IEA Bioenergy

Task 38

an international research collaboration under the auspices of the International Energy Agency

Greenhouse Gas Balances of Biomass and Bioenergy Systems

Introduction

IEA Bioenergy is an international collaborative agreement, set up in 1978 by the International Energy Agency (IEA) to improve international cooperation and information exchange between national bioenergy research, development and demonstration (RD&D) programs. IEA Bioenergy aims to realize the use of environmentally sound and cost-competitive bioenergy on a sustainable basis, thereby providing a substantial contribution to meeting future energy demands.

IEA Bioenergy currently has 13 Tasks, all of which are supervised by the IEA Bioenergy Executive Committee. Each Task has a defined work program and is led by one of the participating countries (Operating Agent). A Task Leader, appointed by the Operating Agent, directs and manages the work programme. In each country, a National Team Leader is responsible for the coordination of the national participation in the task.

Each participating country pays a contribution towards the organizational requirements, and provides in-kind contributions to enable the participation of national experts in a Task.

This collaboration fosters progress in RD&D of new and improved energy technologies for the exploitation of bioenergy resources, and in the identification of the GreenHouse Gas (GHG) benefits of bioenergy use.

IEA Bioenergy Task 38 on *Greenhouse Gas Balances of Biomass and Bioenergy Systems* (which continues work of the previous Tasks XV and 25) brings together the work of national programs in 12 participating countries on GHG balances for a wide range of biomass systems, bioenergy technologies and terrestrial carbon sequestration. The Task considers questions of carbon accounting in the land-use, land-use change and forestry (LULUCF) sector under the United Nations Framework Convention of Climate Change (UNFCCC) and contributes to the work of the Intergovernmental Panel on Climate Change (IPCC).

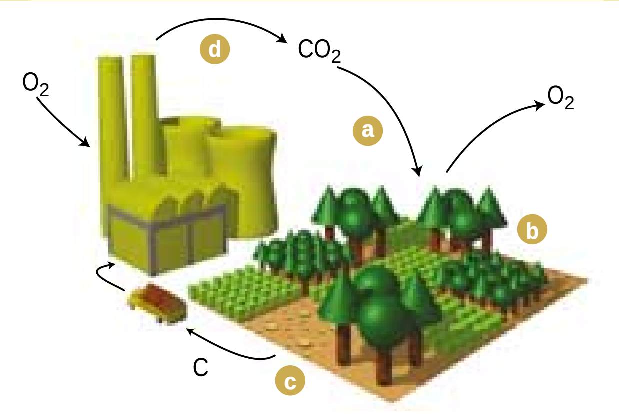


Figure 1: Illustration of the recycling of carbon. a: CO_2 is captured by the growing crops and forests; b: oxygen (O_2) is released and carbon (C) is stored in the biomass of the plants; c: carbon in harvested biomass is transported to the power station; d: the power station burns the biomass, releasing the CO_2 captured by the plants back to the atmosphere. Considering the process cycle as a whole, there are no net CO_2 emissions from burning the biomass.

Objectives

Task 38 builds on the achievements of Task 25, which concentrated on scientific-technical issues and method development. The new Task focuses more on application of methodologies to GHG mitigation projects and programs. Objectives of the Task are to:

- develop, compare and make available integrated computer models and other tools for assessing GHG balances of bioenergy and carbon sequestration systems on the project, activity, and regional levels, and address scaling issues between these levels;
- assess the life cycle GHG balance of such systems, including leakage, additionality, and uncertainties;
- make comparisons of bioenergy systems with e.g. fossil energy systems, as well as comparisons of wood products with other materials such as steel and concrete;
- analyse the country-level and regional potential of bioenergy, forestation, and other biomass-based mitigation strategies, including implications for atmospheric CO_2 reduction;
- aid decision makers in selecting mitigation strategies that optimise GHG benefits, e.g. allocating biomass to energy vs. use as raw material; considering costs and benefits, as well as the practicalities of different mitigation strategies;
- assist in the implementation of forestry, land-use and bioenergy options through methodological work and development of standards for carbon accounting in the energy and LULUCF sectors.

