Implementation of the Kyoto Protocol: what does it mean for bioenergy and C sequestration?

JOANNEUM RESEARCH

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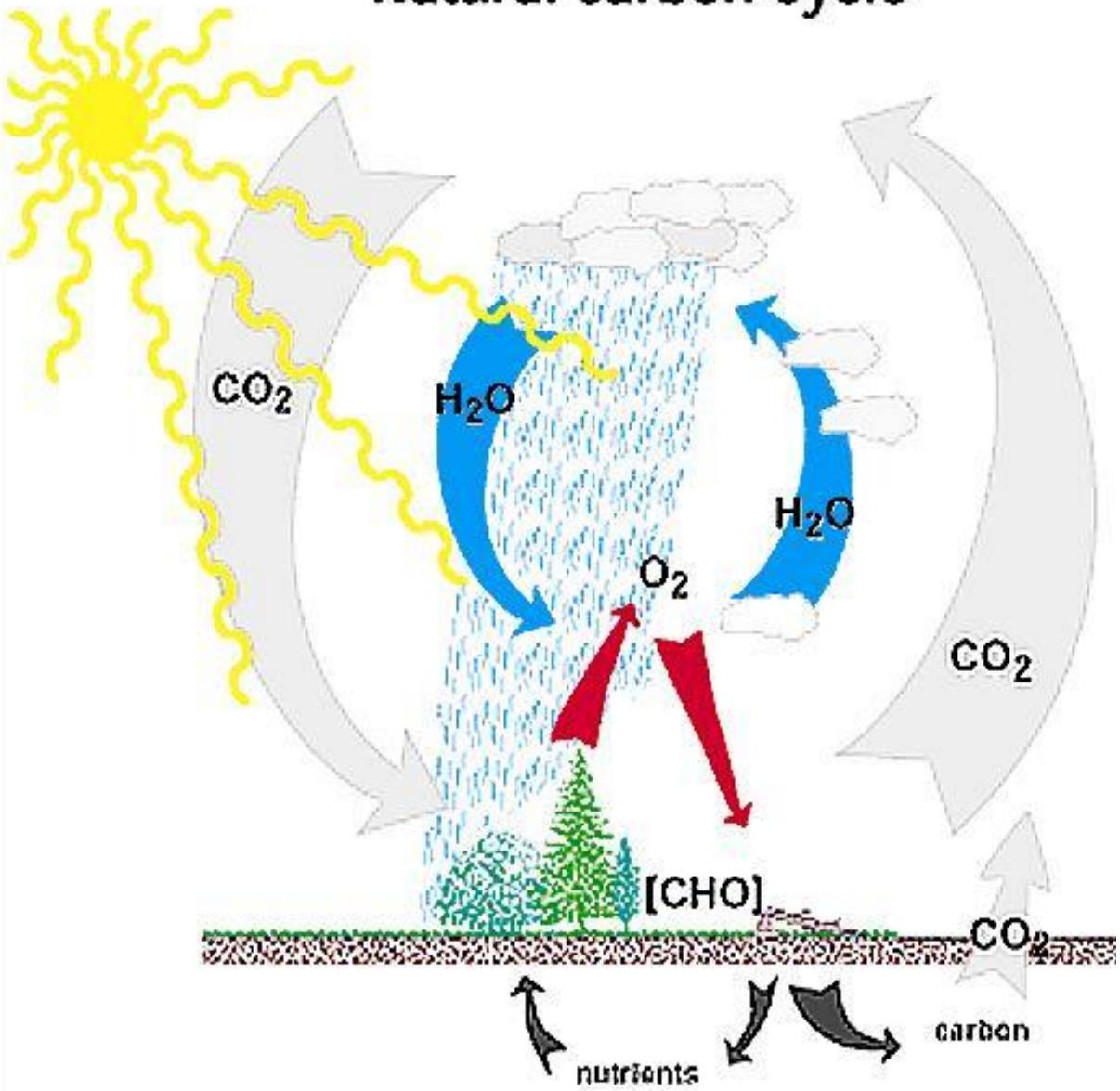
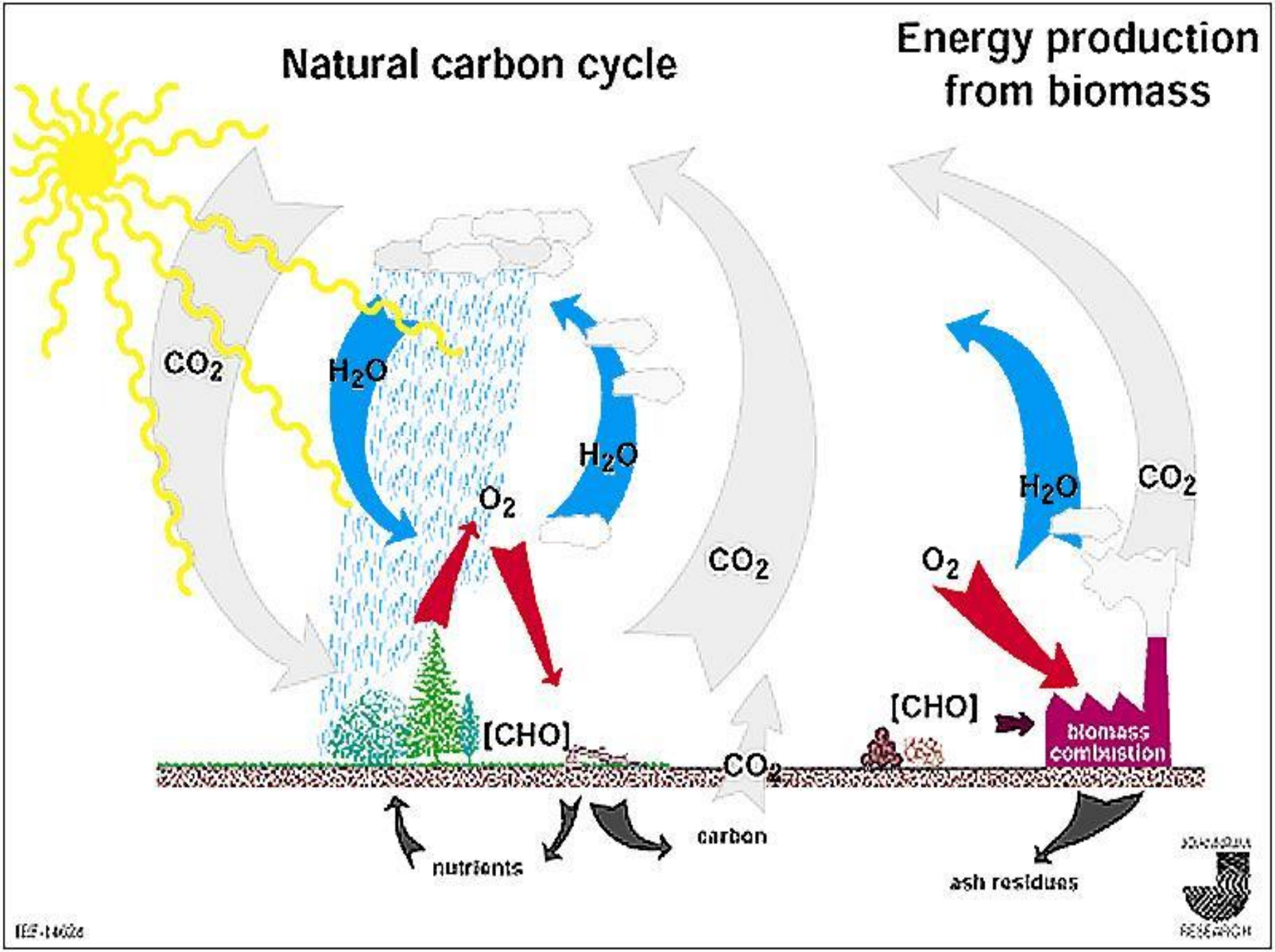
Managing the biosphere

