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Biogenic CO2 accounting of bioenergy from forests'

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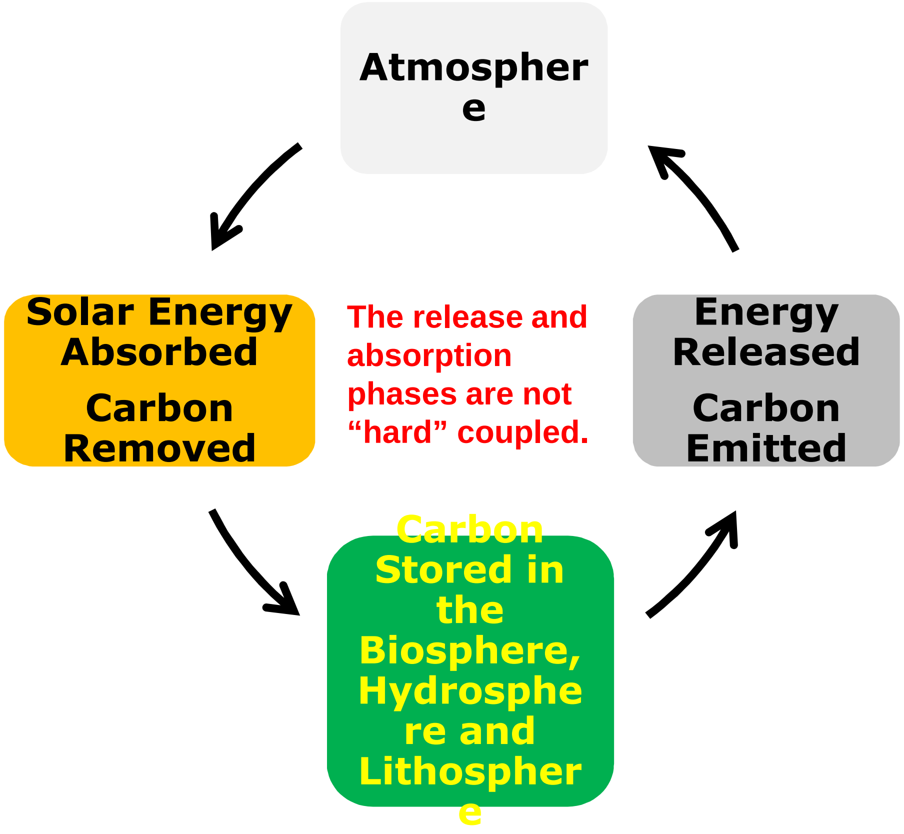
Joint Research Centre

Outline

- Problem definition
- Quantification
- Sensitivity analysis
- Implications for EU energy policy
- Conclusions
- Discussion

Where does the problem stem from?



Causes

1. Use existing carbon capital for bioenergy
2. Accelerating the energy release phase causes a temporary increase of carbon in the atmosphere
3. Accelerating the absorption phase can compensate but it is difficult to accelerate at the same magnitude
4. Continuous or increasing use causes a persistent increase of carbon in the atmosphere

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Where does the problem stem from? (4)

Carbon accounting according to UNFCCC:

LULUCF	+	Bioenergy	=	Atmosphere
Harvest: - 10 C/year Growth: + 10 C/year		0 C		0 C

Carbon neutrality for annual crops.

LULUCF	+	Bioenergy	=	Atmosphere
Harvest: - 10 C/year Growth: + 1 C/year		0 C		+8 C

Biogenic Carbon emissions for slow-growth biomass.

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Where does the problem stem from? (4)

Carbon accounting according to EU-ETS, Kyoto, RED etc…:

LULUCF	+	Bioenergy	=	Atmosphere
~~Harvest: - 10 C/year Growth: + 1 C/year~~		0 C		0 C

Wrong accounting! → Wrong conclusions about high atmospheric GHG savings!

Where does the problem stem from?

Bioenergy Carbon Intensity:

- Wood: 102 gCO_2 / MJ_{energy}
- Hard Coal: 96 gCO_2 / MJ_{energy}
- Natural Gas: 56.4 g CO_2 / MJ_{energy}

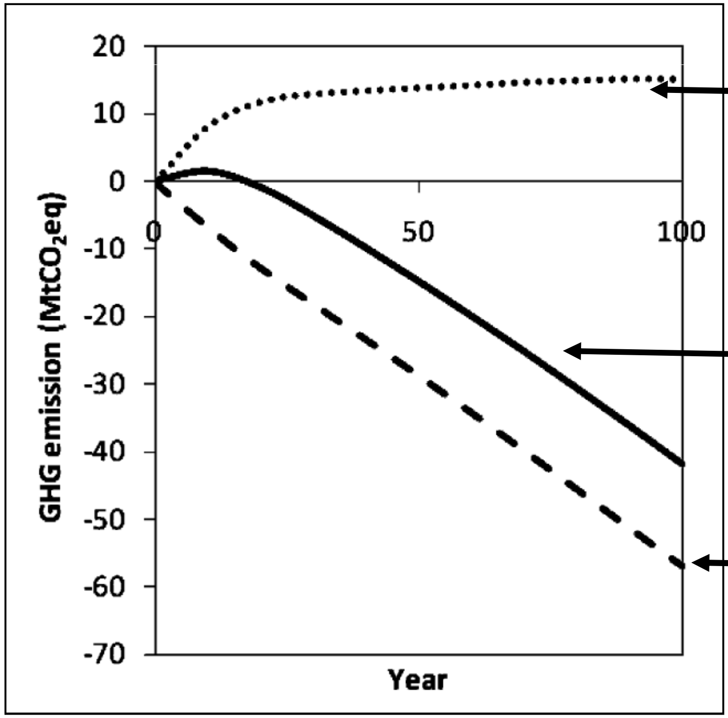
Efficiencies: ~25 – 35% biomass vs. 45 – 50% fossil advanced

