WHITE PAPER

Bioenergy:
An important part in the world's low-carbon future.

Bioenergy will play an important part in the world's low-carbon future.

Bioenergy is set to play a key role as the world transitions to a low-carbon future. Advantages of bioenergy are that it is readily available now and can be utilized with existing infrastructure - in some cases alongside conventional fuels. It is versatile and can be used not only to generate electricity and heat, but also to power transport. It can be incorporated into waste management systems, producing energy from material that was previously considered waste. It is storable and dispatchable, which makes it an ideal complement to intermittent resources like wind power. And most importantly, bioenergy typically produces 75% less carbon dioxide emissions than fossil fuels.

Biomass

Bioenergy is renewable energy that is derived from biomass. The International Energy Agency (IEA) defines biomass as biological material that is directly or indirectly produced by photosynthesis [1]. Biomass therefore consists of plant matter and animal wastes, with the main types being:

- Wood and wood residues, including wastes from the forestry and wood processing industries, and urban wood wastes.
- Organic waste/residues from
  - agriculture and horticulture.
  - fish farming.
  - food and beverage processing and production.
  - landscape management.
  - households.
- Energy crops specifically grown for the purpose of producing bioenergy.
- Microalgae (unicellular, genetically modified organisms cultivated to produce biomass) [2].
- Organic portions of municipal solid waste (MSW) and sewage sludge.

To ensure that bioenergy is truly sustainable, biomass resources should be sustainably supplied, and lifecycle greenhouse gas (GHG) emissions fully accounted for. When measures are planned to increase the supply of bioenergy, it is essential to ensure that sustainable development goals are respected. For example, great care needs to be taken to avoid any changes in land use that could compromise food production or the protection of biodiversity.

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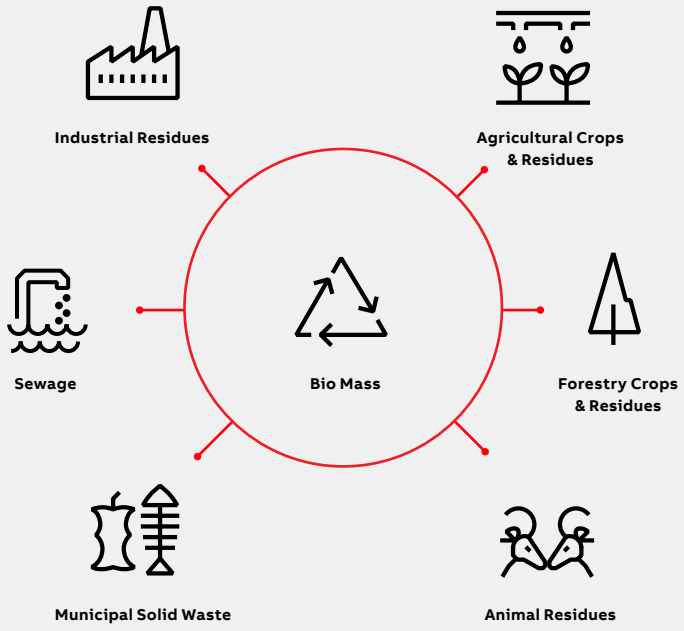
Main sources of biomass



A Different Type of Renewable Energy

In the public debate on renewables, attention tends to focus on wind and solar, possibly followed by hydropower. Even though biomass is not usually the first source of renewable energy that comes to mind, it is in fact the main renewable in today's world [3].

Bioenergy costs more to produce per unit of energy than wind and solar, but it provides important benefits that compensate for its higher cost. Bioenergy boosts grid reliability as a complement to variable resources like wind and solar. It helps societies to deal with waste, enabling energy to be generated from residues produced in different industries, as well as from MSW. Bioenergy can also promote rural development through opportunities to grow energy crops to produce biomass.

Biomass offers great flexibility in energy usage: in addition to traditional combustion to produce heat, it can be converted into solid, liquid or gaseous fuel.

