

ENERGY

***economic
green
unlimited***



Become Independent of Fossil Energy, Choose a New Energy System

Modern man consumes a lot of energy. Globally the main source is still about 80% fossil energy carriers like oil, carbon, gas; also problematic technologies like nuclear energy. The world population is expected to rise to nine thousand million by 2050 – people who demand energy. Fossil energy carriers are limited, harmful to the environment and increasingly expensive.

The security of energy supplies is a major technological and social challenge and will remain so in the long term. In order to meet the political requirements for the reduction of CO₂ emissions the comprehensive use of energy-efficient technologies is necessary in addition to energy savings. Through such means an environmentally friendly, reliable and affordable energy supply can be achieved.

This energy transformation puts the spotlight on renewable energy and new technologies. Decentralized energy supply – by small plants convenient for consumers – can complement existing centralized energy systems which are based on fossil fuels.

The field of bioenergy is a rapidly growing market with new investment opportunities.

The establishment of decentralized bioenergy plants contributes to the security of energy supplies, reduces CO₂ emissions, creates employment and boosts the region concerned.

Boost the Economic Power of Your Region and Find the Key to the Energy Transformation

A sustainable technology, that converts organic waste and residual materials into energy, that can process different feedstocks, that generates storable energy carriers, that produces recyclable by-products, that applies a combined heat and power unit as the most efficient method of using fuels, would be – a "jack of all trades" – a key to energy transformation.

Such a key exists: The innovative Pyro-BAF technology (**B**io **A**ctivated **F**uel) was developed by Professor Andreas Hornung – former director of the European Bioenergy Research Institute (EBRI) at the Aston University in Birmingham and director of the Sulzbach-Rosenberg Institute of Fraunhofer UMSICHT – as well as Ulrich Wirtz – technical director of WSE Ltd.

In 2012, the technology was successfully tested on a commercial scale.



The photos show samples from a test run of the pyro-BAF reactor on 15th August 2012. Miscanthus was used as biomass, glycerin as oil-containing stock.

Over 2000l oil were generated at a rate of nearly 180l/h.

The energy value of the fuel produced is comparable to the 11.8 kW/kg of kerosene. The oil is suitable to CHPs without further treatment.

The Pyro-BAF-Technologie is an efficient two-stage process for decentralized energy production to generate engine-suited fuels from biomass in combination with oil-containing residue for use in combined heat and power plants (see reverse).

There can be various types of biomass used by pyrolysis, the main focus being on waste or residual materials. Hence there is among other things no competition for land for cultivation of food and feed, residues are recycled instead of being disposed of. Due to its flexibility the process is less vulnerable to fluctuation in biomass feedstock prices.

The biomass needs no pre-processing, it can be treated in any form and size ranging from small pellets to chips.

The feedstock for the BAF reactor may range from plastic waste (PE/PP), oil residues or waste oil to bio oils like glycerol.

Again, the reduction of waste to landfill and the cost-cutting of waste disposal is obvious.

New energy sources are generated from biomass and oil-containing waste material by this innovative technology: Gas, biofuel and biochar offering high quality and energy efficiency.

Turn Your Waste into a Valuable Resource Instead of Expensive Disposal

The technology is ideal for companies or institutions having large amounts of biomass and/or plastic waste, such as biogas plants, disposal companies, airports, municipalities, food industry, forestry and agriculture; in general, all companies producing plastic waste or organic waste material and having high disposal costs.

The Pyro-BAF technology can be combined with other bioenergy systems very well, optimally for example with biogas plants. After fermentation the digestates of biogas plants are normally used as a fertilizer. Currently the recycling of manure and digestate as fertilizer is allowed in Germany, but the use is not allowed anymore in other countries causing disposal problems there.

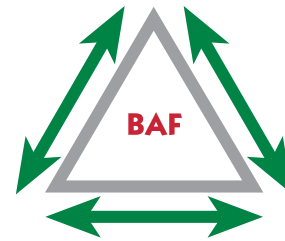
Pyrolysis can exploit the digestate once more. The residual waste volume is minimised. Due to the removal of hydrocarbons the fertilizer value of the residual material is once more compacted by generating biochar. It can be used without problems as a high quality fertilizer – comparable to "Terra Preta" – or an energy carrier. The energy sources generated by the BAF (gas and diesel) are converted into power and heat in the CHP, along with the biogas.

