Indirect carbon dioxide emissions from producing bioenergy from forest harvest residues

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AR. 2010

Repo, A. Tuomi, M. & Liski, J. 2010. Indirect carbon dioxide emissions from producing bioenergy from forest harvest residues. Global Change Biology Bioenergy.doi:10.1111/j.1757-1707.2010.01065.x

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Why the interest for bioenergy is increasing worldwide?

Offers solutions to many problems:

- Decreasing fossil fuel resources → renewable energy resource
- Countries dependence on imported energy → local energy
- Climate change → a mean to cut down greenhouse gas emissions into the atmosphere
  - Rationale: Bioenergy is carbon neutral as CO_2 emissions released in the combustion are taken up again by the next plant generation

Bioenergy is carbon neutral – or is it?

- Bioenergy production can cause:

→ e.g. deforestation

→ decrease in carbon stocks

- Indirect emission occur when bioenergy production reduces carbon stock of biomass or soil.

- Changes in carbon stocks should also be included in the emission calculations [palm oil, ethanol]

CLIMATE CHANGE

Fixing a Critical Climate Accounting Error

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Rules for applying the Kyoto Protocol and national cap-and-trade laws contain a major, but fixable, carbon accounting flaw in assessing bioenergy.

The accounting now used for assessing compliance with carbon limits in the Kyoto Protocol and in climate legislation contains a far-reaching but fixable flaw that will severely undermine greenhouse gas reduction goals (*1*). It does not count CO_2 emitted from tailpipes and smokestacks when bioenergy is being used, but it also does not count changes in emissions from land use when biomass for energy is harvested or grown. This accounting erroneously treats all bioenergy as carbon neutral regardless of the source of the biomass, which may cause large differences in net emissions. For example, the clearing of long-established forests to burn wood or to grow energy crops is counted as a 100% reduction in energy emissions despite causing large releases of carbon.

Several recent studies estimate that this error, applied globally, would create strong incentives to clear land as carbon caps tighten. One study (*2*) estimated that a global CO_2 target of 450 ppm under this accounting would cause bioenergy crops to expand to displace virtually all the world's natural forests and savannahs by 2065, releasing up to 37 gigatons (Gt) of CO_2 per year (compa-

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Emissios resulting from changes in carbon stock

What to do with logging residues after logging in a mature (80-100 years) Norways spruce stand?

a) Leave residues at the site

kuva: UPM

b) Remove residues and use them for bioenergy

kuva: John Deere forestry

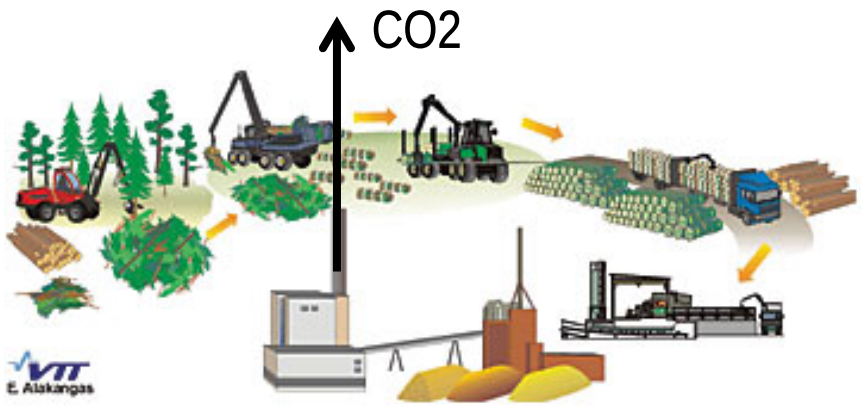
Emissios resulting from changes in carbon stock

a) Leave residues at the site

- Carbon is released little by little into the atmosphere in decomposition
- Logging residues act as a carbon stock
- Fossil fuels can not be replaced

b) Remove residues and use then for bioenergy

- Carbon is released into the atmosphere at once
- Carbon stock of logging residues is lost
- Fossil fuels can be replaced.



