DEDICATED TO MAKING A DIFFERENCE

Biomass

Issue Brief | Energy and Climate

World Business Council for
Sustainable Development

Introduction

Biomass,[1] the oldest form of renewable energy, has been used for thousands of years. However, its relative share of use has declined with the emergence of fossil fuels. Currently some 13% of the world's primary energy supply is covered by biomass, but there are strong regional differences: developed countries source around 3% of their energy needs from biomass, while Africa's share ranges from 70-90%.[2]

With environmental effects such as climate change coming to the forefront, people everywhere are rediscovering the advantages of biomass. Potential benefits include:

- Reducing carbon emissions if managed (produced, transported, used) in a sustainable manner;
- Enhancing energy security by diversifying energy sources and utilizing local sources;
- Providing additional revenues for the agricultural and forestry sectors;
- Reducing waste.

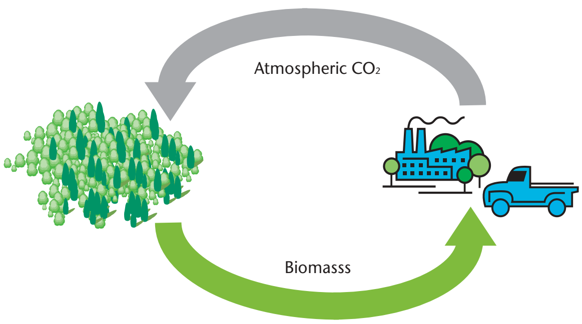
Biomass

Biomass' carbon neutrality

Plants and trees remove carbon dioxide (CO_2) from the atmosphere and store it while they grow. Burning biomass in homes, industrial processes, energy generation activities, or for transport returns this sequestered CO_2 to the atmosphere. New plant or tree growth keeps the atmosphere's carbon cycle in balance by recapturing CO_2. This net-zero or neutral carbon cycle can be repeated indefinitely, as long as biomass is re-grown in the next management cycle and harvested for use.[3] The sustainable management of the biomass source is critical to ensuring that the carbon cycle is not interrupted (see figure 1).

In contrast to biomass, fossil fuels such as gas, oil and coal are not regarded as carbon neutral because they release CO_2 which has been stored for millions of years, and do not have any storage or sequestration capacity.[4]

Figure 1: The carbon cycle



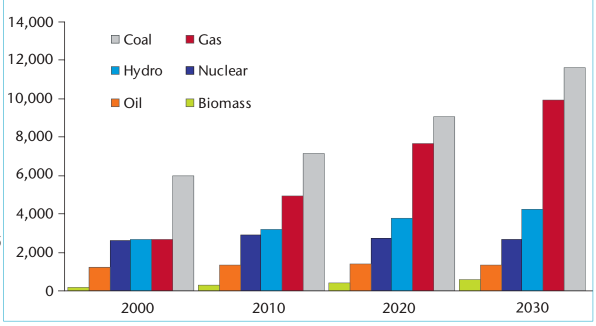
Source: WBCSD.

Biomass for heat and power generation

In 2000, biomass was the largest renewable energy source for electricity generation outside of hydro, generating around 1% of the world's electricity or 167 TWh. Its share is and will remain small in comparison to fossil-based sources (see figure 2).

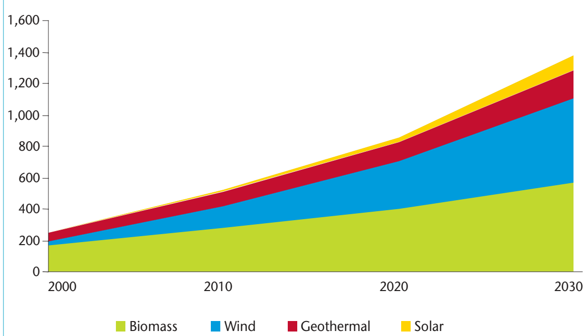
Figure 3 shows that the share of biomass relative to the other renewable sources is expected to decrease due to the high growth rates of wind and solar power. Biomass use for power generation is projected to more than triple until 2030, while wind will increase 17-fold, reaching nearly similar generation capacity levels as biomass. However, wind power is less predictable, due to its very nature, than sustainably supplied biomass generation plants.