- Avoid emissions from terrestrial biosphere (conservation management)
- Sequester additional carbon in the biosphere and in products (sequestration management)
- Substitute renewable biofuels and wood products for fossil fuels and fossil-fuel based products (substitution management)

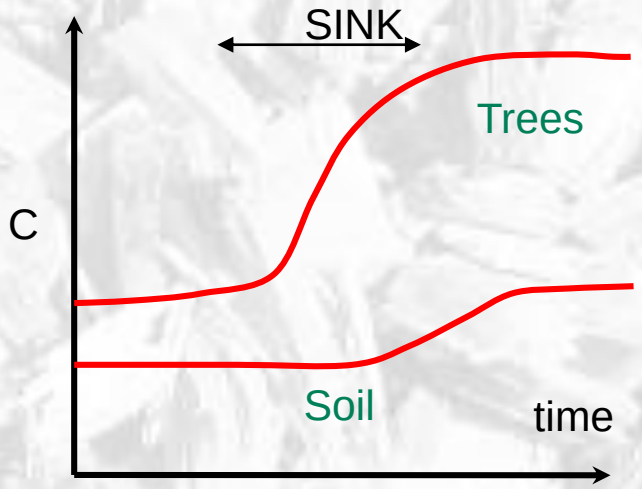
Natural carbon cycle




Natural carbon cycle
Energy production from biomass
CO_2
H_2O
H_2O
O_2
CO_2
H_2O
CO_2
O_2
[CHO]
[CHO]
biomass combustion
CO_2
carbon
nutrients
ash residues

Carbon sinks vs. emission reductions

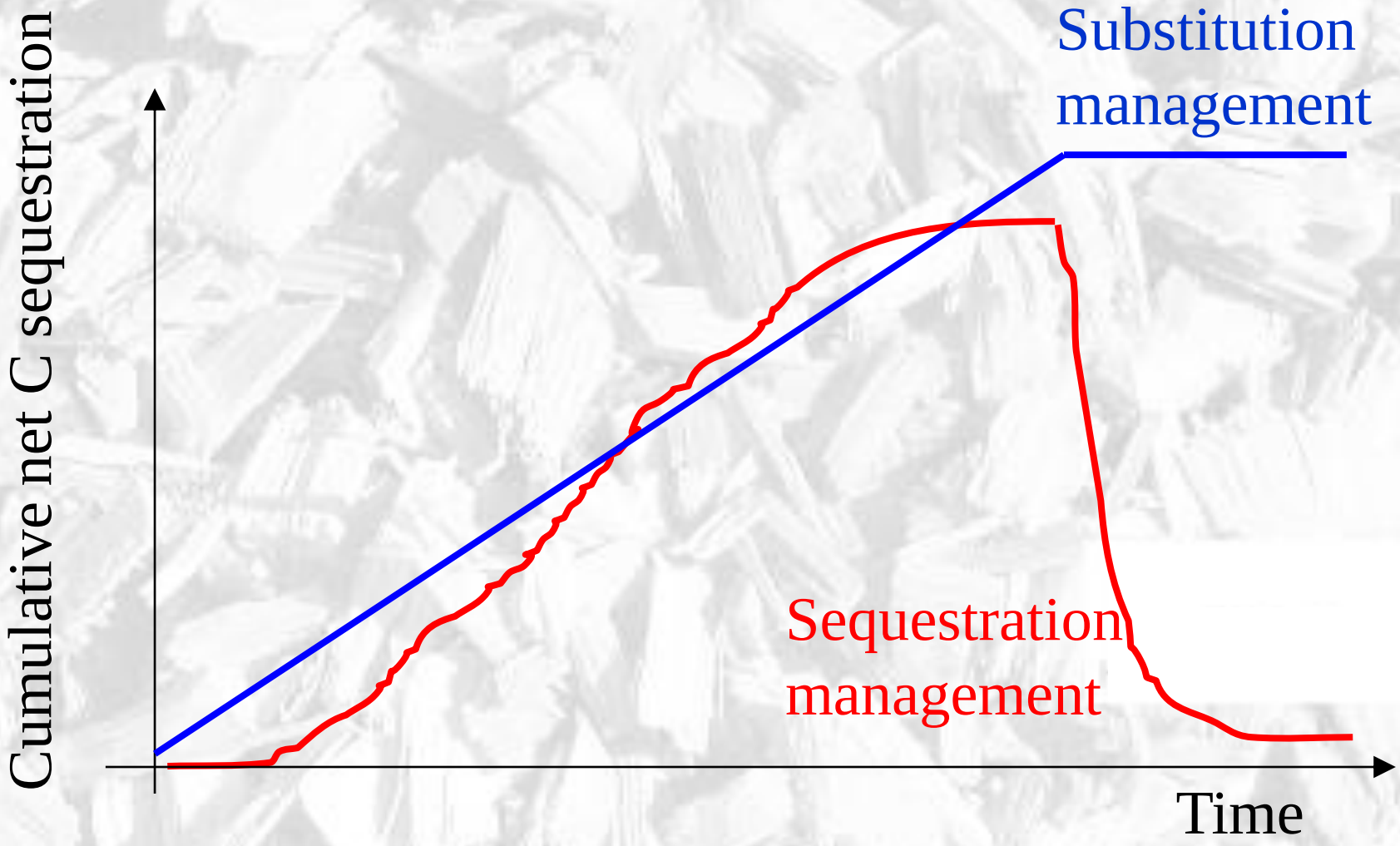
- **Saturation**
  - Amount of land available
  - Amount of C per unit land