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Logging residue decomposition simulations

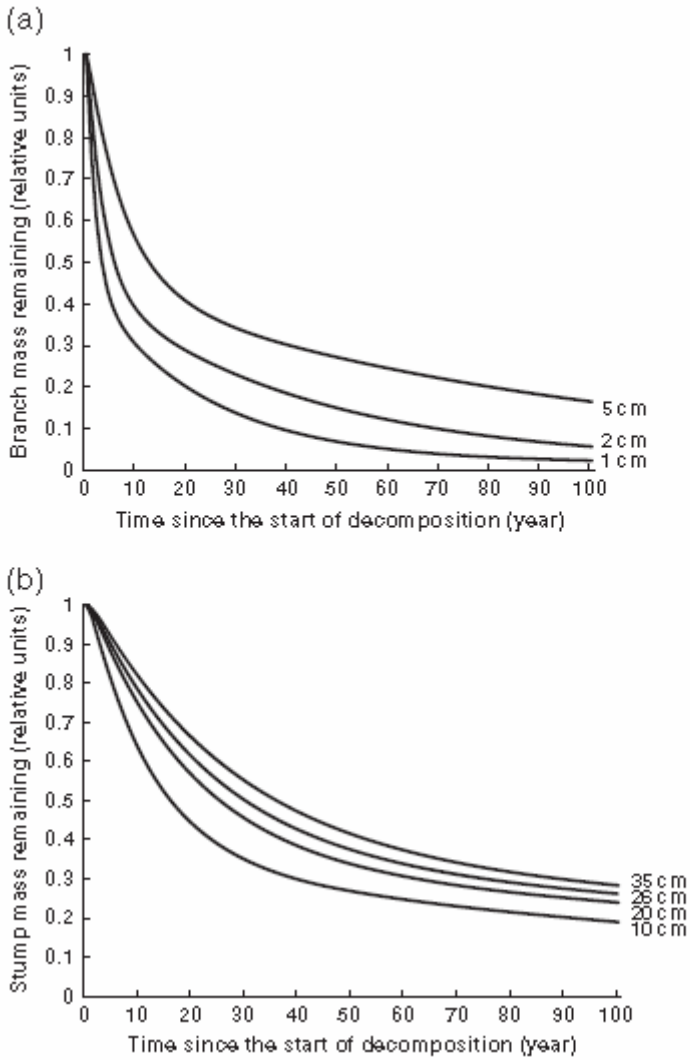
Yasso07 (Tuomi et al. 2009, 2010) is based on a large collection of measurements across the globe:

- litter decomposition measurements (n = 9605)
- measurements on soil carbon stocks and their development (n = 4204)
- woody litter decomposition measurements (n = 2102)

Yasso07 has been shown to give unbiased estimates for the decomposition of woody (Tuomi et al. 2010) and non-woody litter (Tuomi et al. 2009)

How much carbon stored in residues is lost?

- The lost carbon = carbon that would be left in the logging residues if left decompose at the harvest site



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Emissions resulting from changes in carbon stocks?

- The cumulative indirect emissions caused by combusting the harvest residues until year i were calculated by summing up the amounts of carbon left in the harvest residues until this year (i) and relating these emissions to the cumulative amount of bioenergy produced.

Bioenergy from logging residues –total emissions?