Figure 2: Electricity generation (TWh) by source



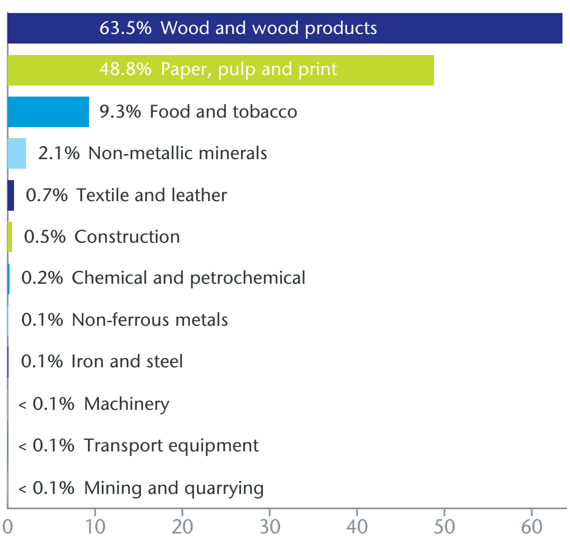
Source: International Energy Agency (IEA), *World Energy Outlook*. 2002.

Figure 3: Electricity generation of renewables in 2000 (TWh)



Source: IEA. *World Energy Outlook*. 2002.

Figure 4: Biomass usage rates in different sectors



Source: WBCSD. *The Sustainable Forest Products Industry, Carbon and Climate Change: Key Messages for Policy-Makers*. 2005.

Biomass

The main industry users of biomass are the wood and wood products industry, as well as the pulp, paper and carton industry. They use substantial amounts of biomass to cover their energy requirements (see figure 4).[5]

These two industry sectors have large usage rates due to the wide availability of biomass in their existing raw material flow. By using biomass, companies avoid transportation costs and ensure cost effectiveness.

Costs are a crucial issue in the expansion of biomass in power generation. The cost structure depends on geographic location, type of biomass and technology used. Overall investment costs tend to be lower for co-firing[6] than for combustion.[7] Combined heat and power technologies can be considerably more efficient than generation only technologies. With respect to feedstock, costs are generally minimized when the production of biomass and its usage happen in the same place.

Biofuels[8]

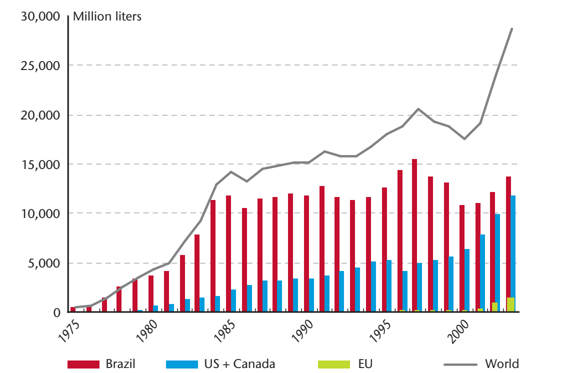
In 2003, worldwide consumption of biofuels was some 30 billion liters. This figure could rise to 120 billion liters in 2020. Ethanol, at more than 25 billion liters (see figure 5), is used much more widely than biodiesel, at around 1.7 billion liters (see figure 6). In comparison, total oil demand was around 4,500 billion liters in 2002 and is expected to increase to 6,200 billion liters in 2020.[9]

Figures 7 and 8 give an indication of the production costs of biofuels and gasoline/diesel. The International Energy Agency (IEA) estimated in 2004 that with an oil price ranging from US$ 25-35 per barrel, low-cost biofuel and gasoline/diesel[10] production costs reach comparable levels.

Biofuel production costs differ substantially, cover wide ranges, and depend on factors such as:

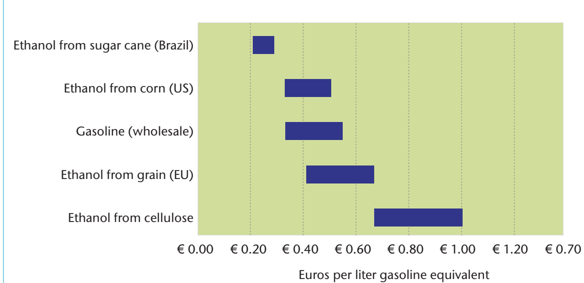
- Feedstock
- Conversion process
- Scale of production.

