Biofuels: Impact on climate change
This presentation will introduce you to biofuels and their impact on climate. You will also learn about future energy challenges.
How big is the energy challenge of climate change?

- It is huge - the world’s current development and energy path will bring a surge in emissions
- A transformation of global energy systems is urgently needed
- But technological transformation is likely to take several decades to complete

Narration: How big is the energy challenge of climate change? It is huge. The current development and energy path will bring a surge in emissions. As a result, a transformation of global energy systems is urgently needed. But technological transformation is likely to take several decades to complete.

In this presentation you will learn about the impact of biofuels on climate. How big is the energy challenge of climate change? It is huge. The current development and energy path will bring a surge in emissions. As a result, a transformation of global energy systems is urgently needed. But technological transformation is likely to take several decades to complete.
Some important questions to consider

- Will biofuels help to mitigate climate change?
- How big is the climate challenge of biofuel production?
- How will bioenergy interact with other land uses?

Refined modeling of interactions between different land uses and bioenergy, food and materials is needed

Source: Berndes et al. 2003
Biofuels can potentially reduce the emissions of greenhouse gases. However, this carbon savings depends on how the biofuels are produced.

Converting forests, peatlands, grasslands or savannas to produce first generation biofuels creates a carbon debt, which can be 17 to 420 times more CO2 than the annual reductions in greenhouse gases that biofuels provide by displacing fossil fuels.

Source: Fargione et al. 2008
Narration: There is some concern that biofuel development will not actually have carbon benefits for extremely long periods of time. This chart illustrates the carbon debt (or emissions) and carbon payback time for a number of different biofuel sources. The best scenario in the group is prairie biomass conversion to ethanol, which will take less than one year to reach carbon neutrality, as opposed to palm biodiesel produced from converted peatland palm plantations, which will take more than 400 years.

Carbon debt and years to repay biofuel carbon debt for nine scenarios of biofuel production. Means and standard deviations are from Monte Carlo analyses of literature-based estimates of carbon pools and fluxes. Upper graph: Carbon debt, including CO2 emissions from soils and aboveground and belowground biomass due to habitat conversion. Lower graph: Number of years after conversion to biofuel production required for cumulative biofuel greenhouse gas reductions, relative to fossil fuels they displace, to repay the biofuel carbon debt. (Source: Sheil et al. 2009).
Carbon savings counteracted by increased nitrous oxide release

- $\text{N}_2\text{O}$ emissions from biofuel production can contribute as much or more to global warming by $\text{N}_2\text{O}$ emissions than cooling by fossil fuel savings.
- Crops with less nitrogen demand have more favorable climate impacts.

Source: Crutzen et al. 2007

**Narration:** The extra nitrous oxide emission from biofuel production has been calculated in “$\text{CO}_2$-equivalent” global warming terms and compared with the quasi-cooling effect of “saving” emissions of carbon dioxide derived from fossil fuels. The outcome was that the production of commonly used biofuels, such as biodiesel from rapeseed and bioethanol from maize, can, depending on nitrogen fertiliser uptake efficiency by the plants, contribute as much or more to global warming by nitrous oxide emissions than cooling by fossil fuel savings.

Crops with less N demand, such as grasses and woody coppice species, have more favorable climate impacts.

The Kyoto Protocol and biofuels adoption

- The Kyoto Protocol’s Clean Development Mechanism offers potential for funding biofuel projects in developing countries
- Complex rules, processes and politics restrict access by Least Developed Countries
- Smaller producers are bypassed in Least Developed Countries

Narration: Because biofuels have the potential to reduce greenhouse gas emissions, the Kyoto Protocol’s Clean Development Mechanism offers potential for funding biofuel projects in developing countries. The complex rules, processes and politics of the Clean Development Mechanism restrict access by Least Developed Countries. Also, smaller producers are bypassed in Least Developed Countries.

Because biofuels have the potential to reduce greenhouse gas emissions, the Kyoto Protocol’s Clean Development Mechanism (CDM) offers potential for funding biofuel projects in developing countries. However, because of the complex rules, processes and politics of the CDM, access to the CDM by Least Developed Countries is restricted. In addition, smaller producers are bypassed in Least Developed Countries.
Examples of restrictions

- Biomass projects are generally large in scale and related to grid-based power systems
- Land-use related projects restricted to include only afforestation, reforestation and certain biomass related processes.
- The EU Emissions Trading System does not currently accept land-use projects
- Small farmers lack expertise in implementing complex methodologies
- There is a lack of upfront funding for projects and investors are less interested in smaller projects with high risks and long timeframes.