A) Emissios resulting from changes in carbon stock

+

B) Emissions from energy production chain

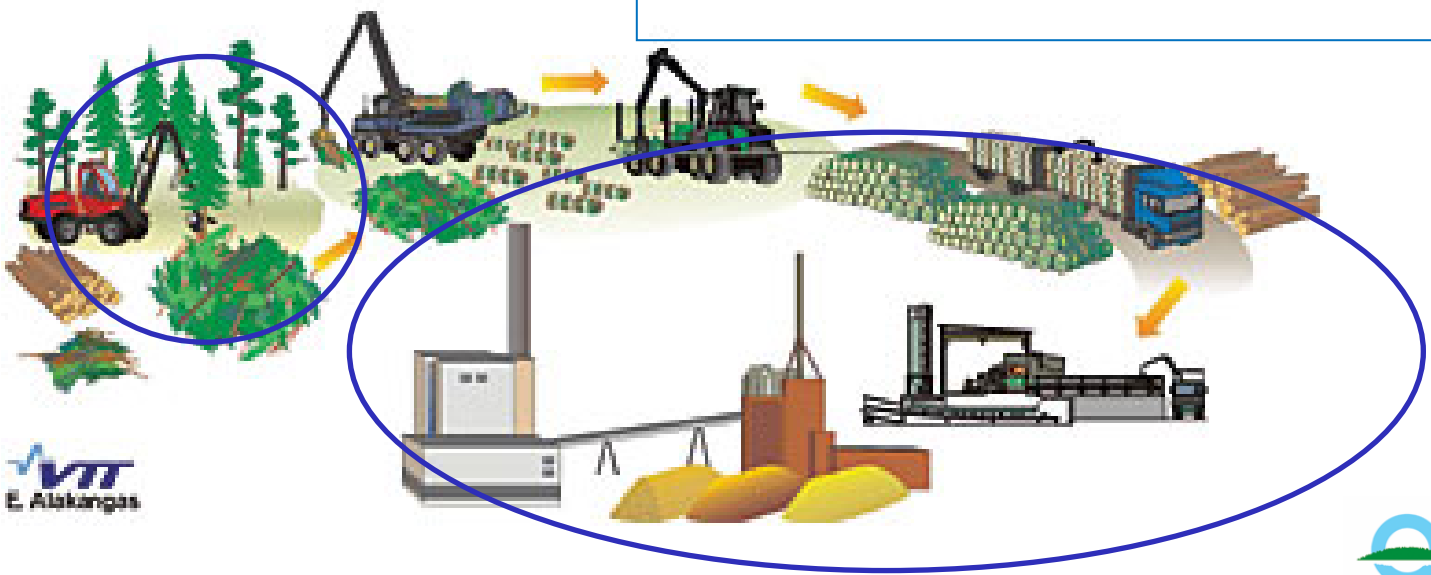
1.collecting, chipping, and transporting the harvest residues,