Standard methodology for GHG balances

Introduction

A systematic framework for estimating the net GHG emissions for bioenergy systems, and the energy systems they would displace, has been developed. The major aspects of this "standard methodology", and a schematic structure, are introduced below.

Carbon stock dynamics

The carbon stocks in plants, plant debris and soils can change when biomass is grown and harvested. Such changes in carbon stock might extend over long periods of time, after which a new equilibrium is approached, thus necessitating time-dependent analyses.

Trade offs and synergies

Afforestation or forest protection measures can be effective measures for mitigating the rise of CO_2 in the atmosphere, but may compete with biomass production for limited land resources. In such cases trade-offs between biomass harvest and carbon stocks in biomass must be considered. An example of synergy is that found in afforestation or reforestation with an integrated production system for wood and bioenergy, in which the stand is thinned to maximize value of wood production, and thinnings are utilized for bioenergy.

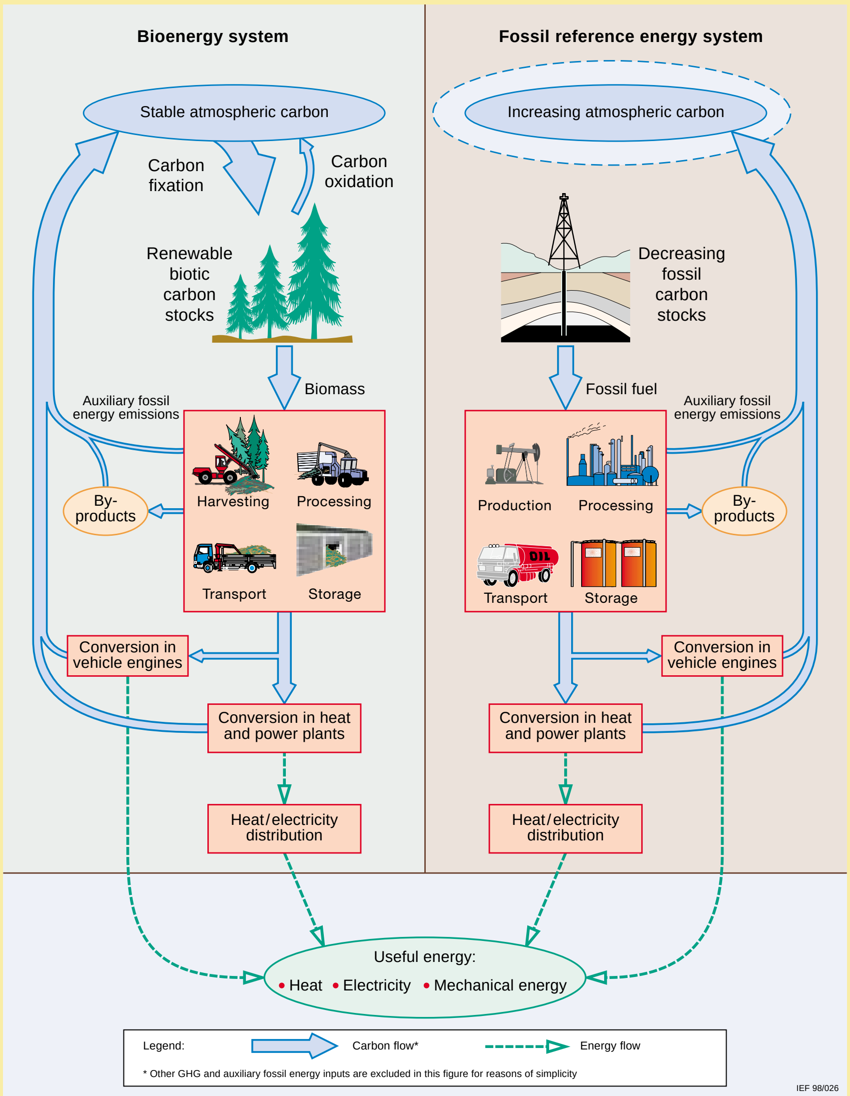


Figure 2: Standard Methodology for calculation of GHG balances

Permanence

Bioenergy provides an irreversible mitigation benefit when it displaces fossil fuels. Mitigation benefits of afforestation or forest protection will be lost if deforestation occurs.

