

# Biochar/Bioenergy Systems and Carbon Markets

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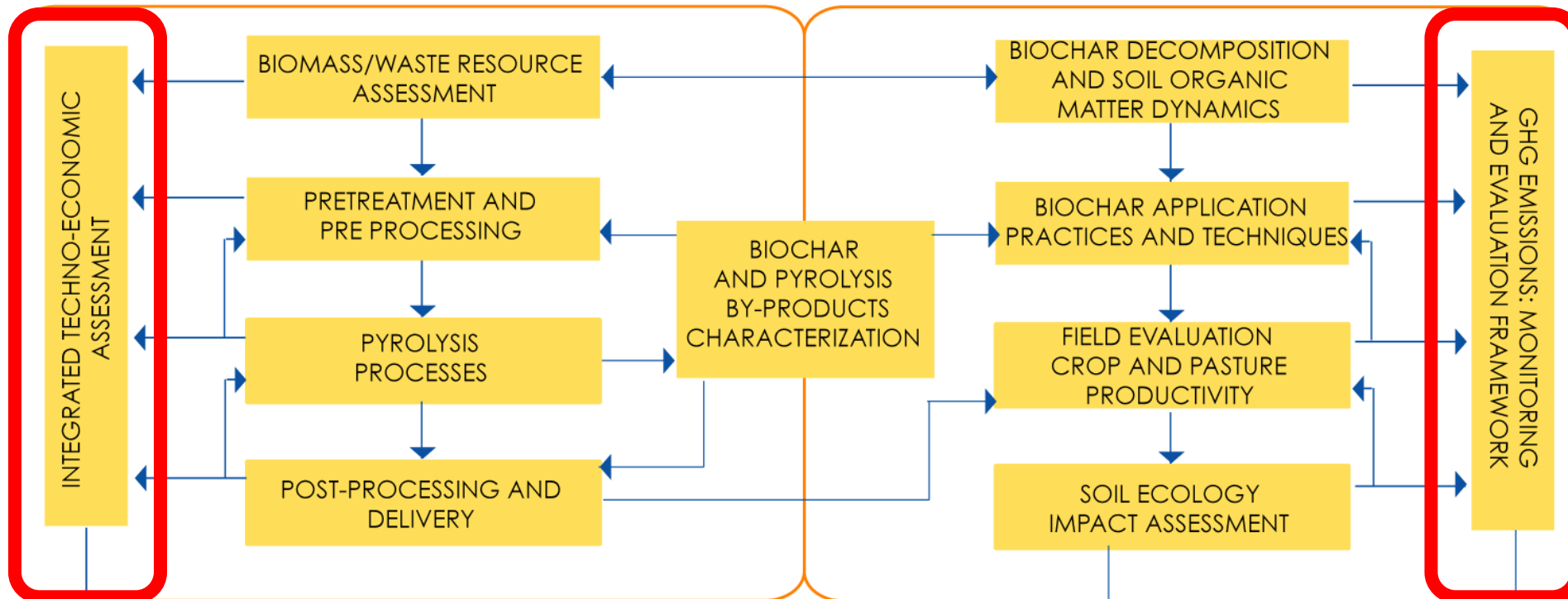
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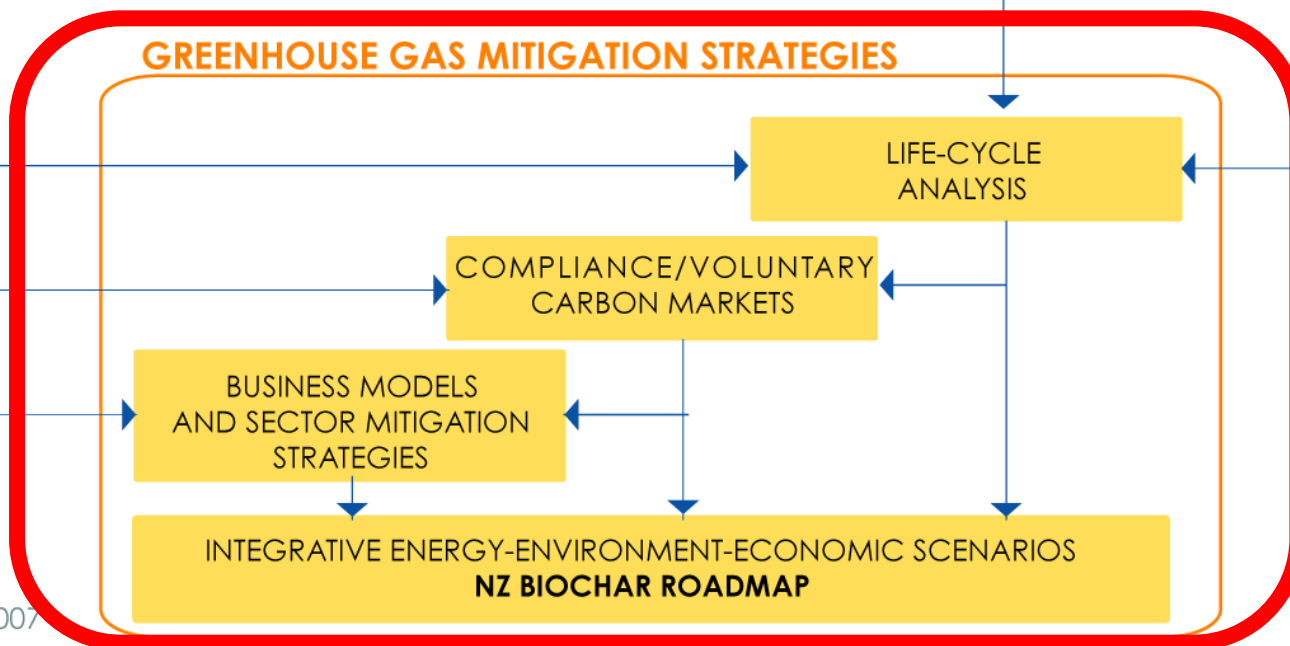
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**PYROLYSIS PLANT ENGINEERING**