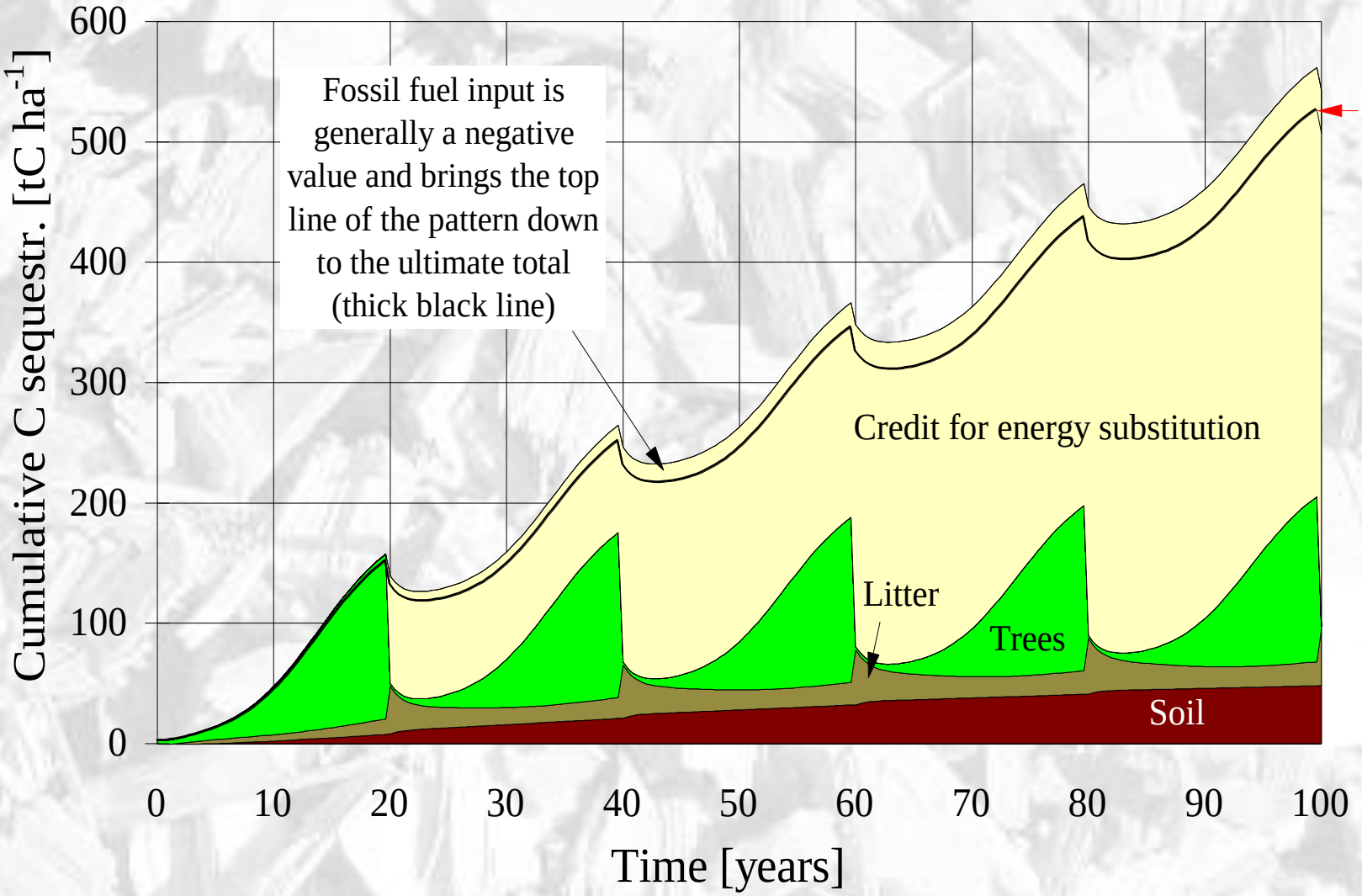
  - 12-15% of global fossil-fuel emissions in next 50 years

