

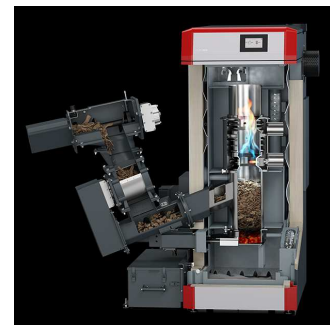
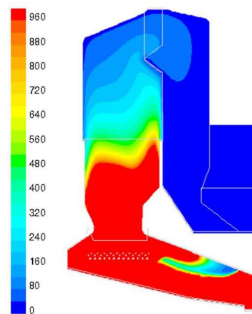


BIOENERGIESYSTEME GmbH

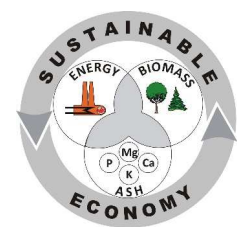
Your partner for energy utilisation from biomass and energy efficiency
Research • Development • Engineering

BIOS BIOENERGIESYSTEME GmbH

Company information, highlights and selected references



8020 Graz, Hedwig-Katschinka-Straße 4, AUSTRIA
T: +43 (316) 481300
office@bios-bioenergy.at | www.bios-bioenergy.at
LG f ZRS Graz, FN 208240 k; UID-Nr. ATU 51448900



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Basic data

The company was founded in 1995 as a Graz University of Technology spin-off in the form of a business partnership. In 2001 the legal status of the company was changed to a limited liability company due to the increasing annual turnover and the integration of senior staff members.

Prof. Ingwald Obernberger, who holds 51% of the shares, is the managing director and founder of the company. The remaining shares are held by 5 experienced staff members, providing a strong basis for the further development of the company.

The present staff of BIOS BIOENERGIESYSTEME GmbH comprises 25 persons, 21 of them are university graduates (in the area of process, energy and environmental engineering and chemistry). The turnover volume amounted to approximately 5 million Euros in 2020.

The company's registered office is located in Graz.

Contact address:

BIOS BIOENERGIESYSTEME GmbH

Hedwig-Katschinka-Strasse 4

AT – 8020 GRAZ

AUSTRIA

TEL: +43 316 481300

E-MAIL: office@bios-bioenergy.at

HOMEPAGE: www.bios-bioenergy.at (contains comprehensive information about the company)



Fields of activity

BIOS BIOENERGIESYSTEME GmbH is active in research, development, planning and optimisation of processes and plants designed to generate heat, cold and power (based on combustion, gasification and pyrolysis), of processes for biomass treatment (pelletising, torrefaction, biochar production) as well as with energy technology solutions for industry and waste heat recovery.

Another special competence of BIOS is the **CFD simulation of biomass combustion, gasification and pyrolysis processes** for a targeted and efficient development of new technologies as well as for optimisation and refurbishment of existing plants. CFD simulations are used practically in all technology developments and improve the understanding of the expiring processes and of relevant influencing variables. BIOS has gained an internationally leading role in the field of CFD simulations of the thermal conversion of solid biomass.

Since October 2015, BIOS has moved into its **new centre of innovation**, which has about 800 m² of office space and about 400 m² of testing facilities and laboratory space, what offers a very good infrastructure for research and development work.

The comprehensive research and development activities in close cooperation with national and international partners and an **own measuring and chemical analysis department** distinguish BIOS in particular and allow its clients to benefit from the latest know-how and developments.

The BIOS team of engineers has **many years of comprehensive experience** in its fields of activity and can refer to a wide range of project implementations and successful developments.

The experience gained in projects that have already been implemented, as well as detailed knowledge in the planning and design of energy systems guarantee that solutions provided by BIOS are at the cutting edge of technology and meet the highest standards of cost effectiveness and environmental compatibility.

BIOS BIOENERGIESYSTEME GmbH is an experienced and **reliable partner for all fields of energy technology**. The solutions offered take account of the latest developments and innovations in this sector and meet the most demanding requirements.