Physical release of CO_2 per energy produced by biomass is at best comparable to that of any fossil source!

Quantification example: Forest Residues

An easy way to quantify the problem:

1. Forest reference system
2. Classic LCA with carbon neutrality (bio-CO2 = 0)



Forest residues decomposition on forest floor

Total atmospheric GHG emissions

Linear GHG savings for fossil fuel substitution

Source: McKechnie et al., 2011

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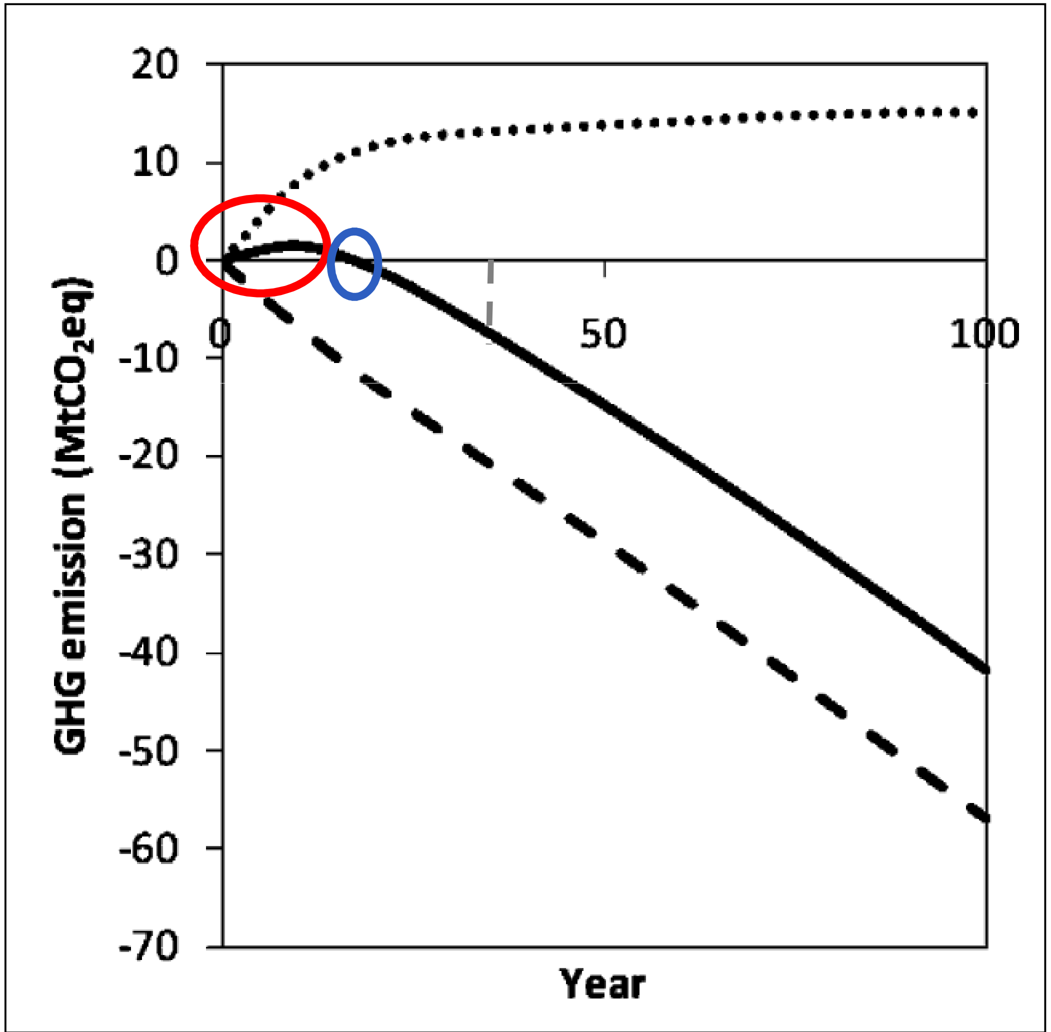
Quantification example: Forest Residues