Emission factors

The net benefit of using biomass energy depends on the carbon emission rates (amount of carbon emitted per unit of energy) of the displaced fossil fuels (e.g. oil, or natural gas). For example, the net emission reduction of switching from coal to biomass will be greater than that of switching from natural gas to biomass, assuming all other factors such as conversion efficiencies remain unchanged.

Efficiency

The efficiency of bioenergy systems (e.g. energy output per unit of feedstock energy or mass) may in some cases be lower than that of fossil energy systems. Recent technological developments have increased the efficiency of bioenergy systems considerably (e.g. Integrated Gasification Combined Cycle—IGCC).

Upstream energy inputs

Production, transport and conversion of biomass fuels require auxiliary inputs of energy, which must be included in the assessment, as must the energy requirements for the supply of fossil fuels on which the reference energy system is based.

Leakage

The use of biomass fuels does not always avoid the use of fossil fuels to the extent suggested by the amount of bioenergy actually used, a phenomenon commonly referred to as “leakage”.

By-products

Bioenergy is often produced as a by-product. There are also cases where bioenergy is the main product and other by-products have to be considered. The emissions and offsets associated with both products and by-products must be estimated and allocated.

Other Greenhouse Gases

Greenhouse gas emissions associated with both fossil and bioenergy fuel chains include not only CO_2, but other gases such as CH_4 and N_2O.

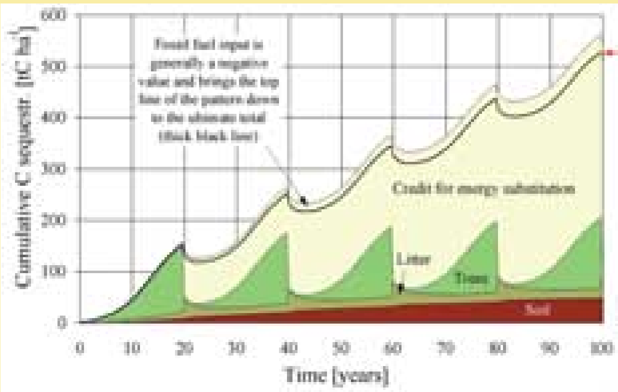


Figure 3: Model results: carbon balance of a fuelwood plantation on formerly agricultural land

Highlights of Task 38 output

Frequently asked questions (FAQ)

“Answers to Ten Frequently Asked Questions about Bioenergy, Carbon Sinks and their Role in Global Climate Change” is a paper that aims to inform industry, researchers, policy makers and interested public about some key issues surrounding these topics. The FAQ explain:

Courtesy of DOE/NREL, credit Warren Gretz

Wood chip production

1. The difference between CO_2 emissions from bioenergy and from fossil fuels;
2. How trees and forests act as a carbon sink;
3. The effect of harvesting on carbon sinks;
4. The area of land required to supply bioenergy to a power station;
5. The area of forest required to offset CO_2 emissions from a power station or from running a car;
6. The types of trees and crops that are best as carbon sinks or for bioenergy and wood production;
7. Integrated land management for carbon sinks, bioenergy and fibre production;
8. How the management of land as a carbon sink or for bioenergy production affects biodiversity and other environmental characteristics;
9. The potential to reduce greenhouse gas emissions by using bioenergy and through terrestrial carbon sequestration;
10. The current availability of technology to allow bioenergy to play a role in reducing atmospheric CO_2.

Country reports

The country reports for each participating country of the Task summarise:

- Background information on the general energy system and GHG emissions, on bioenergy systems, and on the national LULUCF situation;
- Bioenergy and carbon sequestration policies and measures at national, regional and local levels;
- Bioenergy and carbon sequestration implementation projects and research programmes.

A matrix with participating countries (columns) and the topics listed above (rows) is being developed as the “heart” of a hyper-linked system. This work will be presented with supplementary information on a CD ROM and on the Task 38 website.