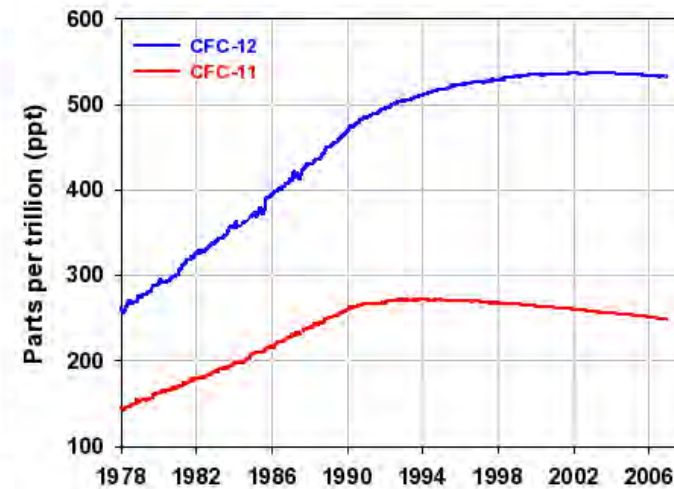
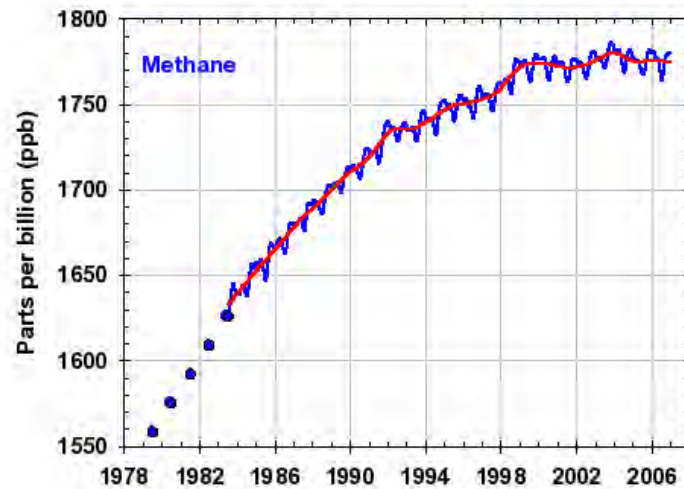
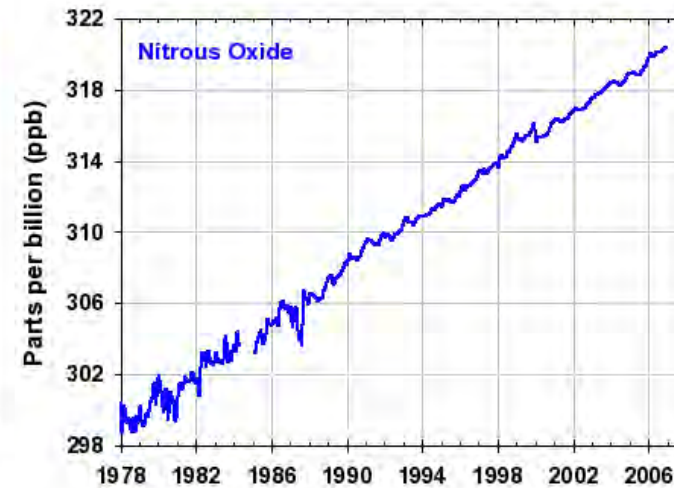
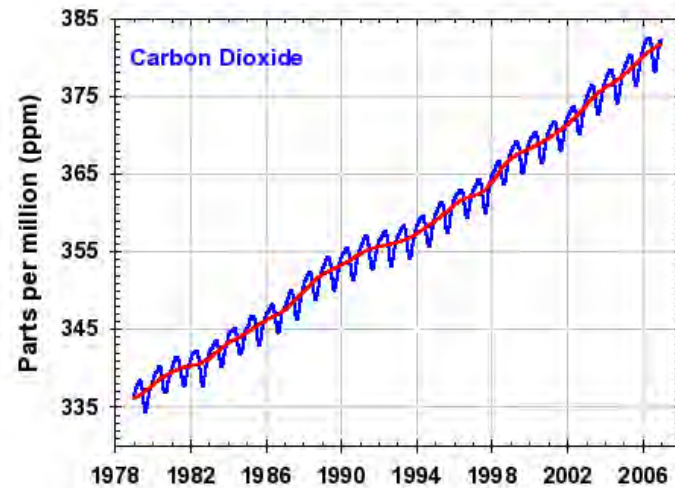
**SOIL SCIENCE**