Carbon Debt

Payback time

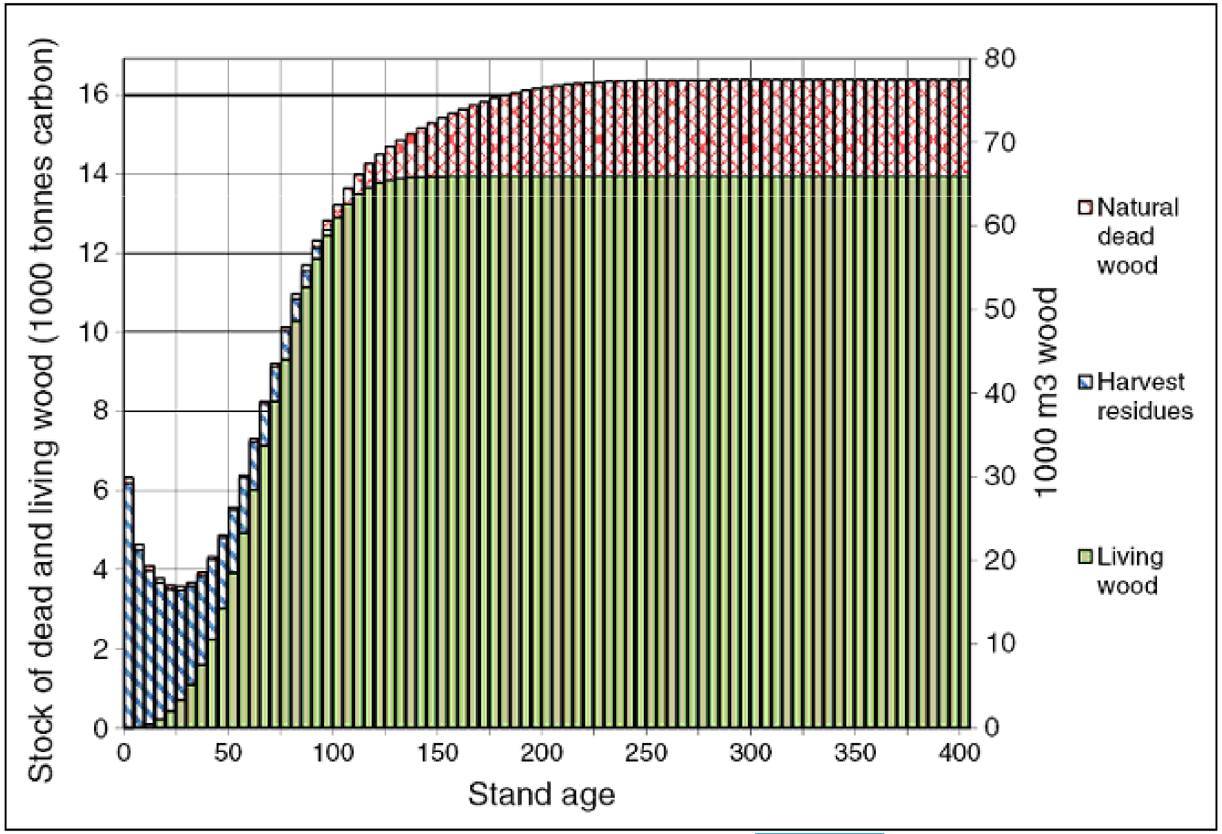
Break-even Time

(Carbon Neutrality is achieved)

Source: McKechnie et al., 2011

Quantification example: Roundwood

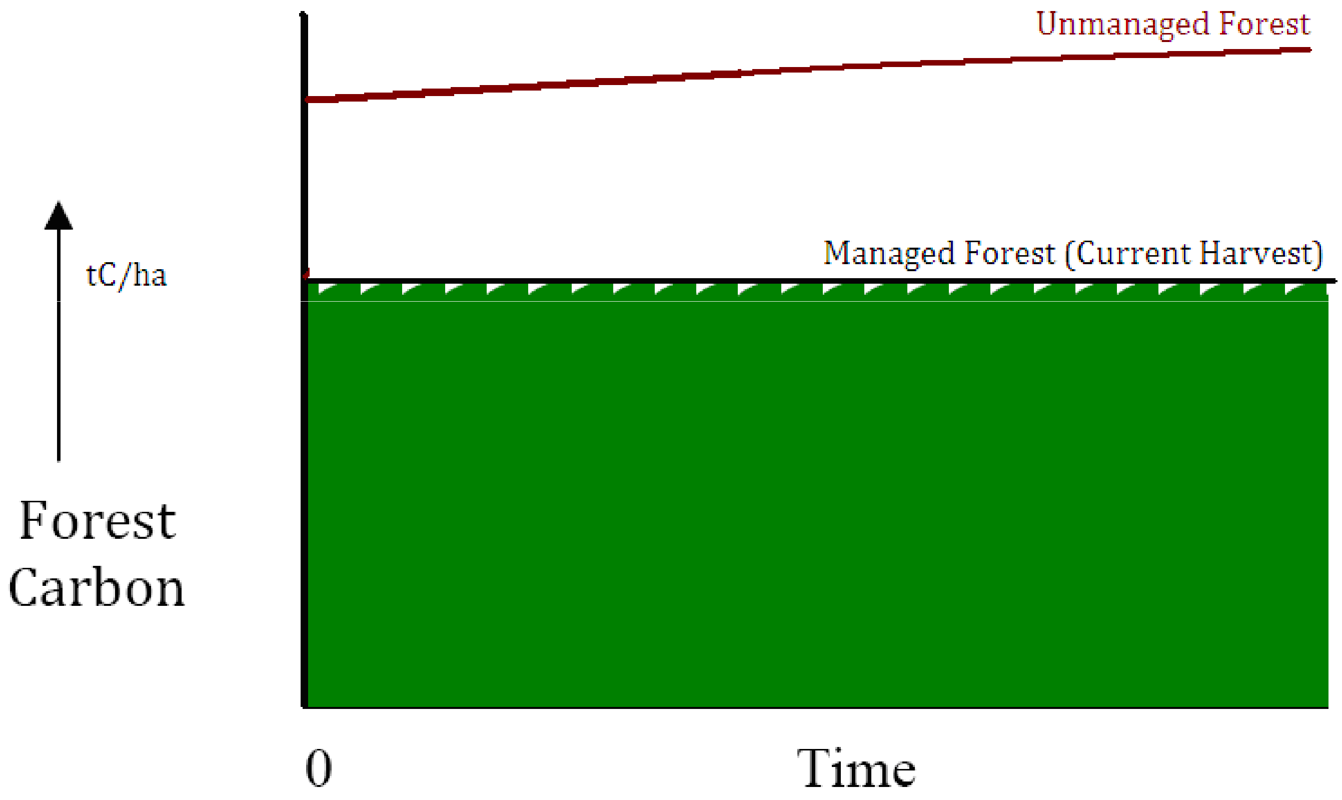
An additional factor needs to be accounted: Growth