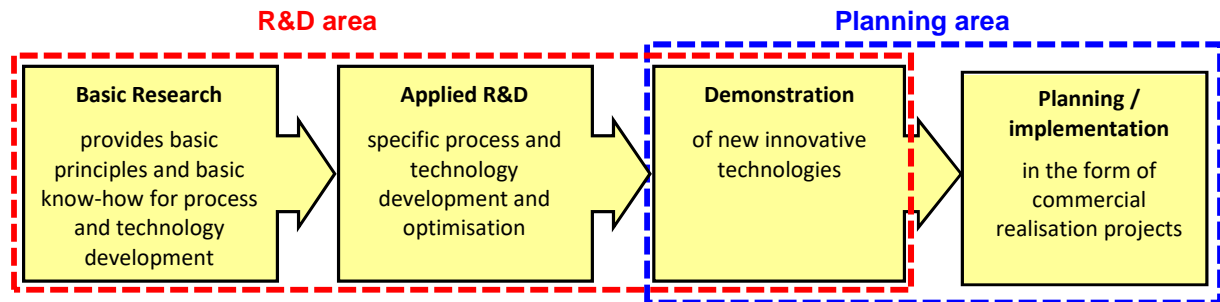
Company philosophy

With research, development and planning activities, **BIOS contributes to a sustainable and CO₂-neutral energy system of the future** and has already made many important contributions through more than 20 years of work.

BIOS has set itself the objective of always being at least one step ahead of the competition in terms of new technological developments and know-how development - this has always been successful over the last 20 years and is reflected in the many highlights of BIOS (see corresponding chapter). This is ensured through close cooperation with national and international research institutions and through the coupling and close cooperation between the company's internal research and planning department.

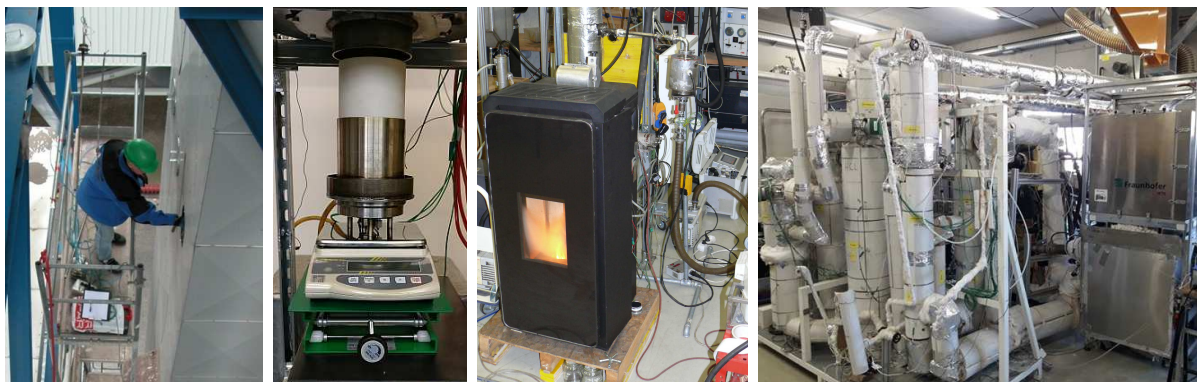
Company structure

Following the activities of BIOS, the company is divided into a research group and a planning group. This structure represents a significant advantage of BIOS compared with other engineering offices and research institutions, since BIOS covers the entire development chain from innovative processes and products to implementation with its key activities. There are important synergies between the R&D and planning areas. Development can be more application-oriented and planning can be more innovative.



These two operating fields are the essential pillars of our company, generate synergies and influence each other. New technologies, developed for customers in the research group, can later be introduced to the market by the planning group through an initial large-scale demonstration. Computer simulations by the research group can support the planning group in the technical design of systems. Measurements and analysis by the research group are an important support when testing and evaluating systems by the planning group. Customers benefit from the added value and synergies of the two groups and the practice-related developments.

Project teams typically consist of between 2 and 6 employees, depending on the size of the project. Projects are managed by a project manager with several years of relevant professional experience. Experienced department heads are in charge of the research and planning departments, as well as the areas of measurement technology and analytics belonging to the research department, as well as CFD simulations. These communicate directly with the management.