**GREENHOUSE GAS MITIGATION STRATEGIES**



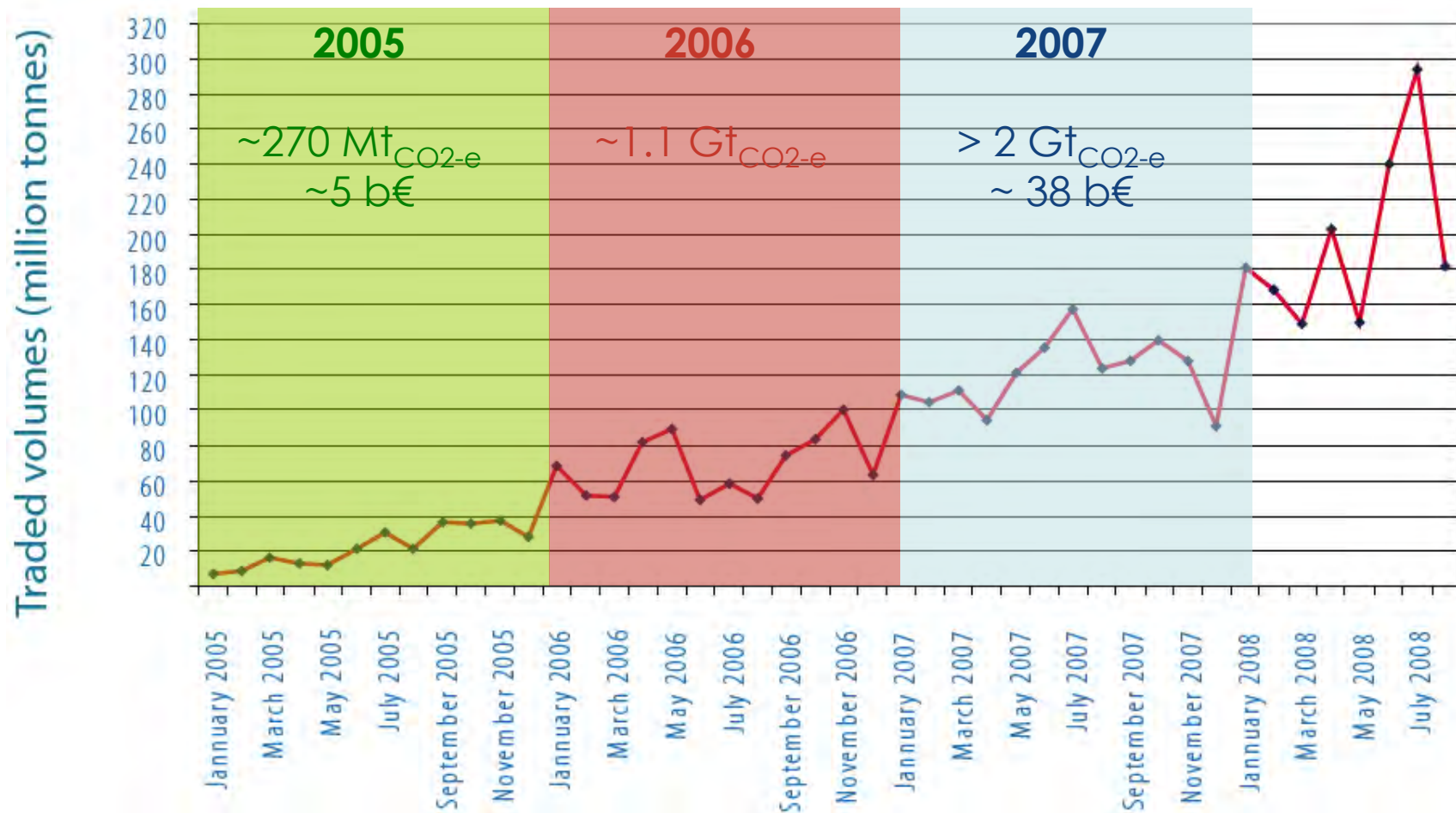
# Anthropogenic influence



# Carbon markets

- Compliance (Kyoto): 3 co-operative mechanisms
  - International Emission Trading
    - platform for trading assigned amount units and project-based emission allowances
  - Clean Development Mechanism and Joint Implementation
    - Project-based mechanisms for the creation of additional emission allowances
- Voluntary:
  - CCX
  - VCS
  - over the counter transactions
  - ...

# Carbon markets growing strong: EU-ETS

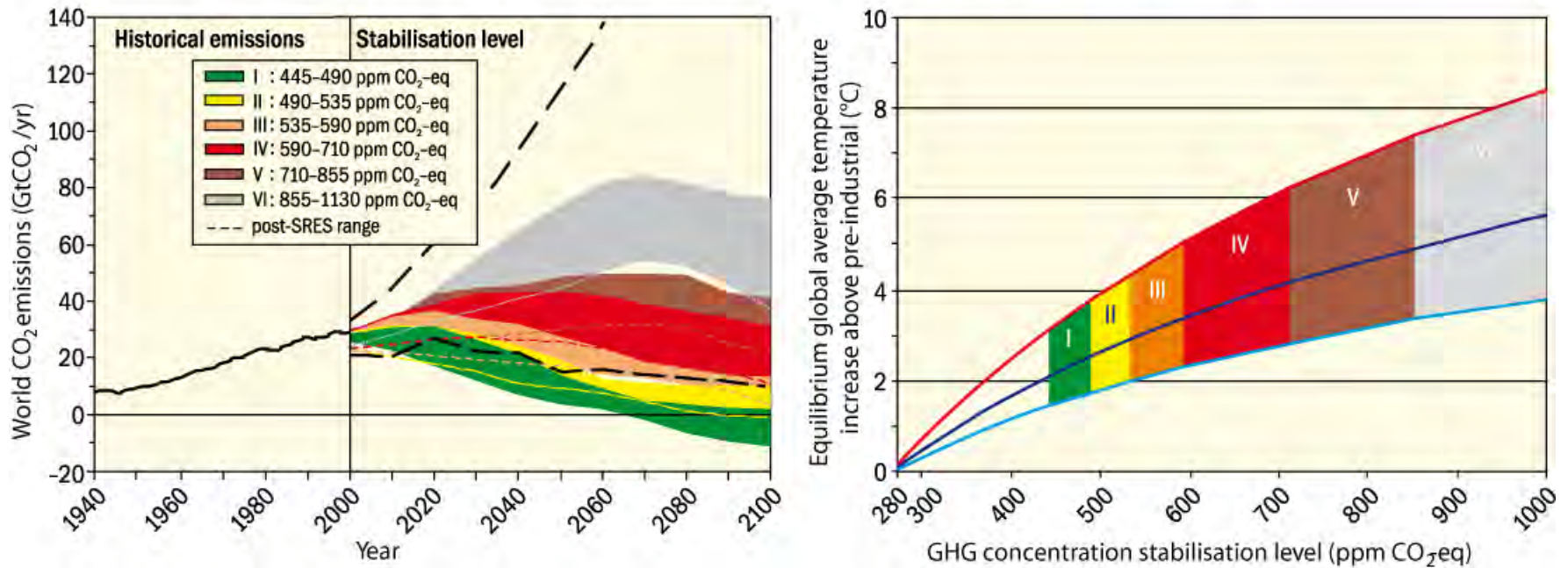


SOURCE: (EC 2008)