Growth curve for a **Boreal Forest Stand**

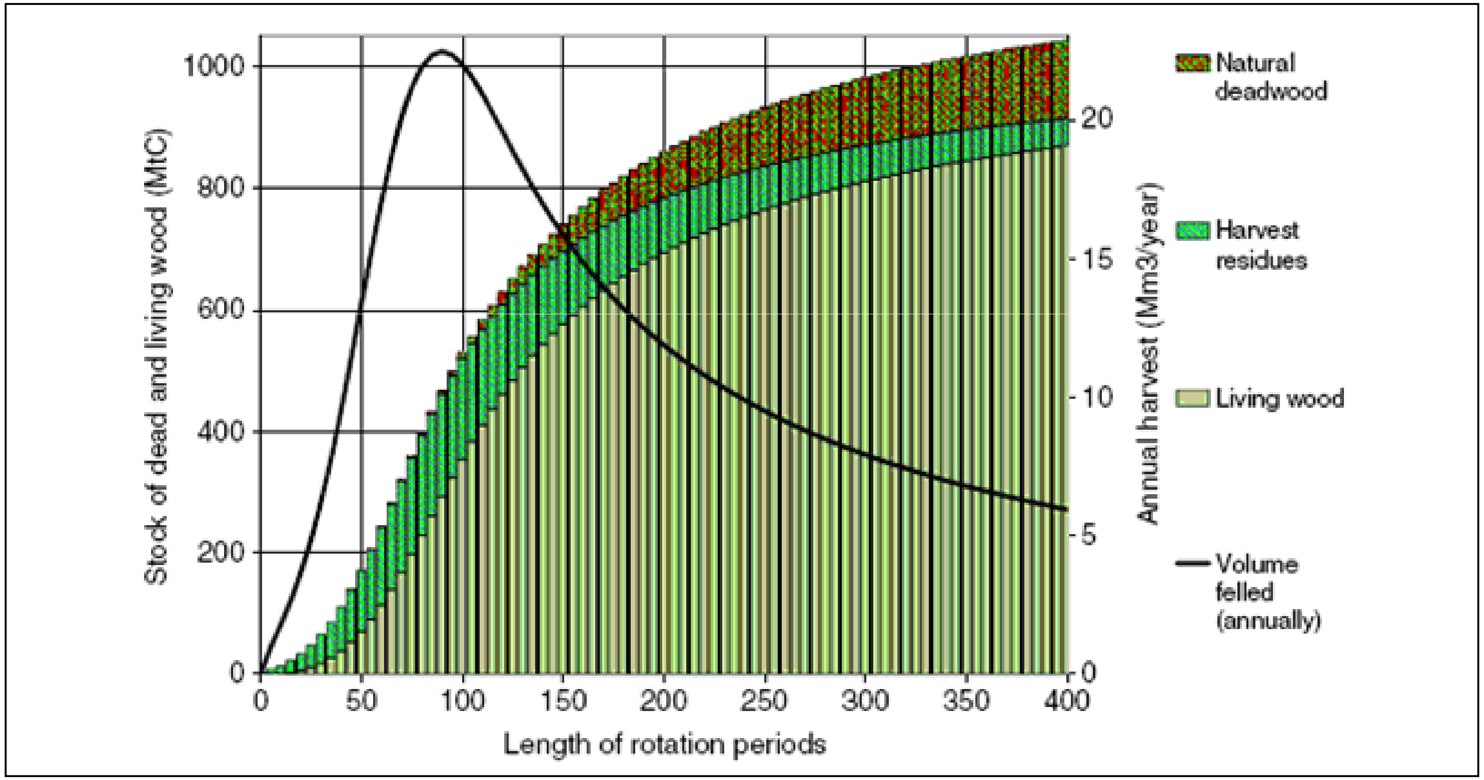
Source: Holtsmark et al., 2012

Forest Landscape (at equilibrium)