- **Permanence**

Permanence


Substitution management
Sequestration management
Cumulative net C sequestration
Time

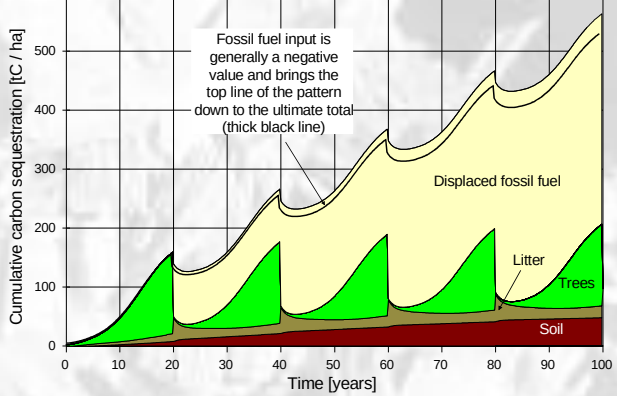
Model results: fuelwood plantation on agricultural land

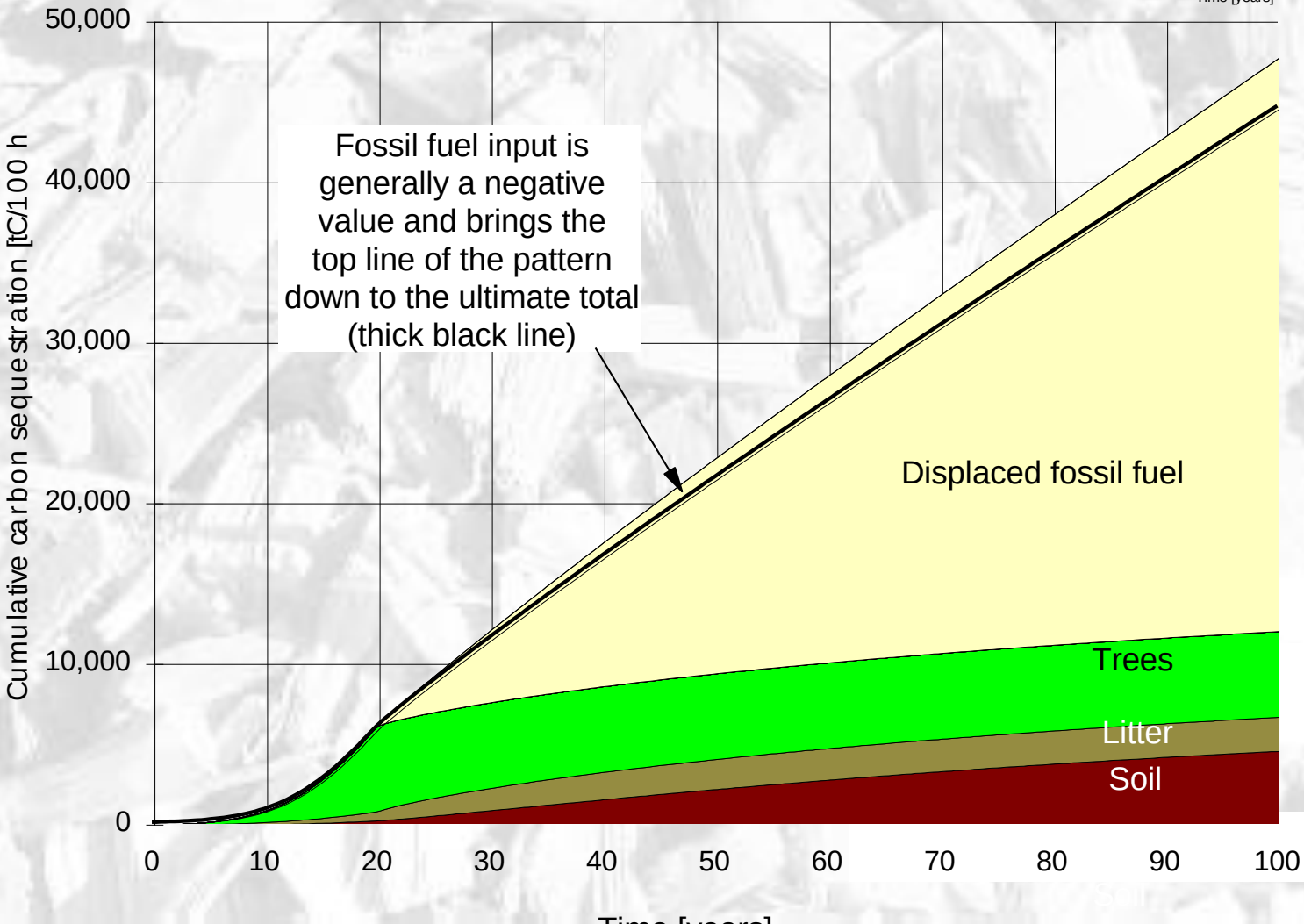


Fossil-fuel substitution

$$\text{Displacement factor} = \frac{\text{efficiency of the bioenergy system}}{\text{efficiency of the fossil energy system}} \times \frac{\text{carbon emission rate of the fossil fuel}}{\text{carbon emission rate of the biofuel}}$$

To be optimized when biomass / land are limited


Cumulative carbon sequestration [tC / ha]
0
100
200
300
400
500
Fossil fuel input is generally a negative value and brings the top line of the pattern down to the ultimate total (thick black line)
Displaced fossil fuel
Litter
Trees
Soil
0
10
20
30
40
50
60
70
80
90
100
Time [years]


Cumulative carbon sequestration [tC/100 h
0
10,000
20,000
30,000
40,000
50,000
Fossil fuel input is generally a negative value and brings the top line of the pattern down to the ultimate total (thick black line)
Displaced fossil fuel
Trees
Litter
Soil
0
10
20
30
40
50
60
70
80
90
100
Time [years]

Categories of national inventories (Annex A of the Kyoto Protocol)

- Energy
- Waste
- Industrial Processes
- Agriculture

(Land-use change and Forestry: terrestrial carbon)

C sinks in the Kyoto Protocol