Courtesy of BrikettEnergi, Sweden

Pellets and briquettes from sawdust

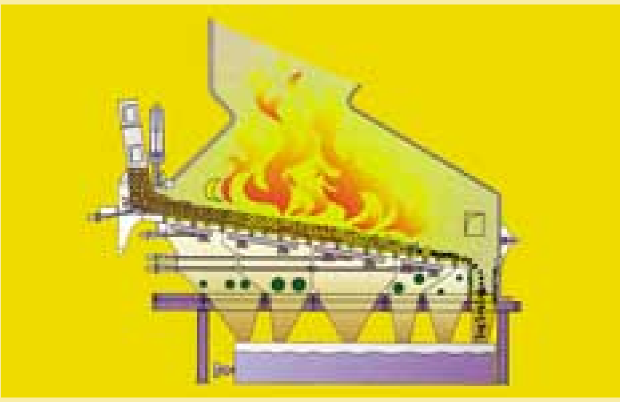
Case studies

Task 38 is applying the standard methodology to specific projects and helps increase experience that is useful in implementation of mitigation projects and programmes. Case studies are therefore conducted to assess and compare the GHG balances of different bioenergy and C sequestration projects in the participating countries. For example:

- In Australia GHG balances of two alternative bioenergy conversion systems (30 MW wood-fired power station, co-firing in a 500 MW black coal-fired power station) in North East New South Wales are compared. The biomass is produced from conventional plantation forestry.
- The New Zealand case study assesses the GHG balance of a sawmill in New Zealand, equipped with a combined heat and power (CHP) plant utilising sawmill residues of bark and sawdust. The current bioenergy system is compared to a reference system based on natural gas.
- In Canada the emission reduction of a small pyrolysis plant, which uses both thinnings from a juvenile spacing program and sawmill residues as feedstock, is examined. The plant produces bioOil for subsequent use either in a pulp mill line kiln or for export.
- The Finnish and Swedish case studies look at the links between increased use of construction wood and the use of biomass-fired cogeneration plants in comparison to fossil fuel use.
- The case study for the United Kingdom is targeted to compare small-scale bioenergy solutions for a rural community versus centralized systems of energy and heat generation, and bioenergy crops versus short-rotation forests versus long-rotation forests.
- In Croatia the GHG emissions reduction potential through biodiesel is assessed in the context of a potential Joint Implementation project.

Overheads

A set of 40 overheads for general use by participants has been completed and is available for National Team Leaders on the Task 38 Intranet. The overheads cover general Task information and specific results from participating countries.



Courtesy of Kvaerner Pulping AB, Sweden

Schematic view of a wood-chip grate boiler for heat production

Workshops

Each year one to two workshops are organized to attract experts on timely issues related to bioenergy, carbon sequestration and GHG from around the world, to enable them to exchange ideas and experience and to provide a creative forum to facilitate collaborative work.

Other work

Impact of soil carbon change on the GHG balance of bioenergy systems

Short-term soil carbon changes resulting from forest establishment, and long-term changes associated with land-use change, will impact on the GHG balance of bioenergy systems. The Task will produce a paper on soil carbon changes in bioenergy and carbon sequestration projects, addressing the implications for GHG balances and carbon accounting under the Kyoto Protocol.

Biomass trade (jointly with Task 35)

As the use of biomass increases especially in more densely populated areas, a need arises for transporting and trading biomass over longer distance. Task 38 is investigating the GHG aspects of trading biomass in various forms, its role in national policies to reduce net greenhouse gas emissions, the role of biomass trade in fulfilling Kyoto Protocol targets, and how traded biomass fuels can be accounted for in national GHG inventories. This work is carried out jointly with IEA Bioenergy Task 35 “Techno-Economic Assessments for Bioenergy Applications”, which focuses on the economic aspects of biomass trade.

Courtesy of UK Forest Research Photo Library

Loading of logs for transportation by truck

Scientific and technical support

The Task contributes to work in the context of National Greenhouse Gas Inventories, for example regarding approaches for estimating and accounting of CO_2 emissions from harvested wood products and biomass fuels, or the development of IPCC Good Practice Guidelines for national emissions inventories in the land use, land-use change and forestry sector.

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12 6 13 11 2 14 7 8

Task 38 National Teamleaders: Numbers refer to the list on the back page of this folder

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