Small-scale methodologies with simpler requirements and processes for bundling projects have been developed to address some of these issues.

Narration: Here are some examples of restrictions. Biomass projects, which are a common type of Clean Development Mechanism project, are generally large in scale and related to grid-based power systems. Rules for land-use related projects in the Clean Development Mechanism are restricted to include only afforestation, reforestation and certain biomass related processes.

At the same time, the EU Emissions Trading System, the largest functioning carbon market, does not currently accept land-use projects. Small farmers are less able to access the carbon market because they lack expertise in implementing complex methodologies. There is a lack of upfront funding for projects and investors are less interested in smaller projects with high risks and long timeframes.

Small-scale methodologies with simpler requirements and processes for bundling projects have been developed to address some of these issues, but there is currently no small-scale methodology for liquid biofuels. There is just one large-scale methodology based on the use of waste cooking oil for biodiesel.

Biomass projects - a common type of CDM project - are generally large in scale and related to grid-based power systems. Their geographical spread is also limited, with most projects in larger developing countries and few in Africa. Rules for land-use related projects in the CDM are restricted to include only afforestation, reforestation and certain biomass related processes such as methane capture from biodegradation. At the same time, the EU Emissions Trading System (EU ETS), the largest functioning carbon market, does not currently accept land-use projects. Small farmers are less able to access the carbon market because they lack expertise in implementing complex methodologies. There is a lack of upfront funding for projects and investors are less interested in smaller projects with high risks and long timeframes.

Small-scale methodologies with simpler requirements and processes for bundling projects have been developed to address some of these issues, but there is currently no small scale methodology for liquid biofuels. There is just one large-scale methodology based on the use of waste cooking oil for biodiesel.
Despite their potential for bringing sustainable development benefits, biofuel projects are less attractive to investors because of high abatement costs, difficulties in proving additionality, difficulties in calculating reduced emissions, and challenges in proving additionality for projects and difficulties in calculating reduced greenhouse gas emissions of projects. Negotiations over the next phase of the Kyoto Protocol are considering options for programmatic approaches to the Clean Development Mechanism. This means that developing countries could benefit from finance from developed countries for putting in place biofuels policies. However, rules over additionality could discourage developing countries from making laws on biofuels. Alternative carbon markets outside the Kyoto process show potential for supporting moves towards biofuels production in developing countries.

However, perverse incentives could arise, discouraging developing countries from putting in place legislation on biofuels because of rules over additionality under the Clean Development Mechanism. There are alternative carbon markets outside of the Kyoto Protocol that show potential for supporting moves towards biofuels production in developing countries. These voluntary markets are smaller, but tend to focus on smaller projects aimed at reducing greenhouse gases and alleviating poverty. However, the quality of projects, in both environmental and social terms, can vary. For this reason, there is a need for more universal standards.
Emissions embedded in trade flows

Environmental input-output models for detailed multi-country analyses of the environmental impacts of trade flows are needed

- Also a need for a quantification of emission embedded in imports and exports
- The current trend of accounting for consumer emissions could lead to the development of an embedded carbon emissions indicator as a headline indicator for sustainable development

Narration: The emissions embedded in trade flows must also be considered. There is a need for environmental input–output models for detailed multi-country analyses of environmental impacts of trade flows. There is a corresponding need for a quantification of emissions embedded in imports and exports. The current trend towards accounting for consumer emissions could lead to the development of an embedded carbon emissions indicator as a headline indicator for sustainable development.

The emissions embedded in trade flows must also be considered. For example, there is a need for environmental input–output models for detailed multi-country analyses of environmental impacts of trade flows. There is a corresponding need for a quantification of emissions embedded in imports (EEI) and exports (EEE). The current trend towards accounting for consumer emissions, which can lead to the development of an embedded carbon emissions indicator as a headline indicator for sustainable development.
Narration: There are several sustainability issues to consider. For example, the conversion of high carbon content systems to arable land releases carbon from ecosystem biomass and soils. In addition, there are substantial emissions of greenhouse gases from direct land use change and indirect land use change. It remains an open issue how a case-by-case calculation of carbon stocks and cumulative carbon stock changes can be made operational. In addition to carbon stock uncertainty, there is a broad range of nitrous oxide emissions. Finally, studies on greenhouse gases associated with biofuels show a high variability in findings, depending on the assumptions taken about factors related to cultivation and the valuation of co-products.
Thank you for your attention