Solid Biofuel

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Solid biofuels provide a useful means for countries to reduce emissions while continuing to utilize existing coal-fired power plants – facilities that may have many years of useful operating life still ahead. Co-firing involves mixing biofuel, such as wood chips, agricultural residues, or other waste, with coal.

This hybrid utilization of biomass in conjunction with fossil fuels could become relatively widespread in the future. For example, Indonesia plans to make co-firing with biomass – such as waste and woodchips - mandatory for all of its coal plants. India has plans to expand co-firing, mainly based on the use of agricultural residues.

Biomass materials such as food waste, grass clippings, leaves, and wood generally represent a large proportion of MSW, which can be incinerated in waste-to-energy (WTE) plants to produce electricity and/or heat. WTE is part of the circular economy.

Liquid Biofuel

Biomass can be converted into liquid biofuels to power transportation. The most common types of biofuels in use today are ethanol and biodiesel.

Ethanol is a renewable fuel that can be produced from various biomass sources by fermentation and distillation. Ethanol is an alcohol that is blended with gasoline to increase octane and cut down carbon monoxide emissions. The EU and several other jurisdictions have passed regulations requiring the addition of ethanol to gasoline in order to reduce GHG emissions.

Biodiesel is non-toxic and biodegradable. It is produced by combining alcohol with vegetable oil, animal fat, or recycled cooking grease. It is a cleaner-burning replacement for petroleum-based diesel fuel.

Liquid biofuels are likely to play an important role in efforts to reduce GHG emissions from transport. They can be distributed using existing networks established for petroleum-derived fuels, and many vehicles can use them with few or no modifications. They are ideal for heavy duty road trucks, and for sectors that are difficult to electrify like shipping and aviation. In fact, bio-jet fuel is seen by the International Air Transport Association (IATA) as a major element in the aviation industry's efforts to reduce CO2 emissions [5].

Biodiesel is a cleaner-burning replacement for petroleum-based diesel fuel

Biogas

Biogas typically refers to a mixture of gases produced by the breakdown of organic matter. It is produced by digestion with anaerobic bacteria, or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. The gases methane, hydrogen, and carbon monoxide can be combusted, and research is being conducted into their use in the production of liquid fuel..esearch is being conducted...an we leave it as a vague Biogas can be used for cooking or heating, to power transportation, and generate electricity.

Together with hydrogen, biogas will probably replace natural gas in industry as a source of high temperature process heat. At the same time, biogas digesters in rural villages could produce clean, renewable cooking fuel for local inhabitants while playing a significant part in overall waste management.

Current situation and outlook

Figures published by the IEA show that electricity generated from bioenergy sources totaled 718 TWh worldwide in 2020. This was an increase of 53 TWh or 8% on the previous year.

According to the IEA's Net Zero Emissions (NZE) by 2050 Scenario [6], by 2030 bioenergy should account for 1407 TWh of electricity production annually. Achieving this figure - almost double the 2020 total - will mean adding an average of 15 GW of new bioenergy electricity generation capacity each year up to 2030, which will require a significant level of investment.

Demand for liquid biofuels totaled 146 billion liters in 2021, with one IEA forecast predicting that this would grow by 28% over the period 2021-2026 [7]. In the NZE Scenario, bio-jet kerosene – a direct replacement for regular jet kerosene – will account for almost 15% of total fuel consumption in aviation as soon as 2030.

The modelling behind the NZE Scenario shows that in 2050 solid bioenergy will cover 60% of total global bioenergy demand, almost 30% will come from liquid biofuels and over 10% from biogases. The Scenario foresees no overall increase in cropland use for bioenergy production and no development of bioenergy crops on forested land – both important conditions for ensuring the sustainability of bioenergy.

Current situation and outlook

The higher relative production cost of bioenergy compared to wind and solar underlines the need for cost-effective production equipment. The machinery must be reliable, efficient, and offer a long lifetime with a low total cost of ownership.