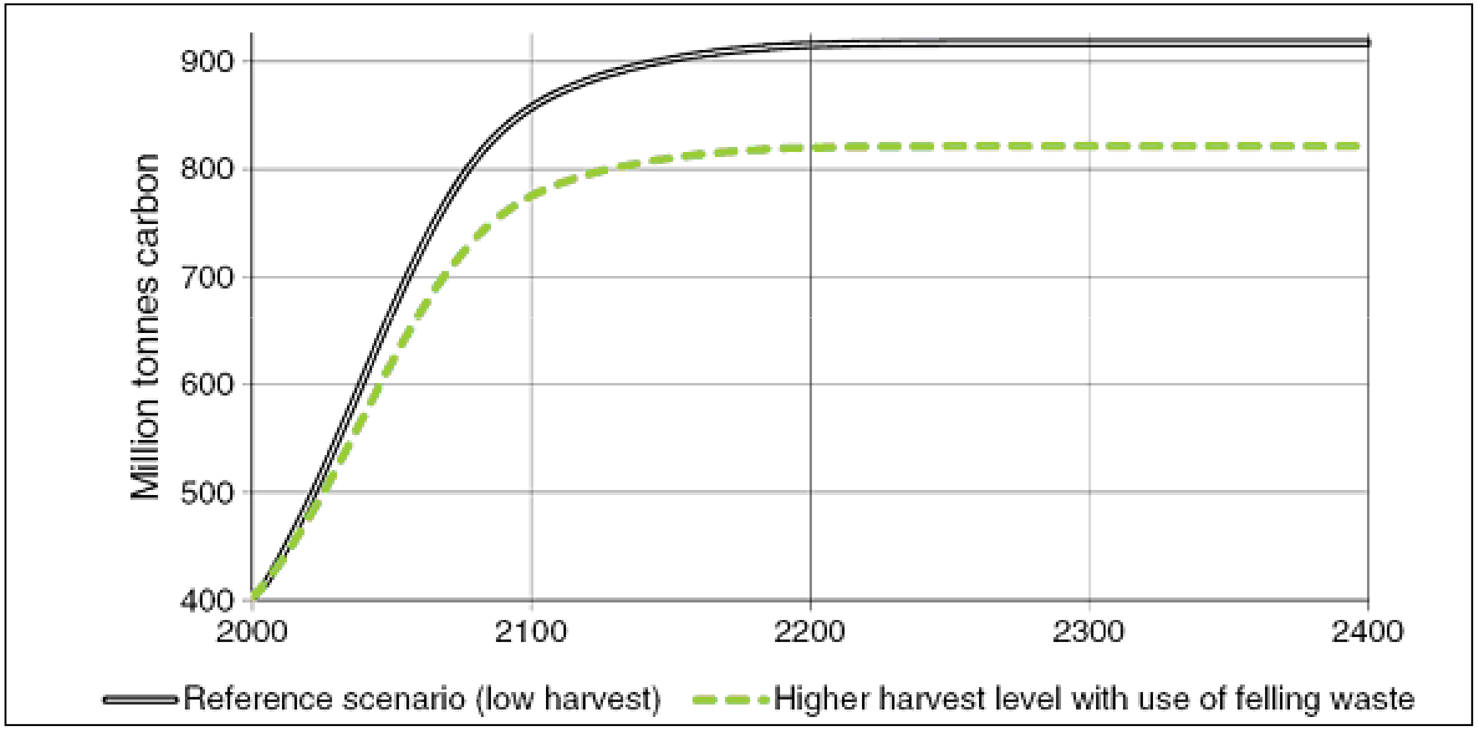
Quantification example: Roundwood

Source: Holtsmark et al., 2012



Carbon stock changes for increased harvest (shorter rotation periods).