The separated water is fed to the biogas plant. Laboratory tests at the Harper Adams University in the UK showed up to 25% higher methane yield in the fermenter through the addition of the process water.

In addition to the specific ones the BAF technology offers the general advantages of a decentralized energy supply. Costs and environmental impacts can be saved by eliminating or reducing transportation due to the construction of a plant on site or in the immediate catchment area of the primary fuel, e.g. a biogas plant. Another benefit is the prevention of losses in the transformation and transmission of electricity. In addition the load on the national grid can be reduced, particularly during periods of peak usage.

The electricity generation efficiency of combined heat and power generation in CHPs, which tends to be smaller in relation to large-scale power plants, is more than compensated by the overall efficiency in exploiting both forms of energy. The (waste) heat can be used in the form of district heat or for business purposes.

economic efficiency



environmental compatibility security of supply

All intentions of the energy political objective triangle (based on ifo Institut) are fulfilled by the Pyro-BAF technology.

Economic efficiency

The suitability of various feedstocks ensures the independence of price fluctuations.

There are no costs for a treatment: drying and pelletizing suffice.

The use of waste or residual materials saves disposal costs.

Waste is not only reduced, but converted into valuable energy (power and heat).

The by-products (biochar) can be used as fertilizer or energy carrier.

From achievement of the break-even point the bioenergy plant will make profits.

Environmental compatibility

The amount of waste material sent to landfill is reduced.

By using waste materials there is no competition for land for food and feed cultivation, thus the discussion of "food or fuel" becomes irrelevant.

The controlled heating level of the pyrolysis avoids the formation of pollutants and tar which may cause clogging and prevent the machinery from working.

The sealed process has no emissions until used in a CHP.

By returning the generated biochar with CO₂ bonded to the soil in the form of fertilizer the overall process is not just carbon neutral, it is actually carbon negative: it is a CCS technology (Carbon Capture and Storage).

Security of supply

The used feedstocks are renewable.

This efficient and sustainable waste-to-energy system ensures the energy supply in the future.

The environmentally friendly system also ensures the supply of energy for future generations.

Would you like to find out more?

**To arrange a personal consultation please contact:
info@wse.de or +49 2461 936080**

Ensure the Economic and Ecological Advantages of an Innovative Technology

At a glance ...

**preserving resources
no competition for land**

reducing waste and disposal costs

**security of energy supply
through a sustainable technology**

strengthening regional sites

growing market with considerable perspective

mature technology

combinable

independence through feedstock diversity

**high energy volume of the generated energy
carriers**

storable

**usable by-products
climate protection by CO₂ capture and storage
rapid return on investment**

comprehensive service

**More information: www.wse.de/wse_bioenergy
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The Pyro-BAF Reactor is a bioenergy power plant to transform organic residues and plastic waste into cost-efficient and sustainable energy.

No cultivable acreages for food or feed need be lost nor ecologically valuable forests and fens destroyed due to the use of waste materials rather than energy crops.

In addition disposal fees and landfills will be reduced.

Decentralized energy supply with power-heat cogeneration has a high efficiency, relieves the national grid, is climate-friendly and helps to secure future energy supplies. In combination with regional recycling the environmental, living and site conditions will be improved in the long term.

Increasing energy demand, limited fossil fuels and the political will to reduce CO₂ emissions are increasing the market for renewable energy.

The Pyro-BAF technology was initially studied extensively on a laboratory scale. In 2012, a 150 kW_{el} system was tested in England.

The technology can be combined with other bio-energy systems, e.g. biogas plants.

Different feedstocks can be used, the exchange is unproblematic. The energy output depends on the deployed primary fuels.

The energy content of the oil generated in the BAF process is high enough to use it directly for decentralized energy production in a combined heat and power unit.

Due to the stability of the oil the suitability for storage and the transportability are very good. During peak hours, the oil can be used in the CHP.

The process becomes CO₂ negative by returning the biochar to the soil in the form of fertilizer.

The financing plan for the Pyro-BAF technology is targeted to be in the black without grants.

