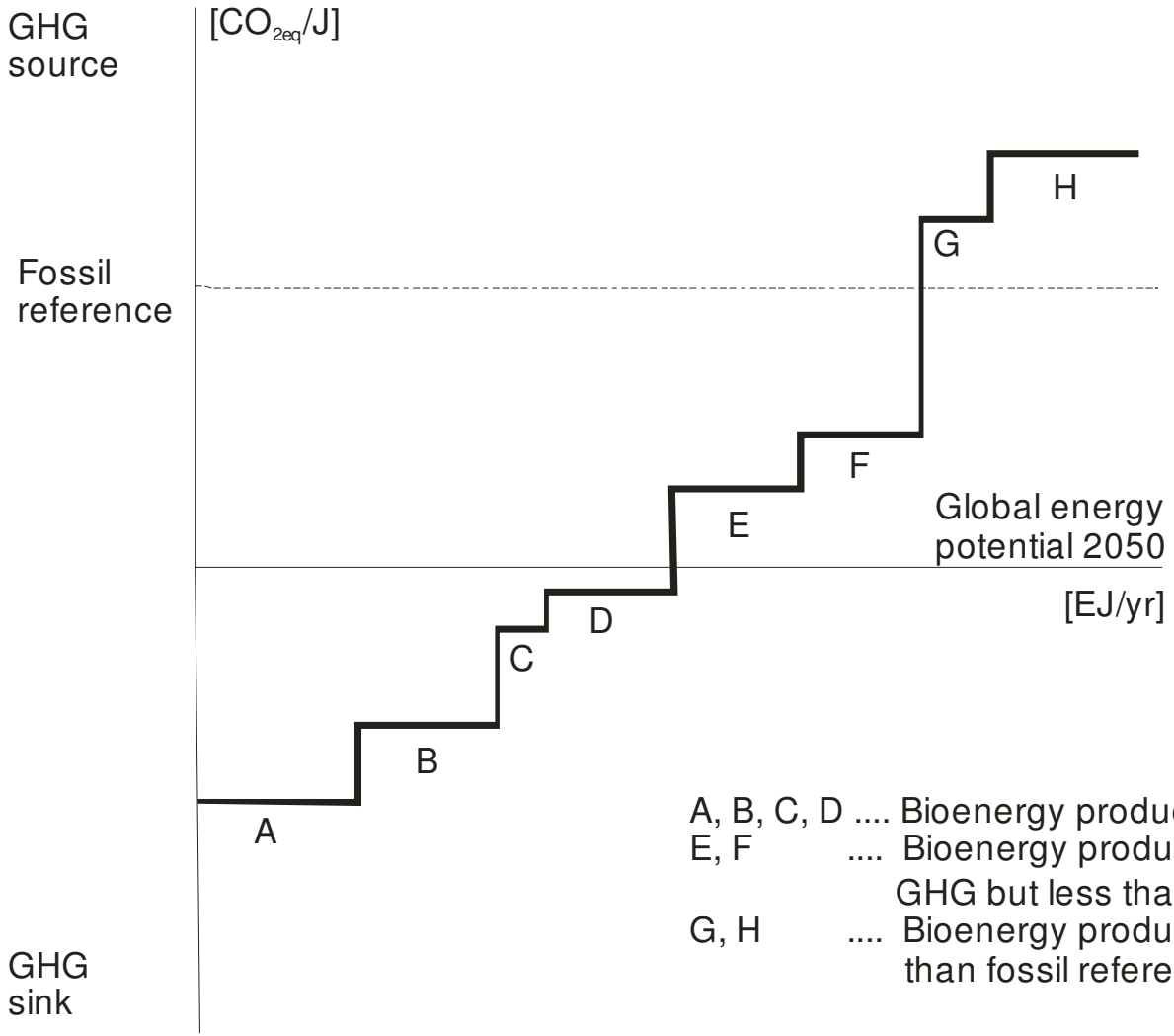
We don‘t know which percentage of the global bioenergy potential is climate-friendly

- Beneficial examples
  - Biomass grown on degraded lands in dryland areas (e.g., salinized croplands in Australia) or on degraded, erosion-prone tropical lands
  - Biomass residues and biogenic wastes that would otherwise decompose (if not needed to sustain soil fertility)
- Questionable to detrimental examples
  - Most current ‚first generation‘ biofuels from cropland (rape/soy oil, ethanol from maize)
  - Increasing harvests in existing forestry systems to produce more fuelwood
- Disastrous examples
  - Palm oil produced on cleared tropical forests, especially if peatlands are lost
  - Almost any energy bioenergy pathway that results in deforestation (directly or indirectly)

Needed: a GHG cost curve of bioenergy



Depends on the agriculture/food system!

A, B, C, D .... Bioenergy production sequesters C
E, F .... Bioenergy production produces GHG but less than fossil fuels
G, H .... Bioenergy produces more GHG than fossil reference