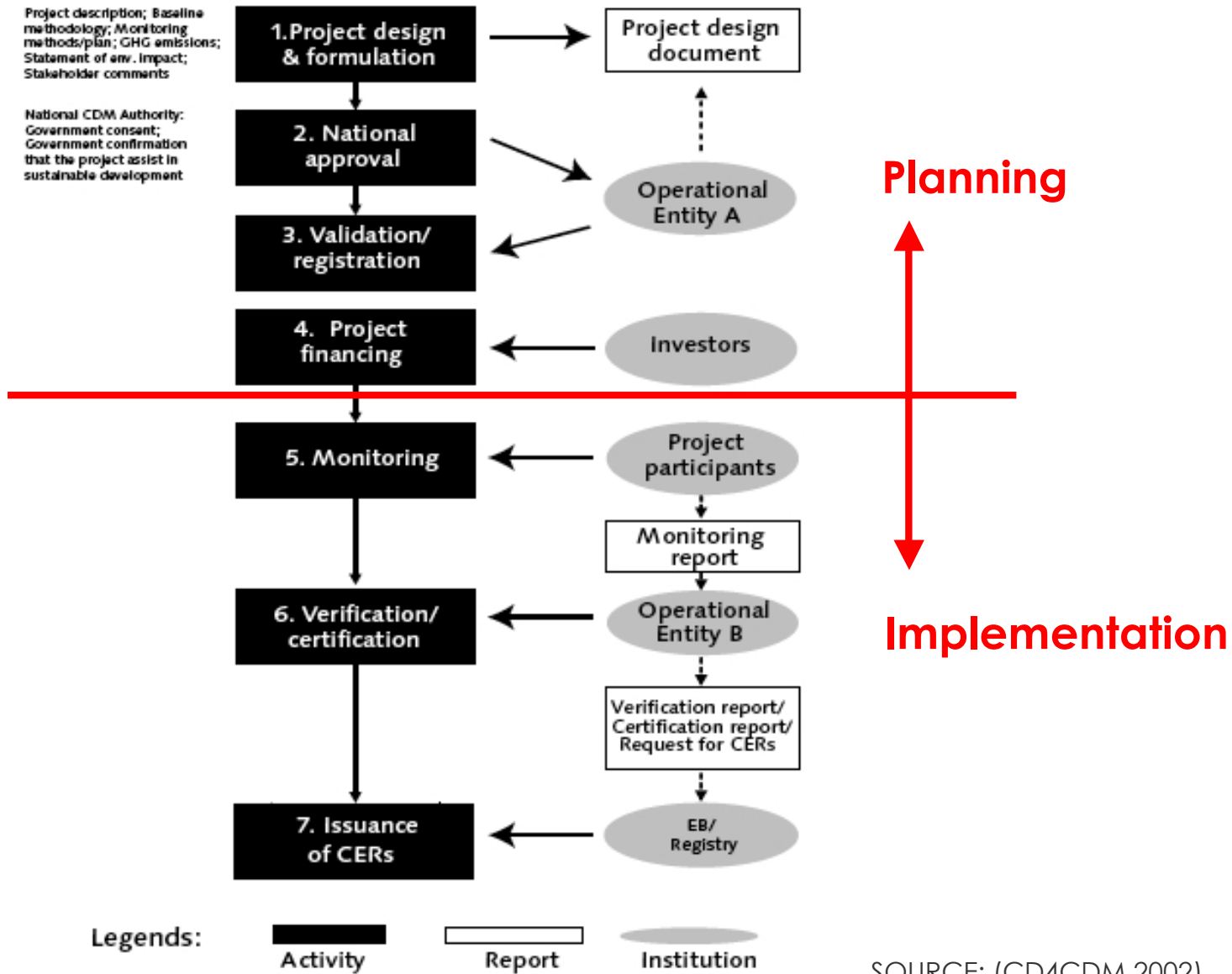
# Stabilization scenarios

CO<sub>2</sub> emissions and equilibrium temperature increases for a range of stabilisation levels



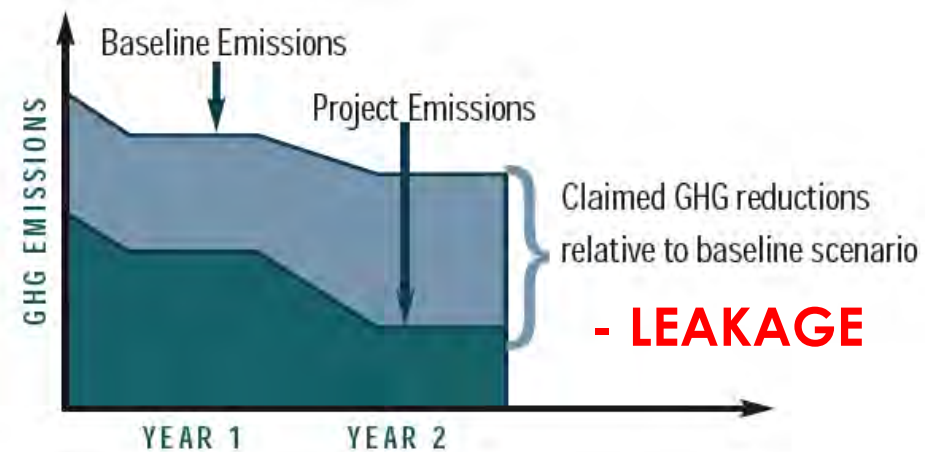
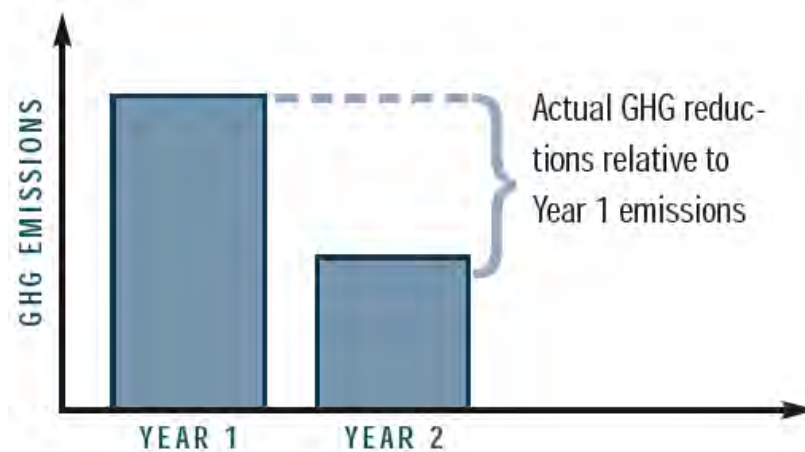
SOURCE: (IPCC 2007a)

# Project cycle for the CDM



# GHG reduction relative to baseline

- Base Year (corporate and national-level GHG accounting)
  - reduction quantified against actual GHG emissions in a historical base year
- **Baseline Scenario (project-level GHG accounting)**
  - reduction quantified against a forward-looking, baseline scenario



SOURCE: (WRI/WBCSD 2005)



# CDM Eligibility Criteria

(from Kyoto Protocol, Art. 12, par.5)

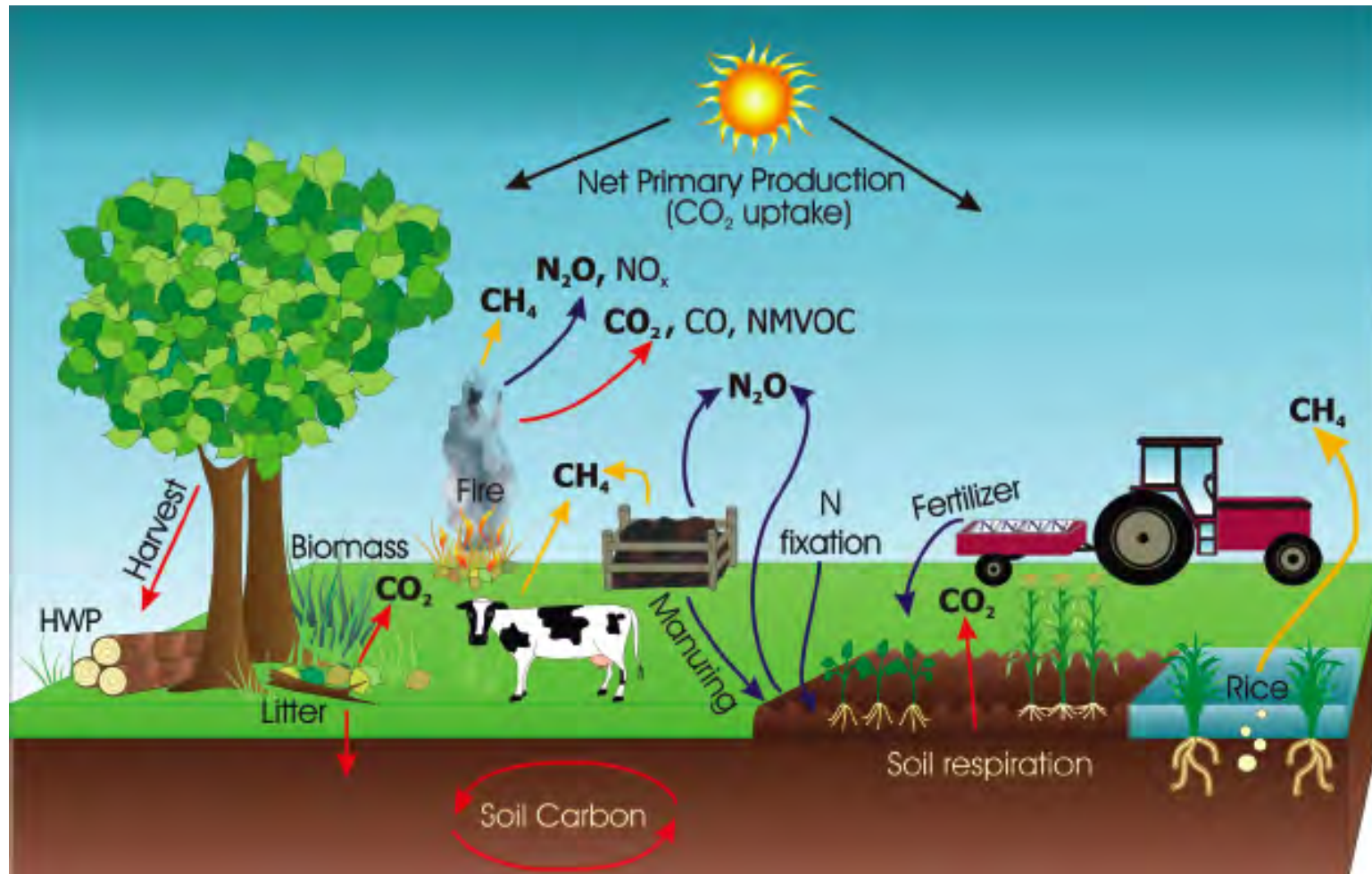
1. the participation of country governments of respective partners of the CDM is voluntary
2. projects result in real, measurable, and long-term benefits related to mitigation of climate change
3. **Additionality criterion:** reductions in GHG emissions from the CDM project should be additional to any that would occur in the absence of the CDM

**NO PROJECT (INCLUDING BIOCHAR/BIOENERGY) IS  
A-PRIORI EXCLUDED FROM THE CDM**

# Additionality and the CDM

- **Additionality Criterion**
  - emission reductions should be greater than, or additional, to the GHG reductions that can be expected to occur in any case
- The focus is on achieving GHG mitigation benefits that are (criterion 2)
  - real,
  - verifiable, and
  - long-term
- **Example: Wind Power**
  - Countries where wind is an established generation technology
    - emission reductions are not additional (e.g. wind power is already considered as an economically attractive option), and therefore not eligible for CDM
  - Wind-power projects developed in low wind areas
    - emission reductions might be considered additional provided that the influence of the CDM in stimulating the investment required is demonstrated

# Managed Ecosystems



SOURCE: (IPCC 2006)

# Kyoto Protocol: LULUCF activities

- Art. 3, par. 3
  - direct, human-induced, afforestation and reforestation activities
  - accounting mandatory under the KP
- Art. 3 par. 4
  - forest land management, cropland management, grazing land management and/or revegetation
  - accounting elective under the KP

**Australia and New Zealand elected not to include 3.4 activities in their KP accounts**

# GHG mitigation through biochar

- ✓ avoided emissions of methane from the decay of biomass
- ✓ offset of emissions associated with the generation; transmission and end-use of electricity, gas and other fuels;
- sequestration of biogenic carbon in the biochar and its storage in soils;
- ✓ reduced emission from fertilizer production, transport and end-use;
- ? reduced emissions of nitrous oxide ( $N_2O$ ) from nitrification/denitrification processes in soils



# Sources, Sinks and Reservoirs

- **greenhouse gas source:** a physical unit or process that releases a greenhouse gas (or a combination of GHGs) into the atmosphere
- **greenhouse gas sink:** physical unit or process that removes a greenhouse gas (or a combination of GHGs) into the atmosphere
- **greenhouse gas reservoir:** physical unit or component of the biosphere, geosphere or hydrosphere with the capability to store or accumulate a GHG removed by the atmosphere by a GHG sink or a GHG captured from a GHG source.

# What is Biochar-C Sequestration?

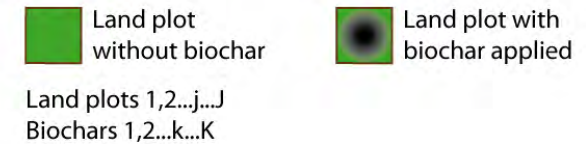
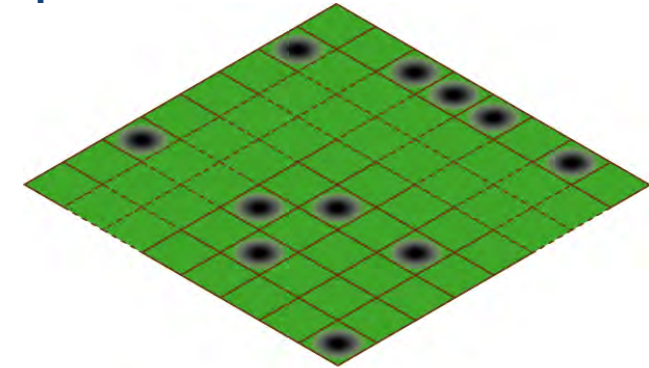
- Afforestation/Reforestation
  - establishment of carbon sinks (forests)
    - capitalize on direct (one-step) removals of CO<sub>2</sub> from the atmosphere
- Carbon Capture and Storage
  - establishment of artificial carbon sinks (capture process) and reservoirs (storage system)
    - capitalize on avoided emission of non-biogenic CO<sub>2</sub> in the atmosphere
- Biochar-C Sequestration
  - establishment of carbon reservoirs (biochar-C pools)
    - capitalize on reduced cycling of biogenic CO<sub>2</sub> back to the atmosphere (indirect removal)

# Accounting Biochar-C sequestration

- Year 0

$$BCS(0)_{j,k} = A_j \cdot AR_{j,k} \cdot CC_k$$

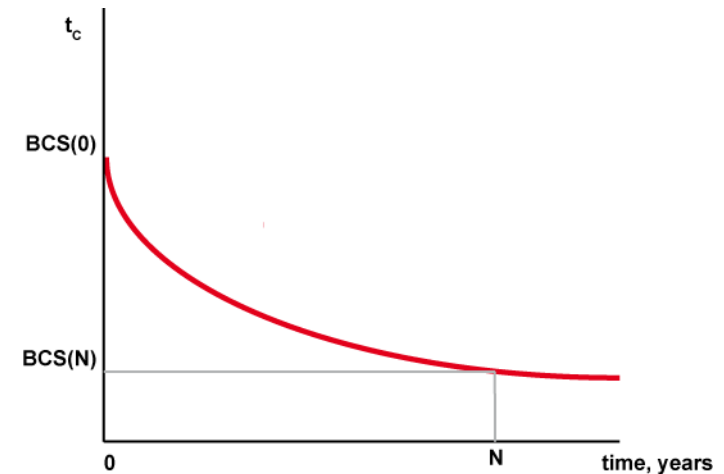
- $A_j$  area of land estate  $j$  where char is applied
- $AR_{j,k}$  application rate of biochar  $k$ , in land estate  $j$
- $CC_k$  carbon content of biochar  $k$



- Year N

$$BCS_{j,k}(N) = BCS_{j,k}(0) \cdot e^{-\frac{N}{\tau_{j,k}}}$$

- $\tau_{j,k}$  average residence (or turnover) time
  - biochar  $k$ , in land estate  $j$  (soil type, climate...)

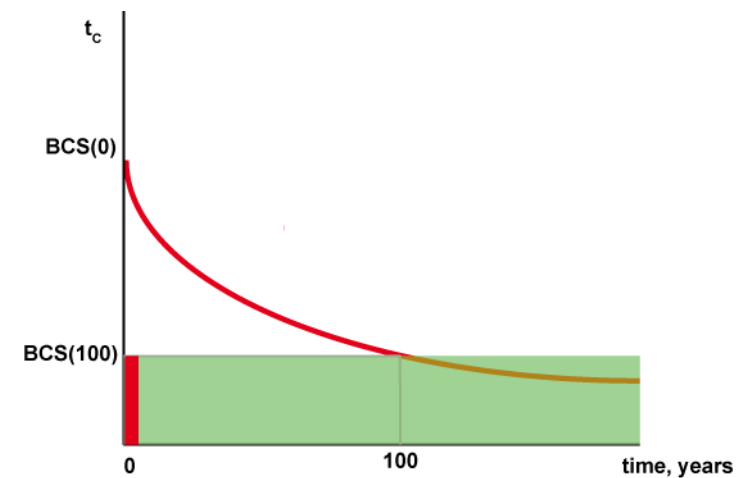


# What emission removals could we claim?

- Carbon market currency  $t_{CO_2-e}$ 
  - relative GWPs over 100 year time horizon
- Biochar-C stored away for at least 100 years does not add to atmospheric  $CO_2$  concentrations and could be counted as a **genuine (but indirect) emission removal**

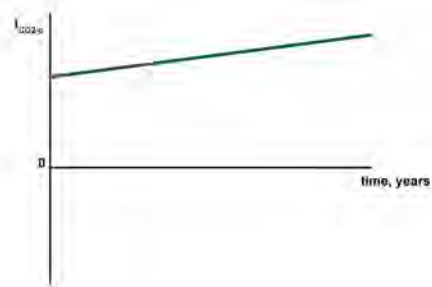
$$BCS_{100} = BCS_0 \cdot e^{-\frac{100}{\tau}} \quad [t_C]$$

$$ER = 3.67 \cdot BCS_{100} \quad [t_{CO_2}]$$

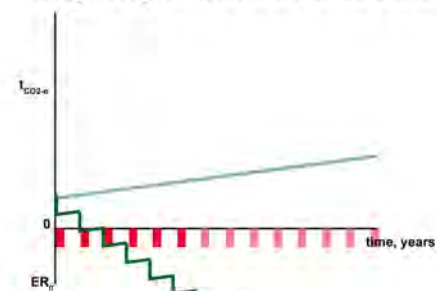


# Emission profiles

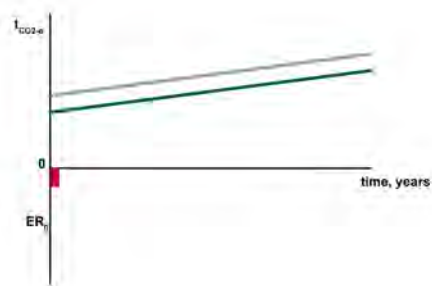
BASELINE EMISSION PROFILE



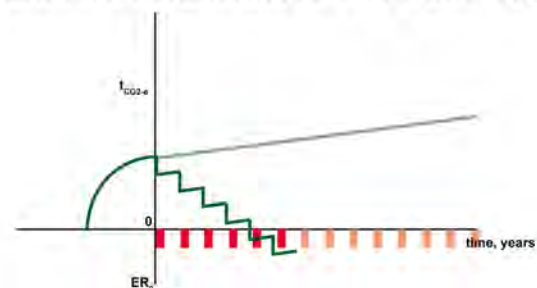
ongoing BIOCHAR-C SEQUESTRATION



one off BIOCHAR-C SEQUESTRATION



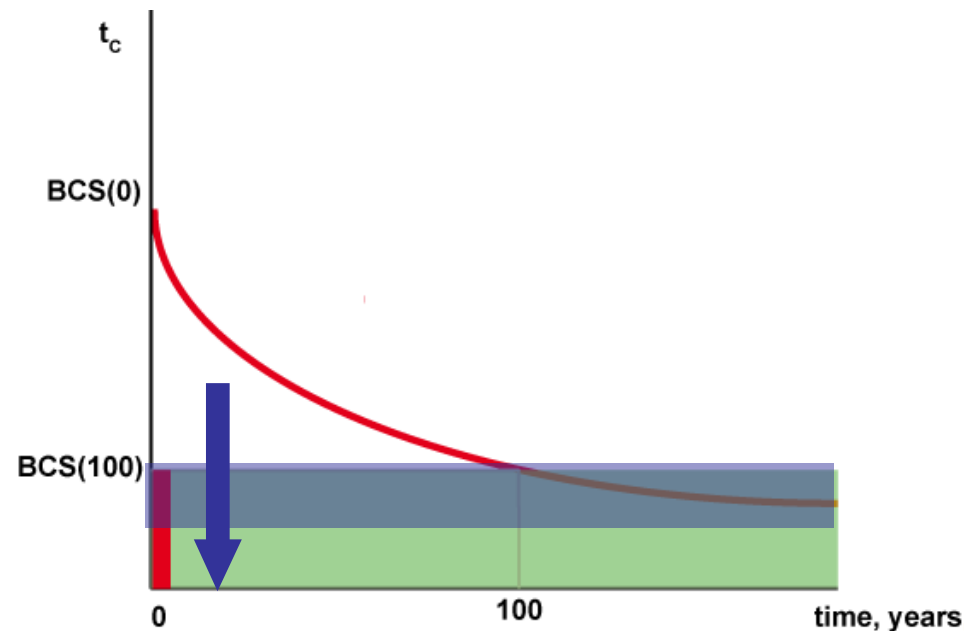
BIOCHAR APPLICATION AFTER LAND-USE CHANGE



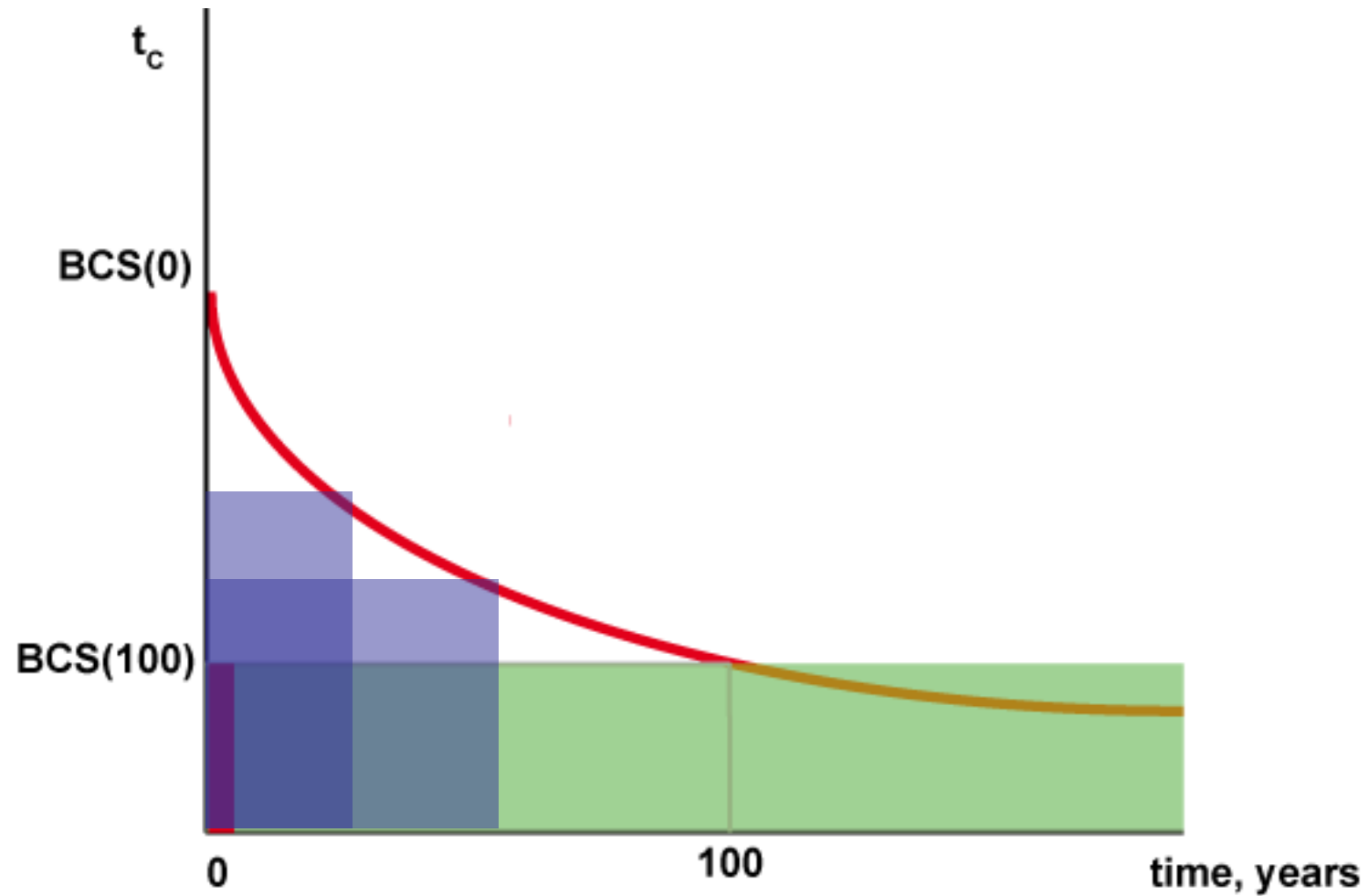


# Should biochar earn different credits?

- Biochar-C sequestration is a low-risk mitigation activity:
  - low technology/environmental risk (as opposed to CCS)
  - mitigation achieved upfront (low implementation risk)
  - permanence implicit
- Issues:
  - monitoring and verification: predicted vs. actual turnover rates



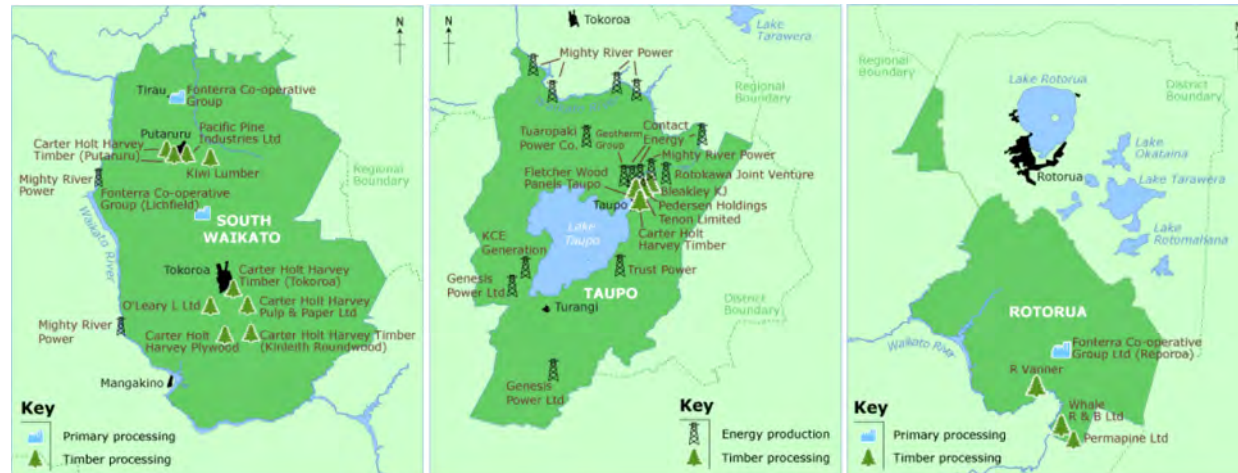
# Should we apply different GWP horizons?