2.emitting methane (CH4) and nitrous oxide (N2O) from combustion,

3.fertilizing the forest to compensate for nutrient loss,

4.recycling ash

range typically from 5 - 18 kg CO2 eq.MWh^{-1}



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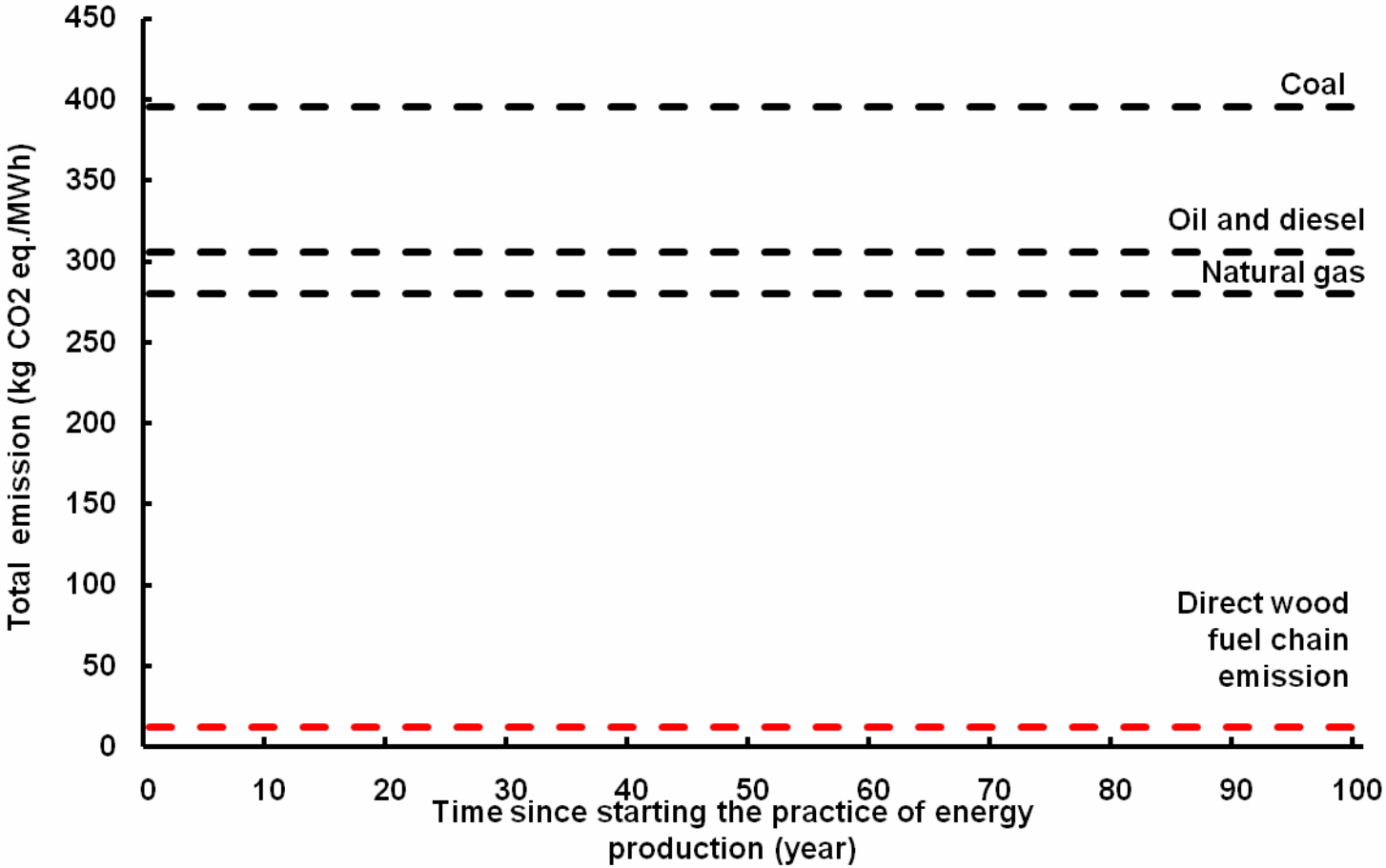
Emissions from energy production chain



