What is Bioenergy?

The term "bioenergy" broadly includes various forms of energy that can be produced from plants and other organic matter that is a product of photosynthesis. Bioenergy harnesses the sun's power to pull carbon dioxide from the atmosphere into a solid carbon form known as biomass. Bioenergy can take several forms depending on the technology used, the biomass source, and the desired form of energy. The broad categories of bioenergy include biopower, biothermal, and biofuels. Biomass can also be converted into a range of renewable chemicals and biobased products that displace fossil-derived products such as plastics.

1. ***Biopower*** is electricity produced from biomass. This can be in the form of chips or pellets that are combusted to drive a turbine that produces electricity. Biomass can be used at a coal-fired power plant to reduce coal used or in facilities that are designed for a specific form of biomass available in the area.

2. ***Biothermal*** is heat that is produced from biomass that is used to heat homes and commercial buildings or used to drive industrial processes. It is used in place of fuel oil, natural gas, or other fossil fuels to reduce fossil carbon emissions. When thermal energy needs are served from the heat produced by power generation, it is known as "combined heat and power" or CHP.

3. ***Biofuels*** are generally liquid transportation fuels that are made from biomass using either an enzymatic or thermochemical process and generally replaces gasoline and diesel.

4. ***Renewable Chemicals and Biobased Products*** are high value products, such as plastics, polymers and other materials, produced from biomass feedstocks instead of fossil-based feedstocks. Renewable chemicals and biobased products store or sequester carbon from the atmosphere, and are important carbon sinks.

WHERE DO PELLETS FIT?

Wood or other forms of biomass can be manufactured into a pellet form so that it is uniform and easy to handle in various bioenergy or biomass transportation processes. Pellets may be used for power, thermal or liquid fuels and are sometimes known as "solid biofuels."

BIOENERGY WORKS IS A PROJECT OF:

BIOMASS POWER ASSOCIATION

BTEC Biomass Thermal Energy Council

Bio Biotechnology Industry Organization

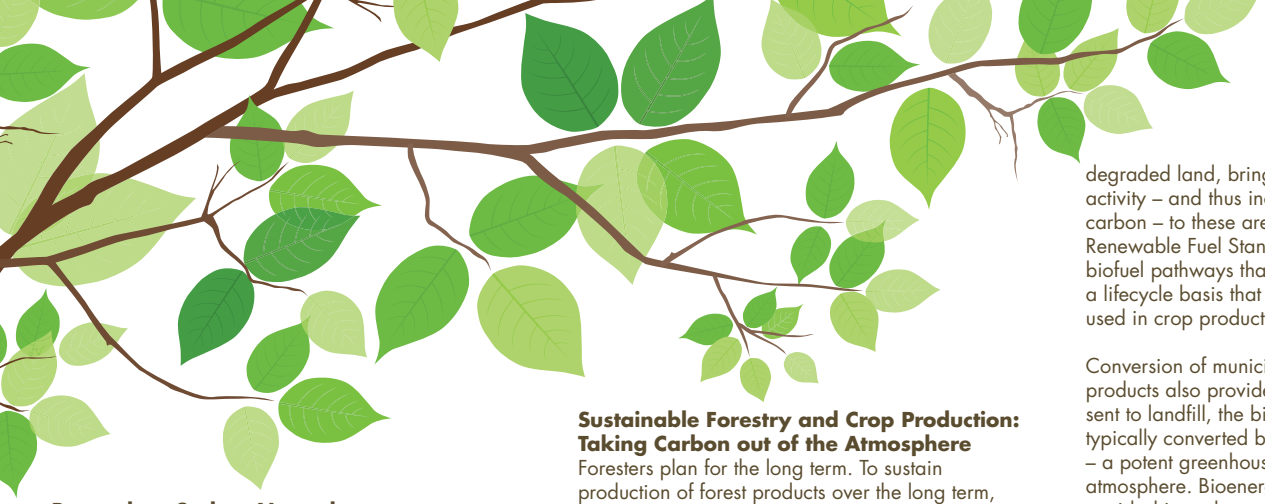
NAFO National Alliance of Forest Owners

Pellet Fuels Institute

USIPA U.S. Industrial Pellet Association

BIOENERGY*WORKS*

A VITAL CONTRIBUTION TO A LOW CARBON FUTURE



Better than Carbon Neutral:
The Bioenergy Triple Play

1. ***Working forests and purpose-grown energy crops remove carbon dioxide from the atmosphere.*** In fact, working forests are much more effective at capturing carbon than unmanaged forests, which grow slowly and have a greater risk of massive carbon releases potentially occurring in wildfires or insect epidemics.

2. ***Biobased products store carbon for a very long time, even while new forests and crops are growing.*** Forest products and other biobased products, such as renewable chemicals, are carbon sinks. And the use of wood for building is much more energy efficient than other materials like steel and concrete.

3. ***Bioenergy displaces the use of fossil fuels and prevents geologic carbon from being released into the atmosphere.*** When fossil fuel use is avoided, the geologic storage of carbon is preserved. This prevents the addition of new carbon to the atmosphere.