# Additionality and Leakage for Biochar

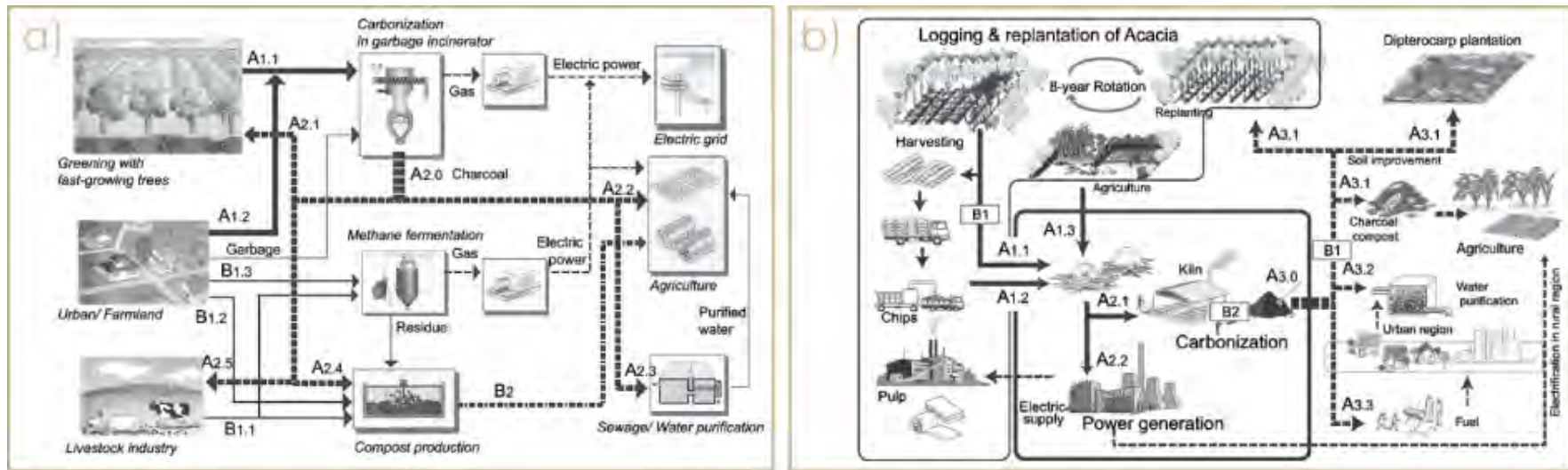
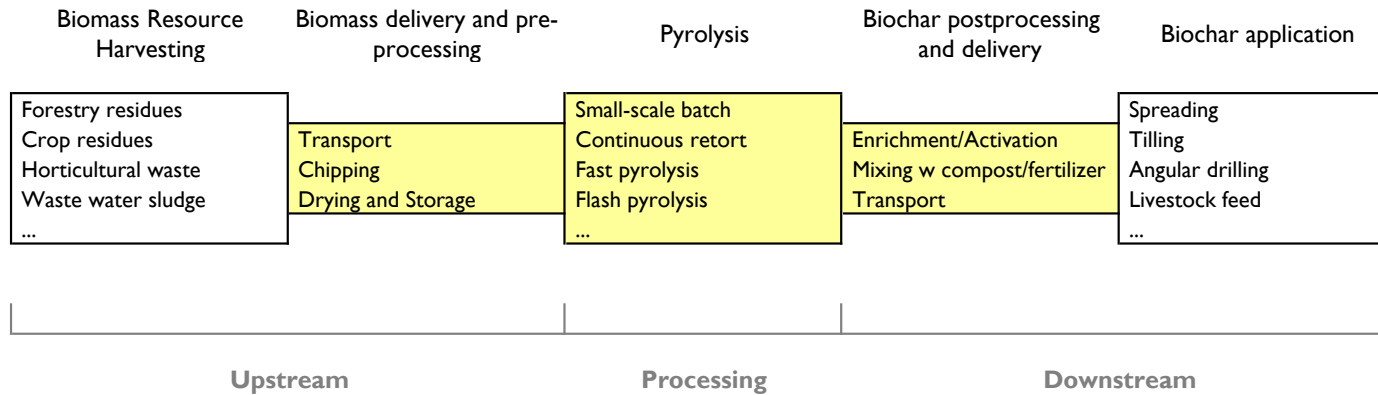
- As the biochar industry consolidates, biochar/bioenergy projects might no longer be considered additional (at least in developed countries)
  - viability achieved through agronomic value + waste management co-benefits
  - >>in the long-term, biochar-C storage could be a key component of national accounts but not eligible for project-based mechanisms**
  - >>National data repositories for char evolution in soils to be developed?**
- Leakage is an issue to be addressed
  - developed countries with tight biomass supplies
  - developed countries with high reliance on biomass energy
  - >>need a comprehensive biochar sustainability framework**

# Central North Island Case Study



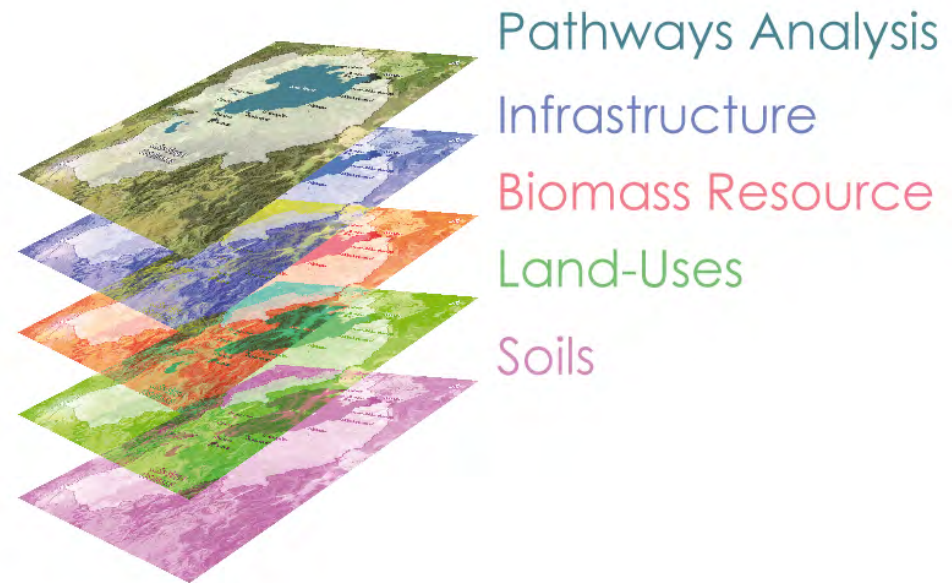
- Stakeholders
  - Env. Waikato, Env. Bay of Plenty, Taupo and Rotorua District Councils, Lake Taupo Protection Trust, Lake Taupo Forest Trust, Carter Holt Harvey, Tokoroa C, Iwis
- Partners
  - Scion, Landcare Research, Carbon Consulting

# Biochar/bioenergy pathways





# GIS enabled framework



# Thank you!

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