Efficiency is essential in order to maximize the energy produced from the available biomass or municipal waste. Even though many processes are currently supported with subsidies, in the long term they must be economically viable.

ABB is a longstanding supplier of equipment for conventional power generation and has shipped more than 50,000 MVA in generators for turbine plants alone. It is now set to become a leading supplier to the bioenergy sector with a portfolio of large motors and generators that covers the bioenergy value chain:

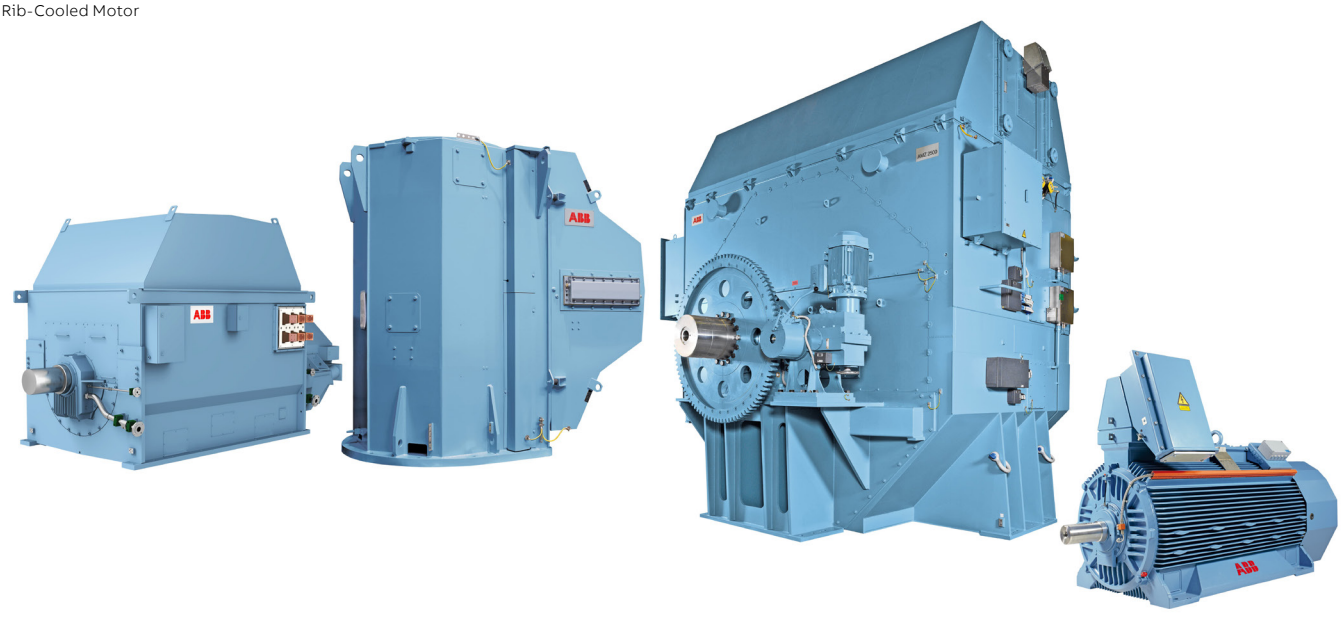
Motors

- Induction - built on a modular platform, can be either engineered or configured to order. Also, versions for hazardous areas. Optimized for variable speed control and ideal for driving pumps, fans, and compressors.
- Synchronous - based on modular and standardized platforms and featuring a flexible design concept. Also, versions for hazardous areas. Outputs up to 75 MW. Available in both fixed and variable speed versions, to power large compressors, pumps and fans.
- Permanent magnet - for premium efficiency. Can be combined with a VSD or used in a direct drive configuration to maximize system efficiency.

Generators

- For engine plants - high voltage versions up to 60 MVA, low voltage covering the range 14 – 5000 kVA.
- For turbine plants - synchronous 4-pole designs. High voltage versions up to 70 MVA.
- Permanent magnet VSD generators, low and medium voltage up to 15 MW.