Quantification example: Roundwood

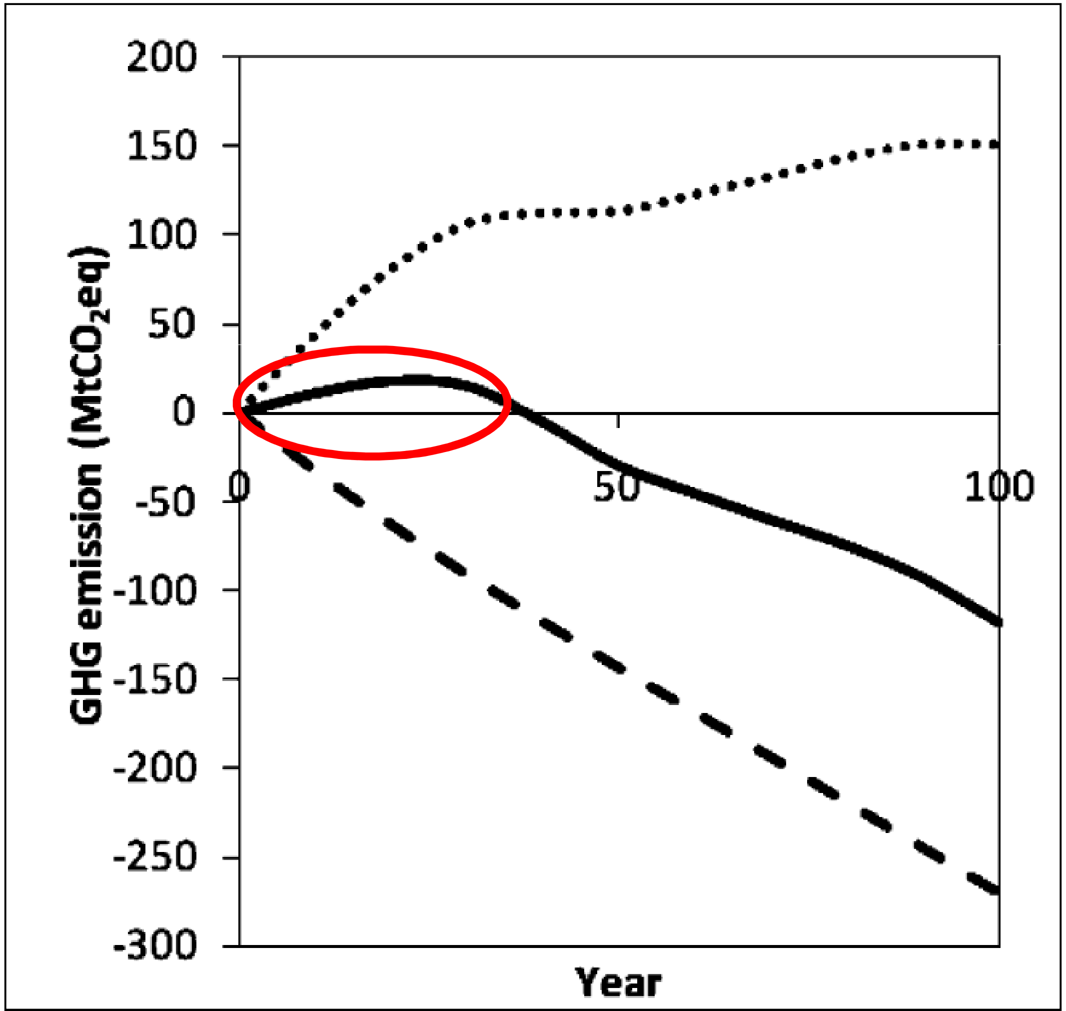


Source: Holtsmark et al., 2012

Carbon stock changes for increased harvest (shorter rotation periods).

Quantification example: Roundwood

- Longer payback times
- Sensitivity to the actual changes in forest management



Source: McKechnie et al., 2011

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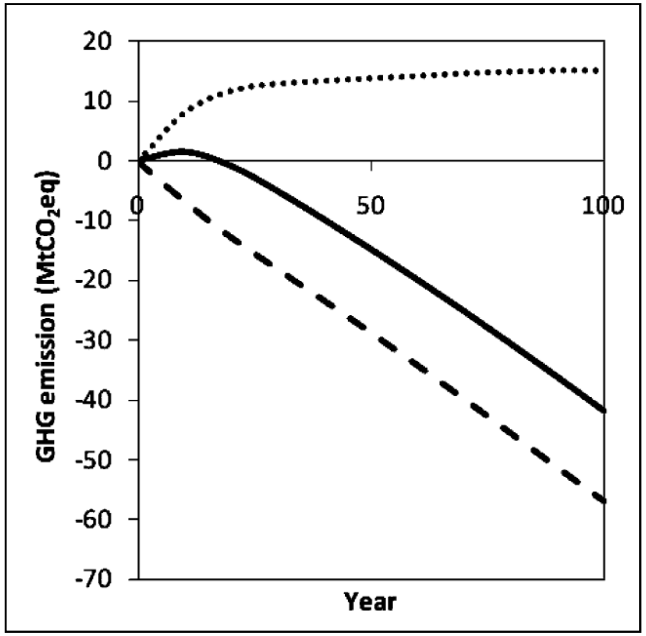
Sensitivity

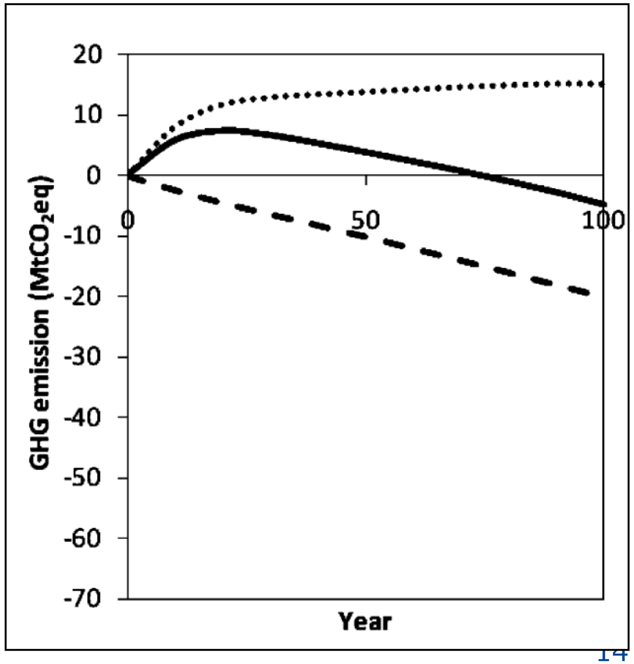
Payback time changes with:

1. Fossil system substituted.
   E.g. high savings from substituting coal electricity →
   smaller payback time.

Wood vs. Coal Electricity

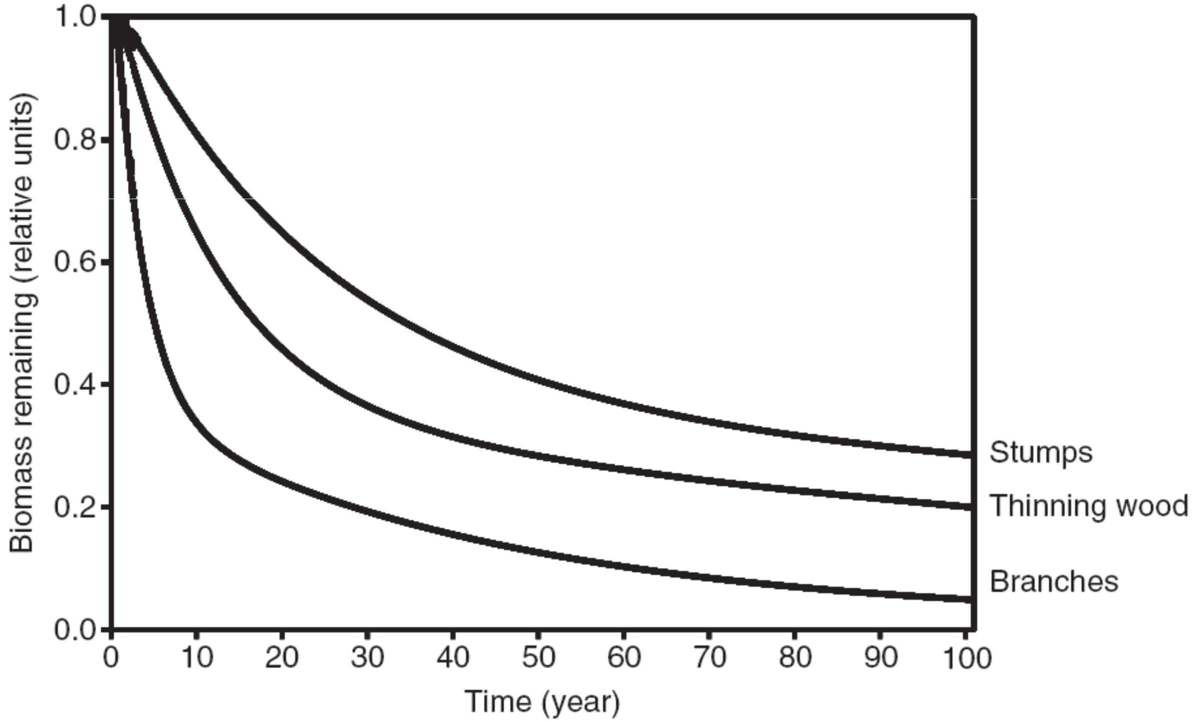


2nd gen ethanol (E85) vs. gasoline



Sensitivity

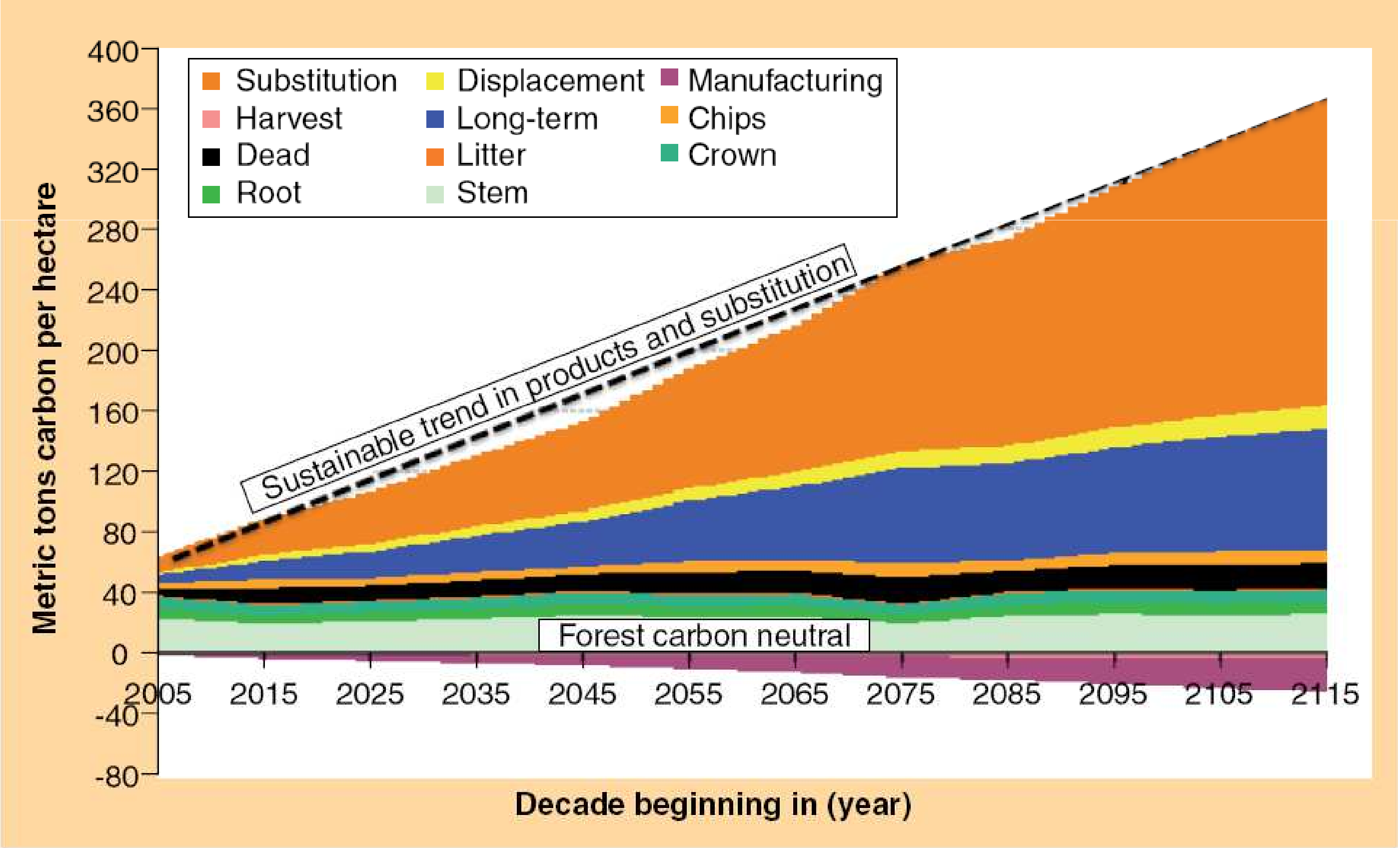
2. Residues size and effects Soil-C and nutrients;