Figure 5: World and regional fuel ethanol production



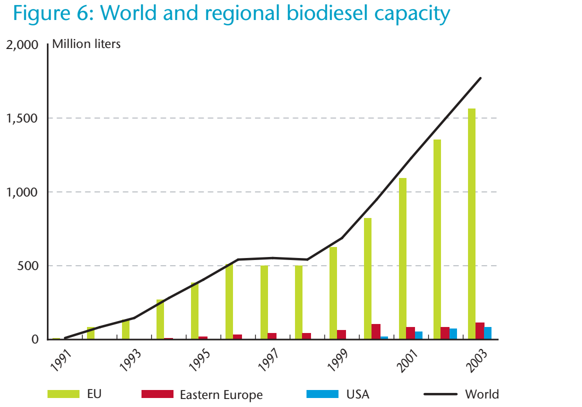
Source: IEA. Biofuels for Transport: An International Perspective. 2004.

Figure 7: Cost ranges for ethanol and gasoline production



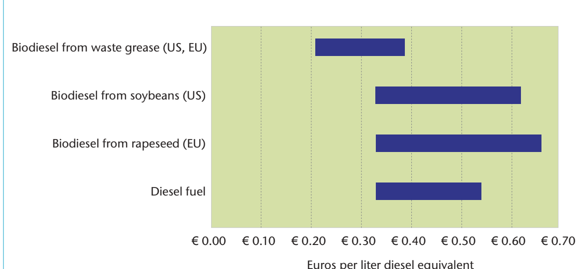
Source: Worldwatch Institute, GTZ and FNR. Biofuels for Transportation – Extended Summary. 2006.

Figure 6: World and regional biodiesel capacity

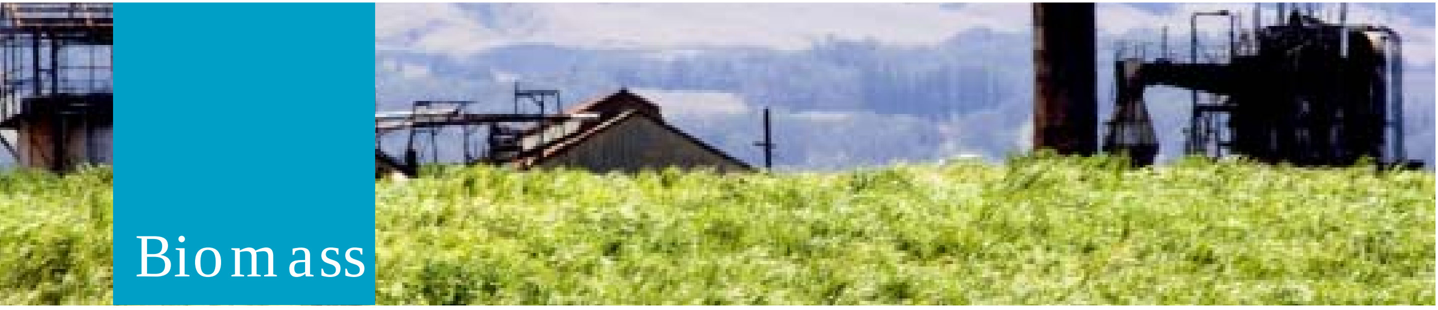


Source: IEA. Biofuels for Transport: An International Perspective. 2004.

Figure 8: Cost ranges for biodiesel and diesel production



Source: Worldwatch Institute, GTZ and FNR. Biofuels for Transportation – Extended Summary. 2006.



Biomass

Biofuels contribute towards CO_2 reduction because the feedstocks used have absorbed CO_2 from the atmosphere during their growth. However, this is only the starting point of the fuel's life cycle, and in fact liquid bio-fuel CO_2 reduction potentials vary considerably as shown by figure 9, due to the following key factors:

- Feedstock;
- Agricultural/forestry production methods;
- Production process used for conversion to biofuels;
- Energy-related value and use of any by-products.

Generally the impact of logistics on CO_2 reduction potential is relatively small in making comparisons between biofuel types.

The highest performing processes/products are those that can use biomass for heat and power needs within the production processes and where the by-products produced are replacing products derived from fossil fuel production routes. Thus ethanol derived from sugar cane in Brazil, ligno-cellulose ethanol,[11] biomass to liquids based on biomass gasification, and Fischer Tropsch Synthesis[12] perform well in terms of CO_2 reduction.

These differing CO_2 reduction potentials, combined with the large range in production costs, result in diverse CO_2 reduction costs, with overall costs expected to fall in the future (see figure 10).

Ethanol

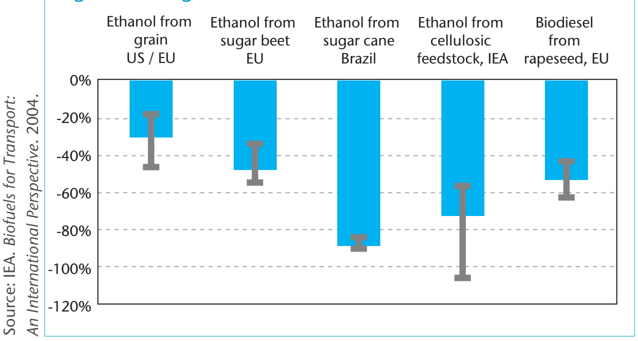
Ethanol produced from sugar cane in Brazil has a low net CO_2 impact in comparision to traditional corn-derived ethanol because:·

- Biomass products such as sugar cane stalks are used for the production of steam and electricity in the process;
- Yields are high and fertilizer use, which is GHG intensive, is applied in limited quantities.

By contrast, ethanol produced from grain in Europe has a higher net CO_2 impact because electricity and steam used during the production process is largely generated from fossil fuels and fertilizer use is higher.

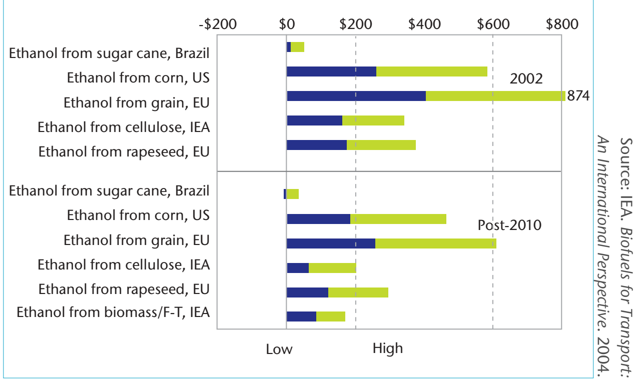
The second generation ligno-cellulose process for the manufacture of ethanol uses agricultural waste products as the feedstock and process waste for steam and electricity production. The net CO_2 impact therefore approaches zero.

Figure 9: Range of GHG reductions from biofuels



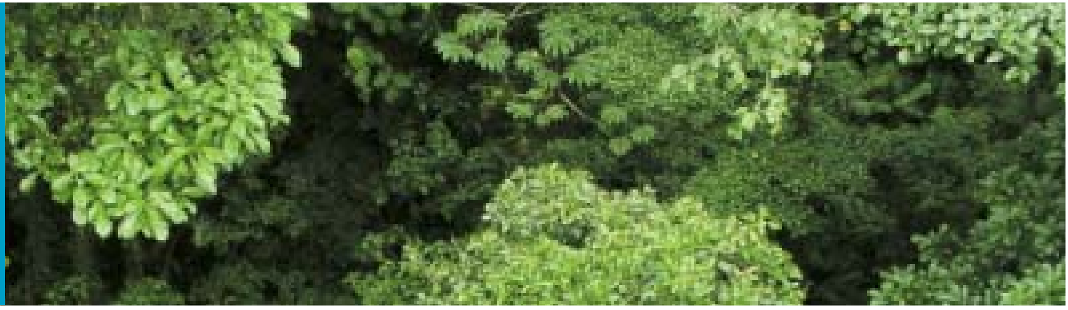
This figure shows reductions in CO_2-equivalent GHG emissions per kilometer from various biofuel/feedstock combinations, compared to conventional-fuelled vehicles. Ethanol is compared to gasoline vehicles and biodiesel to diesel vehicles. Blends provide proportional reductions. For example, a 10% ethanol blend would provide one-tenth of the reductions of those shown here. Vertical black lines indicate range of estimates.

Figure 10: Biofuels cost per metric ton GHG reduction (US$)



Ranges were developed using highest cost/lowest GHG reduction estimate, and lowest cost/highest GHG reduction estimate for each option, then taking the 25% and 75% percentile of this range to represent the low and high estimates in this figure. In some cases, ranges were developed around point estimates to reflect uncertainty. Estimates are not necessarily based on commercial experiences.