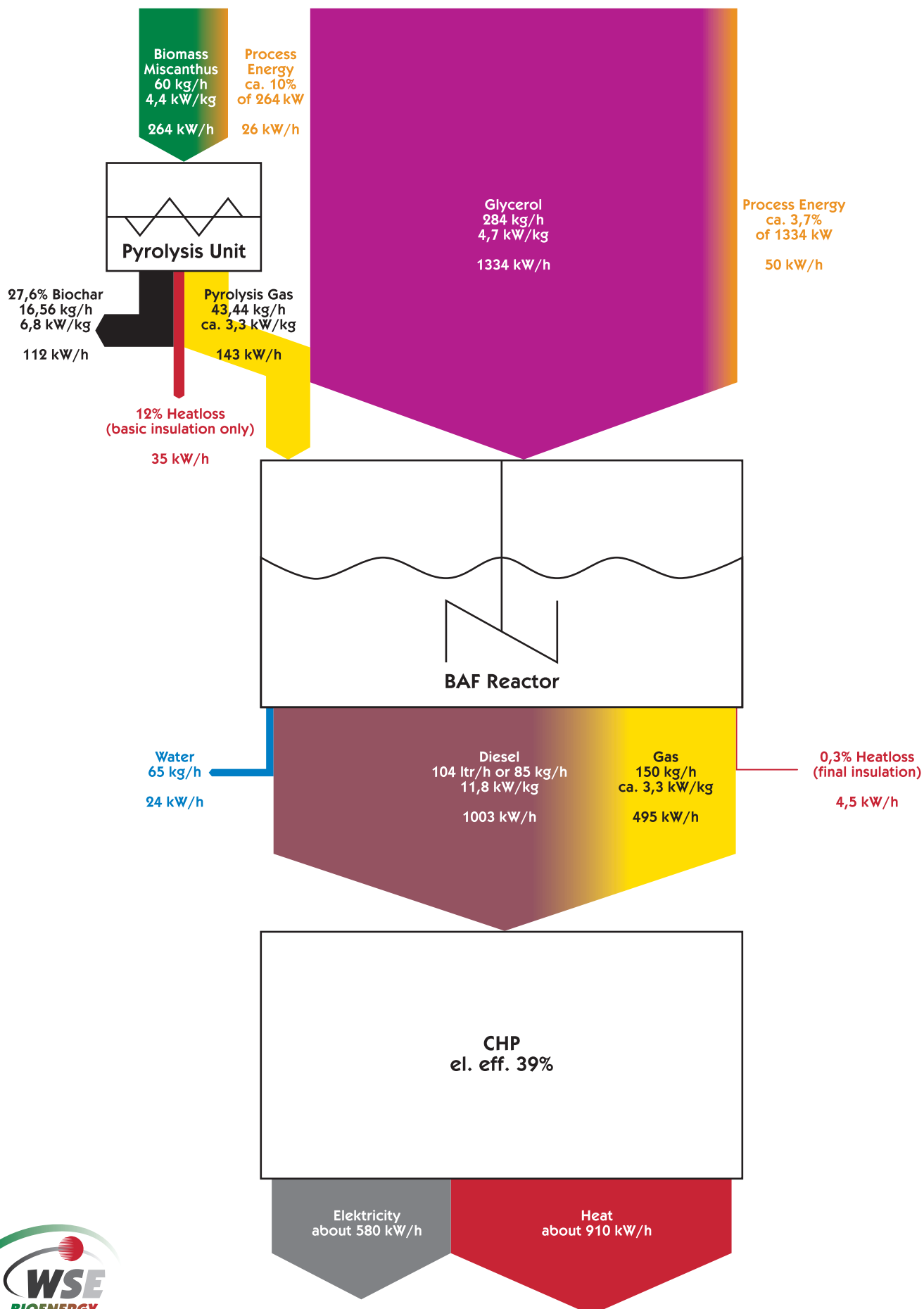
Depending on the site requirements and the feedstocks used, a Pyro-BAF system can pay for itself within three years.

Founded in 1989, WSE is your partner in the bioenergy sector since 2008. We can assist you with everything: from the first feasibility study, to the construction of your plant and even the preparation of all documents needed to achieve a production license according to the German Emission Prevention Law (BimSCHG).

Generate Heat and Power Efficiently with the Pyro-BAF Technology

The Sankey diagram demonstrates the effectiveness of the Pyro-BAF technology.

The ratio of primary energy used to the disposable proportions of electrical energy and heat energy is shown.

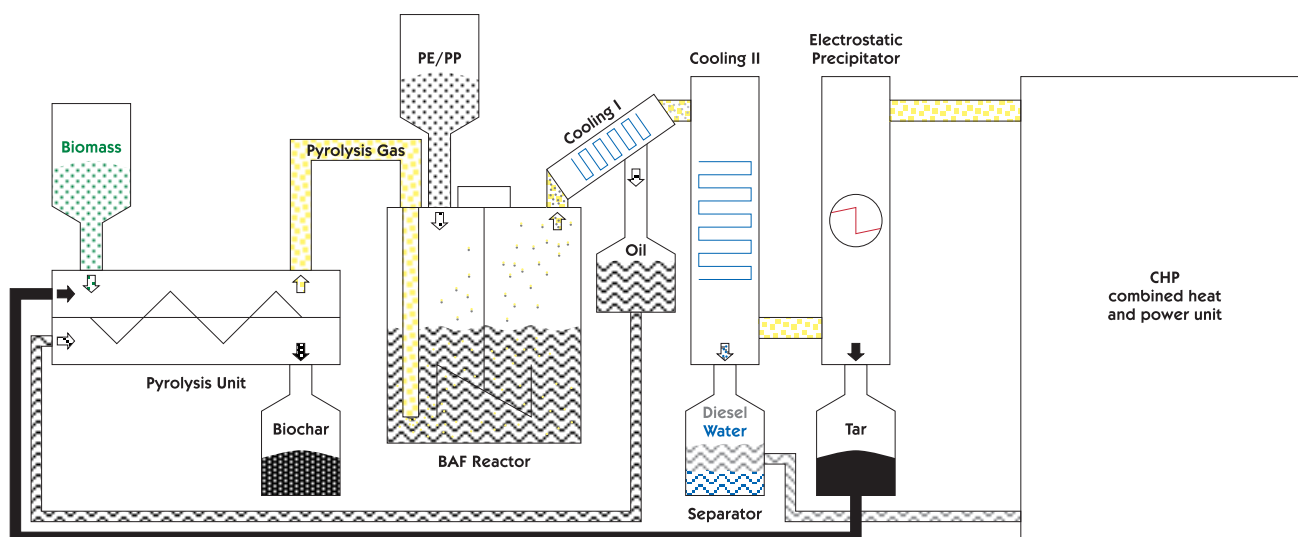


The Pyro-BAF Reactor

The **Pyro-BAF technology** is a two-stage process generating an engine-suited fuel from biomass in combination with oil-containing waste materials for use in cogeneration units. In a first process step the biomass is separated into biochar and pyrolysis gas by means of a pyrolysis unit. As the reaction occurs under controlled heating levels (450-500°C) it avoids the formation of tar and almost no pollutants are generated.

In a second step the resulting pyrolysis gas is fed into the BAF reactor where it reacts with a hot residue oil. The resulting product gas is condensed into an oil component and a diesel-water component by two stages of cooling. Finally the remaining gas is cleaned in an electrostatic precipitator and directly converted into electrical energy in a combined heat and power unit.

The BAF process offers several advantages over pure pyrolysis. On the one hand the pyrolysis gas is cleaned by the oil into which it is fed. On the other hand the gas also reacts with the oil and cracks it in substantially lower temperature ranges than would be possible without pyrolysis gas. This reaction creates a more stable, storable diesel component which also has a significantly higher energy content than pure pyrolysis oil. Optionally more gas or diesel can be produced in the BAF process depending on the feedstock and the temperature used in the BAF reactor. The feedstock for the BAF reactor may range from plastic waste (PE/PP) to oil residues, to bio oils.



Reduce your waste and disposal costs. Turn your waste into money by transforming it into valuable energy. Improve the environmental, the living and the site conditions in your region in the long term.

**Please arrange a personal consultation:
info@wse.de or +49 2461 936080**

Frontispiece: electrical tower – Jetti Kuhlemann; dungheap – Thomas Max Müller / pixelio.de

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