- A(fforestation), R(eforestation), D(eforestation)
- Forest management
- Cropland management, grazing land management
- Revegetation
- AR in the Clean Develoment Mechanism

Bioenergy / Kyoto Protocol

- Considered for meeting national emission limitation targets
- Synergies with afforestation and reforestation
- Trade-offs when full carbon accounting is used (e.g., all of forest management)
- Applicable in Joint Implementation and CDM projects
- Bioenergy is key in many countries for meeting Kyoto targets

“National” rules can be different

- **Policies and Measures**
  - Renewable electricity targets
  - Biofuels directive
  - Taxes, subsidies, efficiency codes …
  - R&D
- **Cap and trade**
  - Bioenergy can be used by participants
  - C sinks more likely as an external “offset” (but can be restricted)
  - Bioenergy projects within country: avoid double counting (eg., “linking directive”)

Bioenergy and “sinks” in the CDM

- **Afforestation and reforestation are “in”**
- **Partially included:**
  - Biomass energy projects
- **Many developing countries do not have**
  - Big opportunities for fossil-fuel reductions
- **Most do have either:**
  - High LULUCF emissions
  - Big LULUCF opportunities
  - Large share of biomass in primary energy

Bioenergy use: 50 EJ/a of 406 EJ/a total energy consumption (1997)