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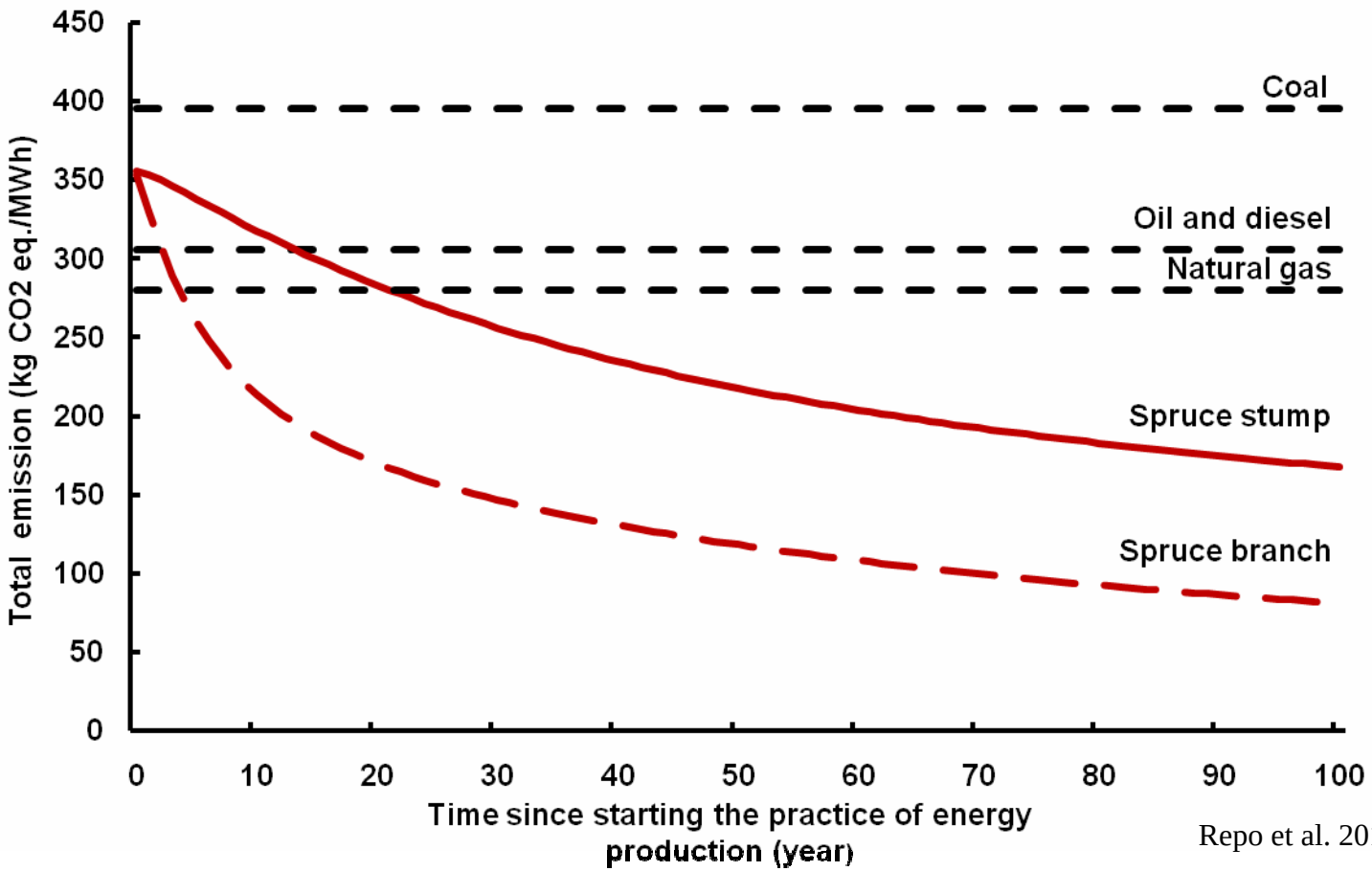
Bioenergy from logging residues –total emissions

A) Emissions from wood fuel production chain + B) from changing carbon stock



Repo et al. 2010

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”Why should we worry about these emissions as the emissions are taken up again by the next plant generation?”

- Comparison: logging residues removed or left at site in addition to ordinary forest management (stems removed)
- If residue removal does not affect growth of the next vegetation generation, the only difference between systems is that less carbon is stored at the logging residue removal site.
- If removal reduces growth, emissions are even bigger.
- Comparisons between energy sources emissions per energy unit produced.

”Why not use logging residues for energy as they decompose releasing CO_2 into the atmosphere anyway?”

- In decomposition CO_2 is released little by little
- In combustion CO_2 is released at once.