A Selection of ABB's Product Portfolio for Bioenergy. From left to right: AMS Synchronous Motor, AMI Induction Motor, AMZ Synchronous Motor, NXR Rib-Cooled Motor



In the case of generators, for example, support is available to customize the entire package around the specific application. In addition to the generator, ABB can supply the cooling system, main terminal box, maintenance tools and control equipment. Also available are system monitoring and protection solutions, plus special support to ensure grid code compliance. Customers have access to local support and fast response with 60 service centers and more than 150 authorized service providers around the world. ABB motors and generators comply with all relevant standards, including IEC, NEMA and ISO.

Alongside large motors and generators, ABB's portfolio for the bioenergy sector includes variable speed drives, low voltage motors, automation systems, and electrification and other products.

A Case 1: Renewable biofuel production, North America

A plant producing renewable fuels, including biodiesel and sustainable aviation fuel (SAF), purchased two ABB AMZ synchronous motors to power reciprocating compressors. The motors are rated at 4 kV and 6,000 HP and the compressors are part of the plant's steam methane reforming process.

ABB was involved at a very early stage – from the budget phase onwards – and built a close working relationship with the customer's engineering team. The design was optimized to meet the customer's requirements, resulting in motors that adhered very closely to specifications.

Case 2: Renewable diesel production, Nordic countries

Burckhardt Compression purchased ABB's AMI engineered modular induction motors for two process gas compressors. The compressors, which comply with API (American Petroleum Institute) standard API 618, will be used in the production of clean, renewable diesel based on feedstocks that include rapeseed oil. The end customer is based in the Nordic countries.

Case 3: WTE cogeneration plant, Sweden

The plant incinerates municipal waste to operate a steam turbine, which drives an ABB AMS synchronous generator. The 4-pole water-cooled generator is rated at 34.5 MVA and 10.5 kV, and the output is fed into the grid. Residual heat goes into the local district heating system. The plant's electricity production is equivalent to the normal annual consumption of 66,000 apartments, while its heat output corresponds to the annual consumption of 21,200 average detached homes.

Conclusion

Biomass can be processed into solid, liquid, and gaseous fuels, making bioenergy extremely versatile. In addition to providing domestic and industrial heat, and electricity, it powers road vehicles, ships and even aircraft.

Compared to fossil fuels it produces significantly lower carbon dioxide emissions, which ensures that it will occupy an important position in efforts to reduce emissions as the world moves toward a greener, more sustainable future.

In order to minimize costs and maximize production from the available resources, equipment for bioenergy production should be efficient and reliable, with a low total cost of ownership. Suppliers with experience, domain expertise and a large installed base of proven products are in the best position to provide the necessary life cycle support and service.

References and further information

[1] www.iea.org

[2] Bio-aviation Fuel: A Comprehensive Review and Analysis of the Supply Chain Components, Doliente et.al., Frontiers in Energy Research, 10 July 2020.

[3] International Renewable Energy Agency, Irena, www.irena.org

According to Irena, about three-quarters of the world's renewable energy use involves bioenergy. However, more than half of that amount consists of traditional uses of biomass, such as the combustion of firewood.

Traditional uses tend to suffer from low efficiency, and the biomass is not generally produced sustainably. By contrast, modern biomass use refers to technologies like wood pellet heating systems, liquid biofuels produced from bagasse and other plants, biogas produced through anaerobic digestion of residues, and other technologies.

[4] EU Joint Research Centre.

[5] See [2] above.

[6] The IEA's Net Zero Emissions by 2050 Scenario is a pathway to reach the goal of net zero emissions globally. It is compatible with a 50% probability of limiting average global temperature rise to 1.5oC. It was presented in the IEA's special report "Net Zero by 2050: a Roadmap for the Global Energy Sector", published on 18 May 2021.

[7] IEA Renewables 2021 Report.

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