Biomass



Sustainability

The production of biomass and biofuels has to be done in a sustainable manner to keep the carbon cycle intact and in balance, and to ensure that the environmental impact of their production is socially acceptable. This means that consumed biomass has to be replaced by reforestation, replanting or similar activities. Biomass produced by unsustainable forestry or agricultural practices, or the permanent conversion of forest and plant areas would break the carbon cycle because the removed biomass is not replaced by new plant and tree growth.

Both the agricultural and forestry sectors, the suppliers of biomass, would be affected by the extra demand for biomass and biofuels as projected by the IEA. Potential outcomes of this additional biomass demand are:

- Supplementary revenue for the agricultural sector;
- A possible shift away from food production towards biomass production;
- Competition for wood fiber for the forest product sector;
- Increased emphasis on sustainable management for biomass energy;
- Supplementary or alternative revenues from the use of wood biomass for fuels as well as traditional forest products.

The land requirements to satisfy growing biomass demands are difficult to estimate and tend to be wide in range. Better resource utilization (e.g., use of fertilizer and exploitation of existing biomass waste) and research and development, especially in developing countries, would increase yields of agricultural products and biomass, thereby avoiding the occurrence of potential conflicts between these two products.

Outlook and way forward

Similar to other energy alternatives, biomass is not a "silver bullet" solution. Independently, it cannot satisfy all the energy challenges, particularly energy security and climate change. But it belongs in a group of alternative energy sources, which, if applied together, ensures that the energy sector is moving towards sustainability. In addition, it is the incremental volume from the renewable supplies that could ease a tight supply/demand balance for gasoline and provide an alternative fuel during a potential gasoline curtailment. Further research and development efforts and their resulting technology developments are necessary in order to achieve additional cost and GHG reductions.

The main limitation of biomass is its availability and how broadly it could be used as an energy source. *Pathways to 2050*[13] indicates that by 2050, the share of biofuels in the road transport mix could reach 15%, up from the current 1%. It also estimates that biomass is likely to be used more intensively in power generation in the near future. In line with these indications, several countries, including Brazil, the USA, and EU member states, have adopted policies to raise the usage of biomass and biofuels in their existing energy mix.

Notes

1. In this context biomass includes solid biomass and animal products, gas and liquids derived from biomass, municipal waste and industrial waste. Biofuels are refined from biomass.

2. World Energy Council. *Regional Energy Integration in Africa*. 2005.

3. Additional CO_2 emissions can be released if fossil fuels are used in production and transportation processes.

4. Although fossil fuels are not regarded as renewable resources and are not naturally carbon neutral, there is growing recognition of the capacity to capture and geologically store large amounts of carbon dioxide from fossil fuel-fired power plants, industrial sources and other combustion processes.

5. World Business Council for Sustainable Development (WBCSD). *The Sustainable Forest Products Industry, Carbon and Climate Change: Key Messages for Policy-Makers*. 2005.

6. Co-firing uses both biomass and conventional fossil fuels.

7. Combustion uses only biomass as a fuel.

8. Includes any type of liquid fuel that is produced from biomass products.

9. IEA. *Biofuels for Transport: An International Perspective.* 2004.

10. Changing oil prices lead to fluctuations in the production costs of gasoline and diesel.

11. Ligno-cellulose forms the primary structural component of plants. Ligno-cellulose ethanol can be produced from a great diversity of biomass including waste from urban, agricultural and forestry sources, unlike normal ethanol, which is made from sugars.

12. The Fischer Tropsch Synthesis comprises a chemical reaction in which carbon monoxide and hydrogen are converted into liquid hydrocarbons of various forms.

13. World Business Council for Sustainable Development (WBCSD). *Pathways to 2050 – Energy and Climate Change.* 2005.

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) brings together some 180 international companies in a shared commitment to sustainable development through economic growth, ecological balance and social progress. Our members are drawn from more than 30 countries and 20 major industrial sectors. We also benefit from a global network of 50+ national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues.

Our objectives include:
Business Leadership – to be a leading business advocate on sustainable development;
Policy Development – to help develop policies that create framework conditions for the business contribution to sustainable development;
The Business Case – to develop and promote the business case for sustainable development;
Best Practice – to demonstrate the business contribution to sustainable development and share best practices among members;
Global Outreach – to contribute to a sustainable future for developing nations and nations in transition.

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