→ timining

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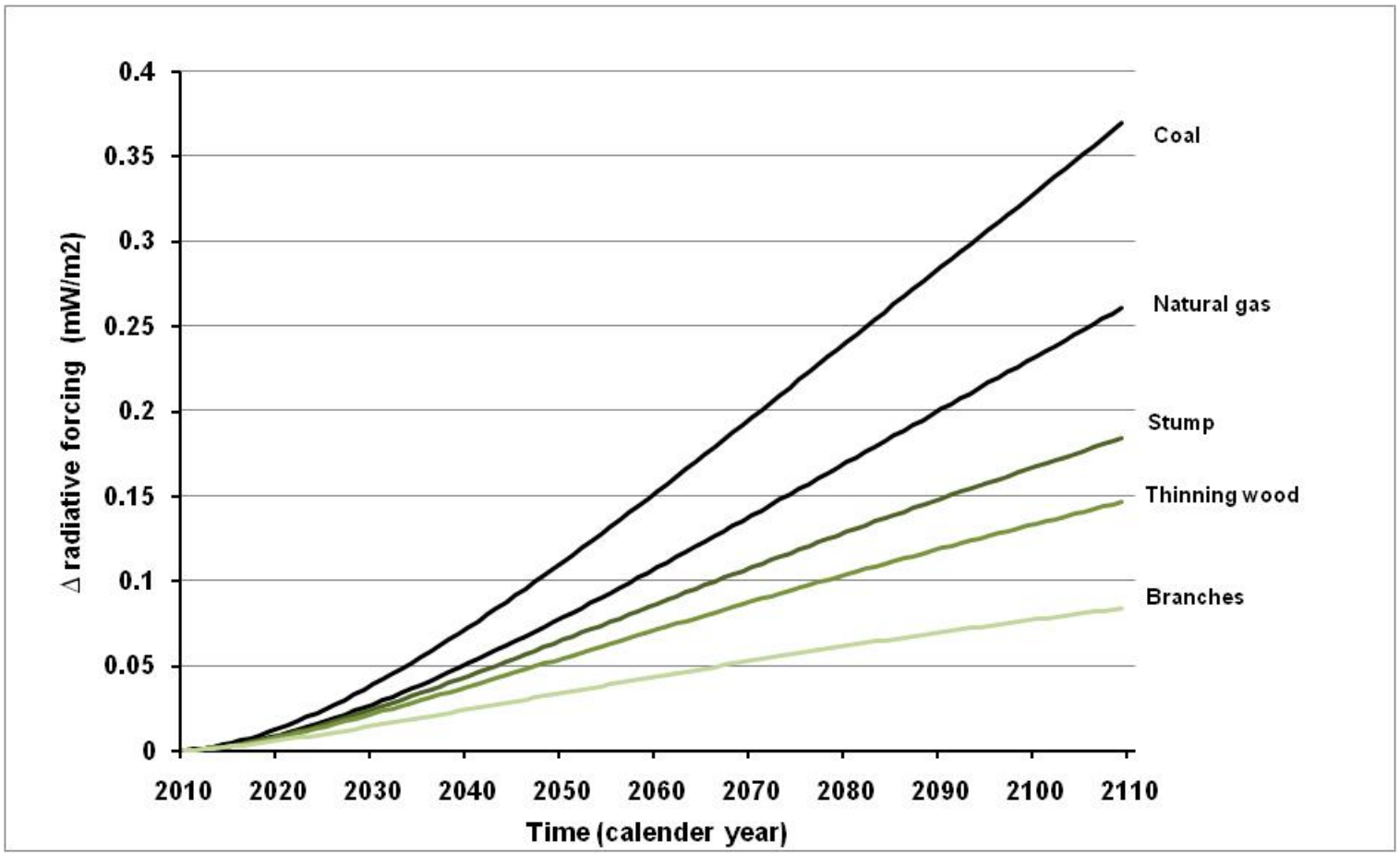
Climate impact of different energy sources



Repo et al. unpublished results

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Conclusions 1/2:

- Logging residue bioenergy causes CO_2 emissios
- A great majority (85-97 %) of these emissions result from a decline in the carbon stock of the harvest residues.
- Emissions per energy content are highest and comparable those of fossil fuels when practice is started (first 4-22 years).
- The logging residue bioenergy emissions decrease over time
- Logging residue with small diameter decomposes faster than one with large diameter.

Conclusions 2/2:

- Emissions can be reduced by allocating residue removal to quickly decomposing harvest residues
  - Energy use of stumps causes 1,5-2 times larger CO_2 emissions than the use of branches
- Logging residue bioenergy is not as effective tool for climate change mitigation as reductions in emissions are in next the years and decades
- Effective climate change mitigation requires emission reductions now.