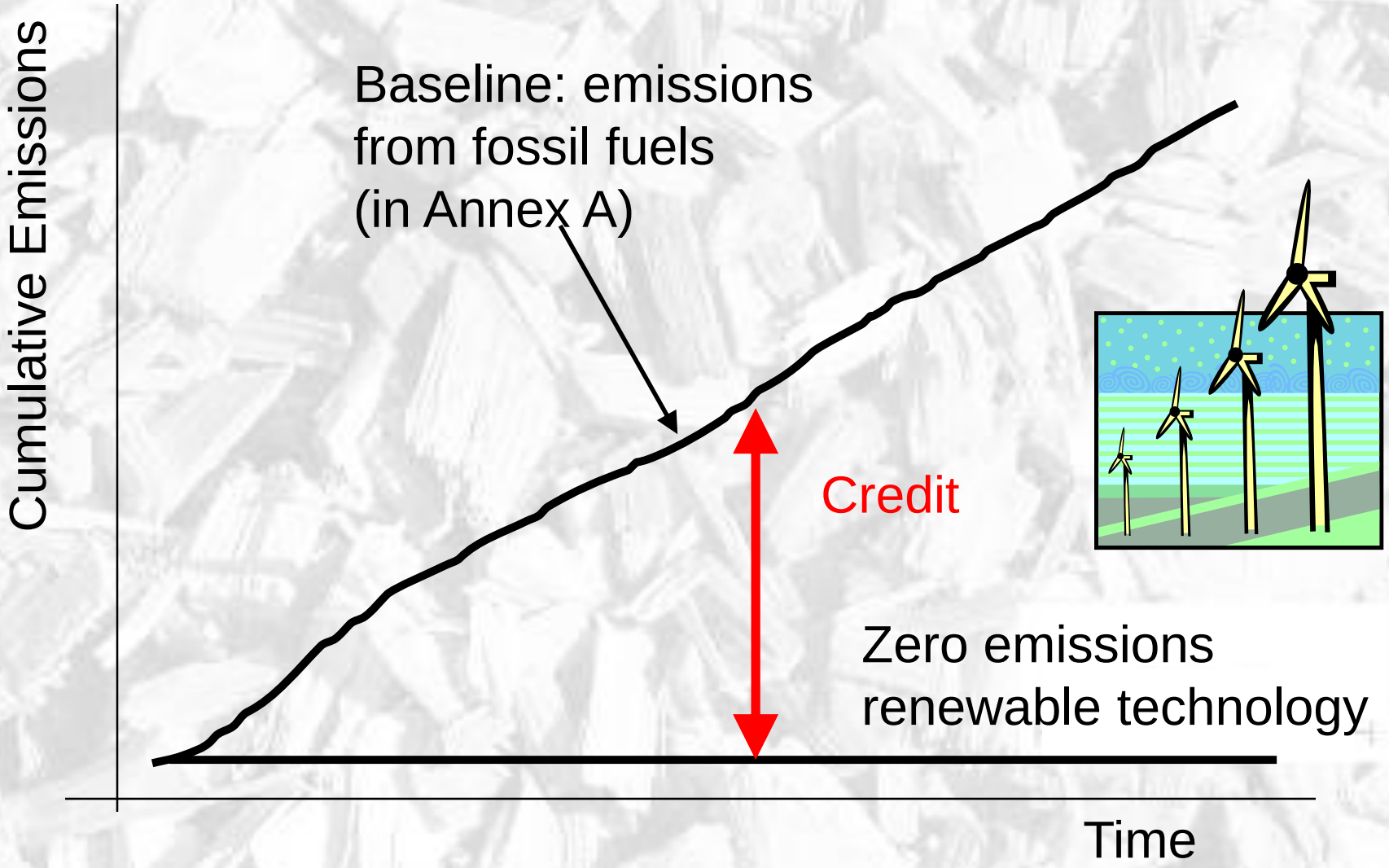
- Use of biomass fuels in 13 countries of different economic, climatic, and demographic conditions

Country	Total energy consump. [PJ]	Bio-energy consump. [PJ]	Share of bio-energy [%]	Popu-lation density [cap/km^2]	Total energy per cap. [GJ/cap]	Bioenergy per capita [GJ/cap]
Austria	1,053	100	9.5	94.3	137	13.0
Germany	15,012	84	0.6	230.8	189	1.1
Japan	17,390	6	0.0	331.9	141	0.0
Poland	3,595	40	1.1	126.5	94	1.0
Sweden	1,971	230	11.7	21.1	230	26.8
USA	84,321	3,482	4.1	28.1	337	13.9
Brazil	5,155	1,604	31.1	18.5	35	10.8
China	36,632	9,287	25.4	129.2	32	8.1
Egypt	1,502	380	25.3	56.3	29	7.2
India	16,554	8,543	51.6	301.6	20	10.1
Malaysia	1,488	663	44.6	58.6	83	37.1
Tanzania	954	925	97.0	32.5	37	35.6
Zaire	435	362	83.2	18.2	12	9.7