Source: Repo et al., 2011

Sensitivity

3. Use of wood for long-lived products –additional carbon pool (effective carbon capture and storage!)



Source: Lippke et al., 2011

Sensitivity

4. Forest management techniques: fertilization, higher yields species, afforestation of other areas

5. Effect of natural disturbances (e.g. fires)

6. Albedo effect

Results from literature review

AUTHOR	AREA	FOREST TYPE	STUDY BOUNDARIES	SCENARIOS	REFERENCE SYSTEM	PAYBACK TIME (yr)
(McKechnie et al., 2011)	Ontario	Temperate	Forest management unit	Temperate, additional harvest	Electricity coal	Residues 16 Roundwood 38
(McKechnie et al., 2011)	Ontario	Temperate	Forest management unit	Temperate, additional harvest	Gasoline (ethanol)	Residues 74 Roundwood >100
(Holtsmark, 2012)	Norway	Boreal	Forest management unit	Boreal, explicit forest model, additional harvest	Electricity coal	190
(Holtsmark, 2012)	Norway	Boreal	Forest management unit	Boreal, explicit forest model, additional harvest	Gasoline (ethanol)	340
(Colnes et al., 2012)	US SE forests	Temperate			various	35 to 50
(Colnes et al., 2012)	US SE forests	Temperate			various	35 to 50
(Colnes et al., 2012)	US SE forests	Temperate			various	35 to 50
(Walker et al., 2010)	Massachusetts	Temperate		Temperate, 1 stand 1 harvest; 2 baseline scenarios, 3 bioenergy scenarios	Oil, thermal or CHP	3-15
(Walker et al., 2010)	Massachusetts	Temperate		Temperate, 1 stand 1 harvest; 2 baseline scenarios, 3 bioenergy scenarios	Electricity coal	12-32

Results from literature review

AUTHOR	AREA	FOREST TYPE	STUDY BOUNDARIES	SCENARIOS	REFERENCE SYSTEM	PAYBACK TIME (yr)
(Walker et al., 2010)	Massachusetts	Temperate		Temperate, 1 stand 1 harvest; 2 baseline scenarios, 3 bioenergy scenarios	Electricity Natural Gas	59 - >90
(Zanchi et al., 2011)	Austria	Temperate		Spruce	Electricity coal	250
(Zanchi et al., 2011)	Austria	Temperate		....	Electricity Natural Gas	> 300
(Zanchi et al., 2010)	Austria	Temperate		....	Electricity Natural Gas	> 300
(Repo et al., 2012)	Finland	Boreal		....	Electricity Natural gas	Branches 8 Thinning 20 Stumps 35
(Repo et al., 2012)	Finland	Boreal		....	Electricity Heavy fuel oil	Branches 5 Thinning 12 Stumps 22

Conclusions

1. "Cheap and easy" bioenergy sources are not enough to cover increasing demand;
2. Markets turned to forest biomass for new resources;
3. The assumption of carbon neutrality is not appropriate for forest biomass;
4. Incomplete accounting in policy stimulates even more the use of forest resources by assigning flawed high GHG savings to them;
5. The "flawed" GHG savings will also divert resources from other wood product markets which have higher potential for climate change mitigation
6. JRC strongly recommends to factor these emissions into EU policy
7. The way to do that will be a mix of scientific modeling and political will, but we are still at the beginning of the process.

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