Sustainable Forestry and Crop Production: Taking Carbon out of the Atmosphere
Foresters plan for the long term. To sustain production of forest products over the long term, they collectively manage stands of trees across all age classes, including young and rapidly growing trees as well as older stands of trees whose growth has slowed. Keeping total forest growth and harvest in balance across many age classes is an essential part of sustainable forestry and renewable energy production. Translated into terms of carbon, a sustainable forest in balance is absorbing as much carbon from the atmosphere as is removed for forestry products – possibly more.

Sustainable forests not only remove carbon from the atmosphere and store it in a solid form, but once harvested and turned into lumber and other wood products, store carbon in wood houses, bridges and furniture, creating balanced levels of carbon cycling into and out of the sustainable forest. That is why, in recent research by a consortium of 15 universities, sustainable forestry is said to be "better than carbon neutral."

Sustainable purpose-grown energy crop production is also a sink for carbon. As in forests, a significant portion of the carbon removed by crops from the atmosphere in photosynthesis is added to the soil and permanently removed from the atmosphere. Many energy crops can be grown on marginal or degraded land, bringing new photosynthetic activity – and thus increased uptake of atmospheric carbon – to these areas. EPA analysis for the federal Renewable Fuel Standard has identified several biofuel pathways that are net carbon sinks – even on a lifecycle basis that includes emissions from energy used in crop production.

Conversion of municipal solid waste to fuel and products also provides major carbon benefits. If sent to landfill, the biomass component of MSW is typically converted by natural processes to methane – a potent greenhouse gas – and released to the atmosphere. Bioenergy production from MSW avoids this methane release – and the carbon emissions from fossil fuels that would otherwise be burned for energy.

Where Biomass Comes From
Solid biomass comes from four major sources:

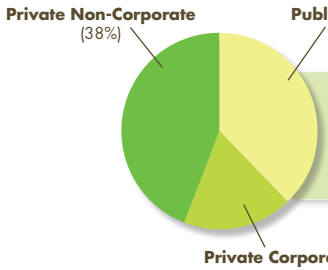
1. ***Traditional Forestry:*** Sustainably managed forests in the US provide a wide array of forestry products while continuing to produce many public benefits from clean water to biodiversity. While wood for energy as a forestry product is at the low end of the value range, it is an important market for forest residuals, thinnings and less marketable wood that are produced while managing for productive and healthy forests.

The most common sources are:
- **Forest residuals,** branches and other debris produced during logging that contributes to forest fire risk. This also includes residues produced in manufacturing forest products.
- **Thinnings**, small trees harvested to allow the remaining forest to continue growing rapidly and reduce risk of fire and disease.
- **Less marketable wood,** including larger material that may be defective or deformed but needs to be removed as part of forestry treatment.

2. ***Purpose-grown crops:*** These are crops that grow rapidly and are grown specifically for energy feedstocks. They include species such as corn, energy cane, switchgrass, *Miscanthus*, hybrid poplar, or even algae.

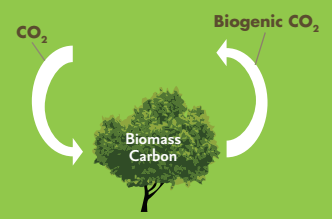
3. ***Agricultural co-products:*** A wide array of cellulosic fiber is produced as a byproduct of agriculture and can be used for energy. This includes corn stalks, peanut shells, and wheat straw.

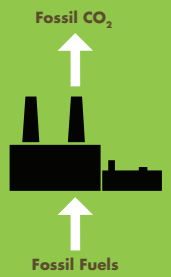
4. ***Municipal Solid Waste:*** Municipal solid waste typically contains a significant biomass component. Food waste, yard waste and construction wood waste are all examples of biomass found in municipal solid waste.



BREAKDOWN OF U.S. FOREST OWNERSHIP
Forest ownership in the U.S. represents a diverse portfolio of interests that range from preservation and protection of public values to commercial forestry enterprises to non-industrial and family forests managed for a wide range of forest attributes.

BIOGENIC AND FOSSIL CARBON IN THE ATMOSPHERE





Biogenic Carbon: A Cycle
Photosynthesis is nature's own biotechnology. Because of photosynthesis, plants harness the power of the sun by actually pulling carbon dioxide out of the atmosphere and converting it to a solid form: cellulose. In doing so, not only is carbon captured and stored, so is the energy of the sun. When a natural or bioenergy process draws from biologically stored carbon, the carbon dioxide that is released is carbon that has been recycled from the atmosphere as a part of a balanced, natural cycle.

Fossil Carbon
The use of fossil fuels for energy causes an irreversible and one-way flow of fossil carbon into the atmosphere. Fossil fuel combustion removes carbon from permanent storage in the earth and introduces it as new and added carbon into the atmosphere. When bioenergy replaces fossil energy, new carbon being introduced into the atmosphere is immediately eliminated.

Intergovernmental Panel on Climate Change Agrees: Bioenergy is Good for the Climate

"A combination of bioenergy production with carbon sink options can result in maximum benefit from mitigation strategies. This can be achieved by planting energy crops such as short rotation coppice into arable or pasture land, which increases the carbon density of that land, while also yielding a source of biomass... In the long term, a sustainable forest-management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit."