



# Sustainable Energy and Transport:

## Carbon balances of woody biomass for energy in the Economic Commission for Europe (ECE) region

### UNECE Sustainable Transport Division

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# Research objectives

## 1<sup>st</sup> Objective

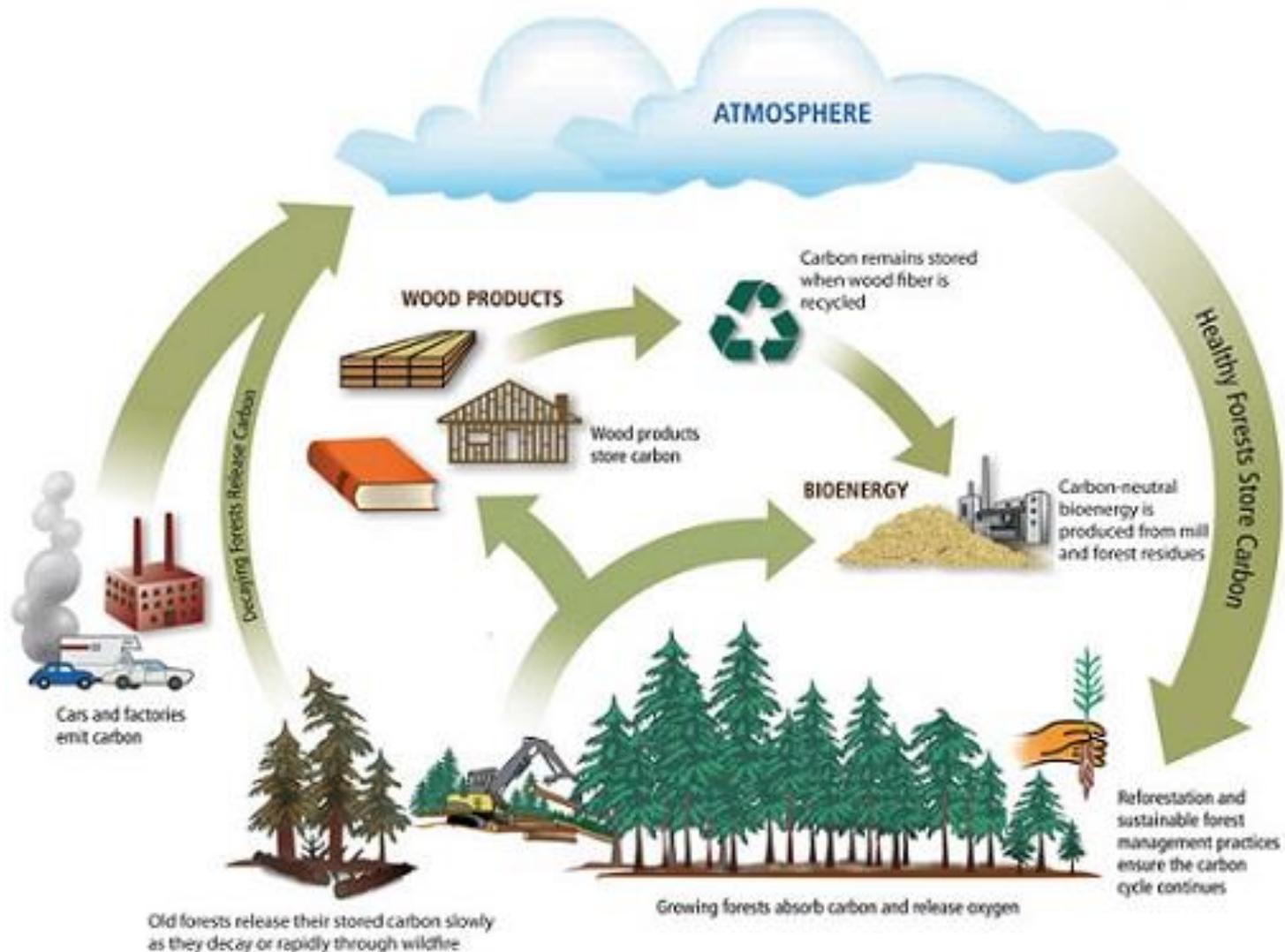
- Examination of frameworks related to carbon accounting in the context of wood energy neutrality
- Determine commonalities and differences - with an empirical application using CO2FIX model

## 2<sup>nd</sup> Objective

- Statistical analysis to determine Relation btw. CO<sub>2</sub> stock and Sustainable Forest Management (SFM)



# Sustainable Forestry Carbon Cycle

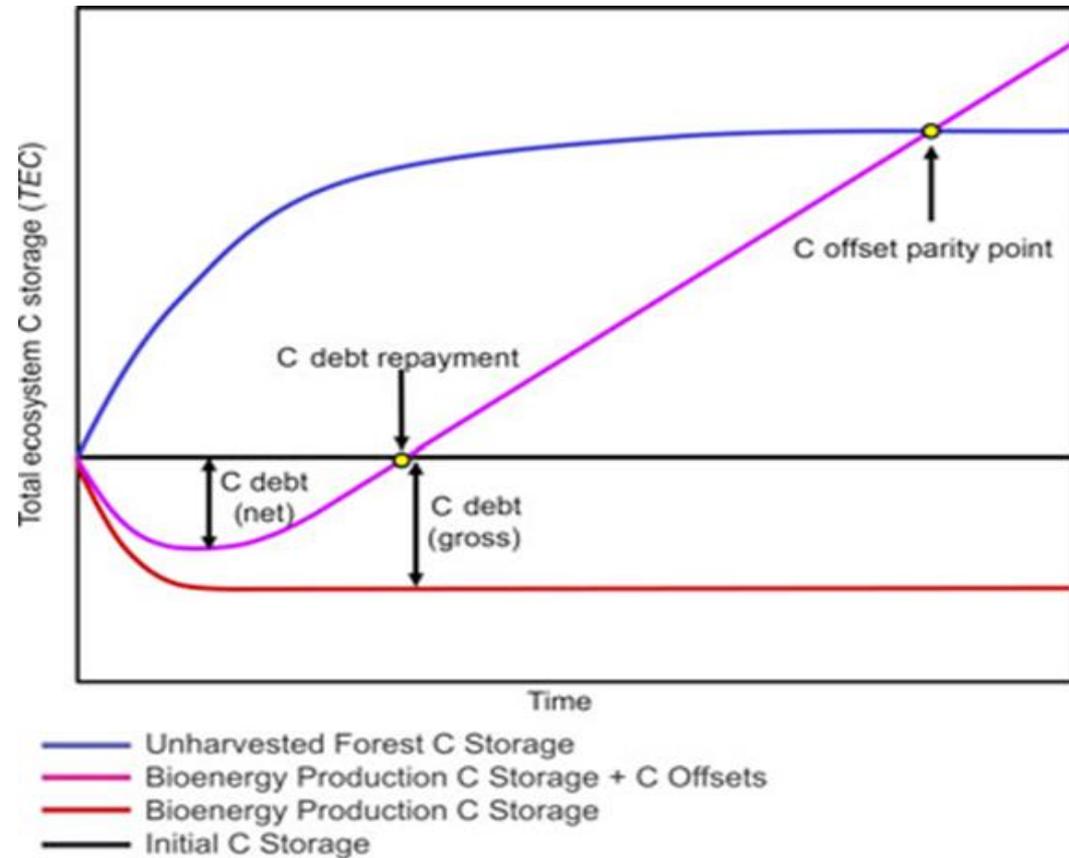


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# Carbon debt vs Sustainable Forest Management

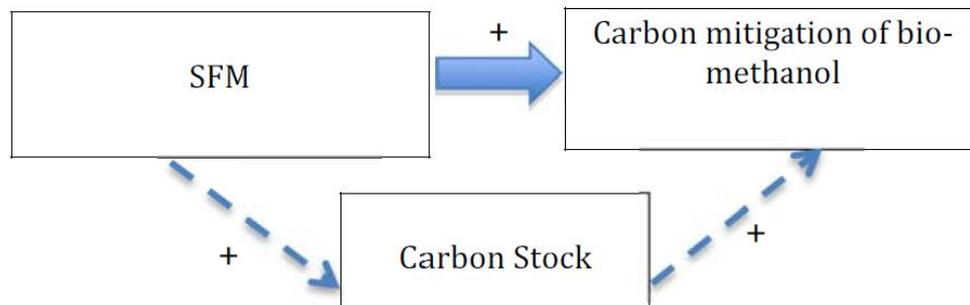
- ❑ Forest fellings diminish CO<sub>2</sub> storage without counterbalancing production of equivalent energy derived from = quantity of carbon emitted by Fossil Fuels (FF).
- ❑ Carbon storage lost through bioenergy production (“carbon debt”) needs a period of time to be recovered : “carbon debt repayment time”.
- ❑ Opponents of the concept of carbon debts assume in the counter-factual scenario that SFM would result in a carbon neutrality state.



# Research hypothesis

Could sustainable forest management to mitigate carbon emitted in the atmosphere by passenger vehicles?

Operational hypothesis and work scheme:



Selected two variables related to:

- (ii) mitigation of vehicle carbon emissions and
- (i) sustainable forest.



# Testing the dependent variable: Relation btw. Bio-methanol and CO2 mitigation when woody biomass is produced through SFM.

Answering to Q: What would have happened to the carbon stock in forests if it had been used to produce methanol for passenger cars, replacing petrol.

- Scenario 1:** two regions of Finland for **boreal forest**.
- Scenario 2:** three regions of Germany for **temperate forest**.
- Rotation length of 50 years for a total of 200 years**
- Established BAU baseline to compare projected CO2 from bio-methanol vs petrol system producing = energy**
- Determine the carbon mitigation by replacing petrol with bio-methanol through CO2FIX V 3.1 model**



# Testing the independent variable SFM:

## Relation btw. SFM and CO2 stock

- ❑ “Independent variable” SFM on the basis of different variables from available databases (FAO, 2015a; UNECE, 2015).
- ❑ Montreal process, which defines the characteristics of SFM through seven main criteria.
- ❑ Each criterion is defined by a number of indicators. For reason of simplicity and data availability, selected some of them for each criterion.
- ❑ With the above indicators, I developed a scale rating for the new SFM variable.
- ❑ Two linear regression models were used: (i) one referred to temperate forest and (ii) the other one referring to boreal



# Results (1): Relation btw SFM and CO2 stock

- ❑ For the temperate forest significant positive relationship between “SFM” and “carbon stock”:
  - The greater the score of the SFM, the bigger in average the percentage of carbon stock in the forest.
- ❑ No significant relationship for Boreal forest. This result is caused by many factors and doesn't mean that this relation does not exist.



# Results (2): Carbon mitigation

❑ **Bio-methanol and technology used in the research leads to 26% of carbon mitigation**

❑ **The result of Temperate forest system (scenario 1) is more efficient:**

➤ **Each ha of forest is replacing at the end of the examined period of 200 years 1,420,770.44 kg/ha of petrol with 2,042,745.10 kg/ha of methanol.**

➤ **Strong relation btw SFM & CO2 stock**

➤ **higher amount of petrol replaced by bio-methanol (compared to boreal)**

**The above demonstrate indirectly the relation between SFM and carbon mitigation of bio-methanol.**



# Conclusions

## Why do studies on carbon balances of woody biomass for energy result in such relevant differences? Because of:

- forest management
- type of forest, biomass quality and type used to produce bioenergy
- time frame
- considerations on land-use change (Johnson, 2009, p.1; Bowyer et al., 2012, p.24),
- type of alternative technologies,
- data quality sources used in models to calculate carbon storage and CN,
- distribution method, system boundaries
- BAU referencing system (fuel and technologies to be substituted) and other assumptions, such as indirect land-use change effects (ILUC), soil quality emission and storage, forest products, discounting factors etc.)

**Note: The conclusions of this study cannot be extended to other types of forests! E.g Rain Forests**



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