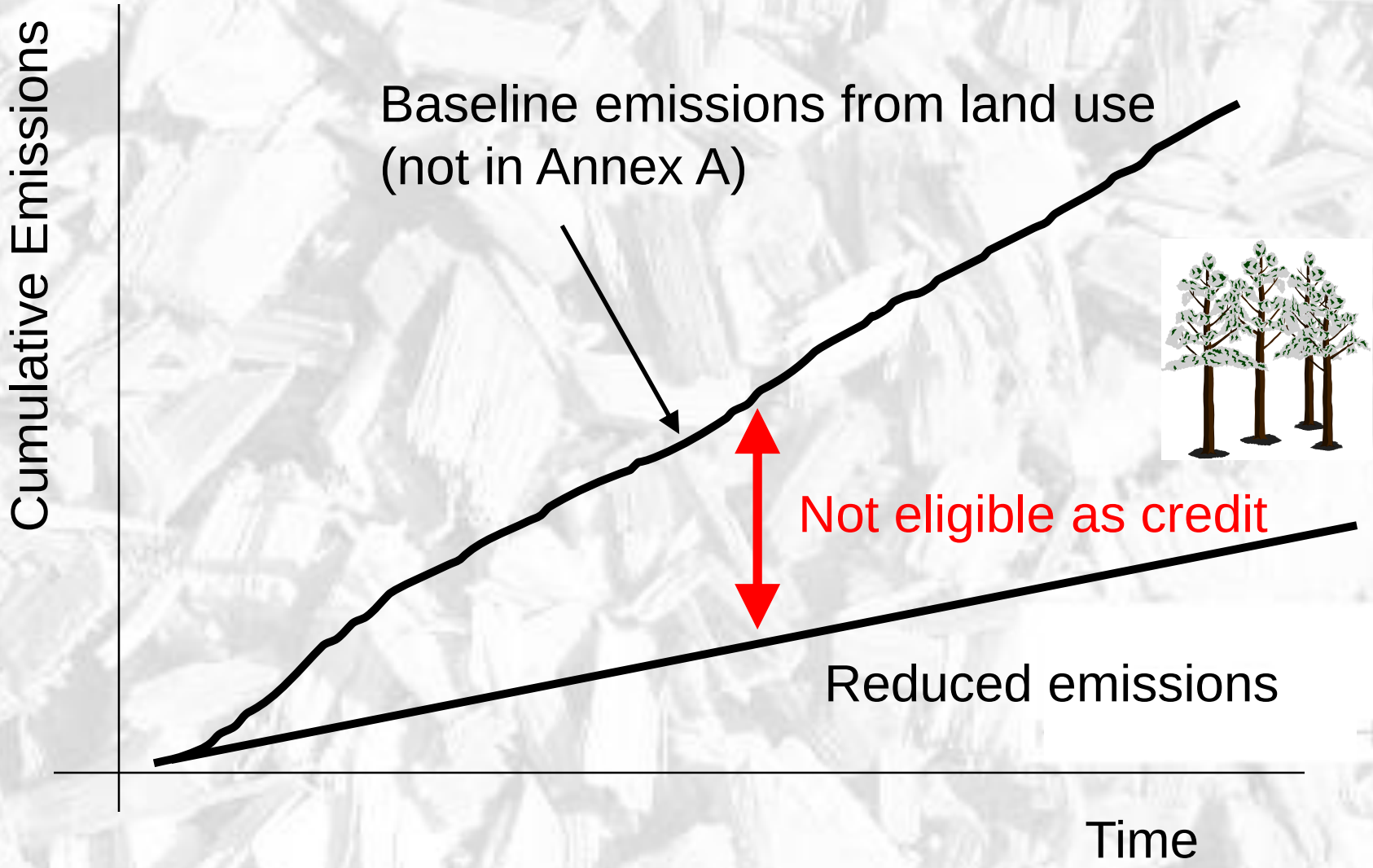
Bioenergy in the CDM

The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. **A baseline shall cover emissions from all gases, sectors and source categories listed in Annex A (of the KP) within the project boundary.**

Renewable energy in the CDM



More efficient biomass energy



Research needs bioenergy / CDM

- Demonstrate how increased efficiency of biomass use in developing countries can reduce GHG emissions with limited
  - **Leakage**
  - **Non-permanence**
- …and providing
  - **Technology transfer**
  - **Sustainable development**
- Providing options for inclusion of efficiency enhancements in bioenergy in the CDM

For example …

- requiring a minimum amount of useful energy

  for each ton of carbon credited in land use systems

would

- provide incentive for efficiency enhancements
- restrict the use of pure “sinks” projects
- address deforestation, a significant source of emissions

Some key findings

- C sinks and bioenergy can support each other
- Bioenergy can reduce fossil fuel consumption continuously, avoiding problems of saturation and non-permanence
- Policies for carbon sinks should be designed carefully not to compromise bioenergy use
- Bioenergy in developing countries needs to be rethought in the context of the CDM.