Working areas - planning and optimisation

- **Plants designed to generate heat, cold and power from biomass**
 - Application of different technologies (ORC process, steam turbine, gasification + gas engine, gasification + gas turbine, Stirling engine, screw-type engine, thermoelectric generators, ...)
 - Use of solid, liquid and gaseous fuels produced from biomass and substrates
- **Waste heat recovery systems**
 - e.g. downstream of biomass furnaces, industrial processes, gas turbines, ...
- **Heat pumps, chilling and cooling plants**
- **Energy centres**
- **Process heating systems**
- **Hybrid systems (combination of different technologies)**
 - Solar energy / biomass
 - Solar energy / heat pump / biomass
 - Industrial waste heat / biomass
 - Industrial waste heat / heat pump / biomass
- **Heat storage systems**
 - Low and high temperature storage, latent-heat storage systems
- **District heating networks**
- **Pellet production plants**
- **Biomass torrefaction plants**
- **Biomass refinery concepts based on biomass pyrolysis**

Working areas R&D

- **Development, planning and optimisation of combustion systems, boilers, gasification and pyrolysis technologies, furnaces, storage systems, flue gas cleaning systems and cooling systems by special tools dedicated to the related processes:**
- **CFD simulations (Computational Fluid Dynamics) under application of specially developed process specific codes**
- **Design and test of pilot plants**
- **Efficiency and emission measurements for the check and evaluation of new technologies**
- **Analyses (biomass fuels, ash and aerosols, waste water)**
- **Fuel, ash and dust characterisation**
- **Development of concepts for sustainable ash utilisation**
- **Development of computer software and databases**

Working areas consulting, expertises, QM Holzheizwerke (quality management wood heating systems)

- **Monitoring as a basis for plant optimisation**
- **Development and implementation of measures to increase energy efficiency**
- **Consultancy concerning the Energy Efficiency Law**
- **Coordination and participation in national and international research, development and demonstration projects**
- **Application and management of national and international project funding**
- **Quality management in accordance with "QM Holzheizwerke" in Austria**
- **Expertises on ash-related issues, special biomass fuels, biomass combustion, gasification and pyrolysis technologies, as well as regarding process control and hydronic systems**

Highlights

Awards

- As a **co-organiser of the 4th Central European Biomass Conference**, 2014, from January 15th to 18th, at MSC Graz, with around 1300 participants from 45 countries, BIOS received the **Congress Award Graz** together with the Austrian Biomass Association.
- In the category “11 to 100 employees”, BIOS BIOENERGIESYSTEME GmbH received the **Hidden Champion 2013/2014** due to its **innovative strength**.
- As a result of many research and development work in cooperation with the Styrian company KWB - Kraft und Wärme aus Biomasse GmbH, in St. Margarethen an der Raab, **BIOS and KWB were jointly nominated for the VERBUND-E-Novation Award 2015** for the "KWB Multifire - New burner technology for recycling residues from agriculture".
- The TDS Powerfire wood chip boiler from KWB, co-developed by BIOS, received the innovation prizes "Energie Genie" and "Energy Globe Award".
- The new zero-dust biomass combustion technology from Windhager (PuroWIN technology), co-developed by BIOS, received the "plusXAward" and "Energy Globe Award" innovation prizes.
- The biomass-fired CHP technology based on Organic Rankine Cycle (ORC) developed by BIOS, which was first realised EU-wide in the Admont wood industry as part of an EU demonstration project and which was subsequently upscaled and optimised in a further EU demonstration project in the Lienz biomass CHP plant, received the "**Energy Globe Award**".
- Die new hybrid-biomass boiler technology of SL Technik GmbH (ECOS-Technology) co-developed by BIOS achieved word records regarding the boiler efficiency in 2020 (**Guinness World Records** Holder), was nominated for the „Energy Globe Award“ and received several „plusXAward“ innovation awards.
- In recognition of special achievements in the interest of the province of Styria, the Styrian government has granted BIOS BIOENERGIESYSTEME GmbH the **right to use the Styrian coat of arms** in 2019. At the company's 25th anniversary celebration, Governor Hermann Schützenhöfer handed over the high state award to managing director Ingwald Obernberger at the company's headquarter in Graz. This award expresses the fact that BIOS has earned merits for the Styrian economy through extraordinary achievements and that it occupies a leading and generally respected position.



Publications and successful projects

Due to its comprehensive R&D activities, BIOS has so far already

- **More than 250 publications in international journals and conference proceedings**
- 6 publications of books
- **About 300 national and international scientific lectures** in more than 160 biomass conferences, symposia, professional conferences, seminars and workshops
- **More than 20 keynote lectures by the managing director, Dr. Ingwald Obernberger, at international conferences**

BIOS has been, or is, involved in **more than 20 completed/running EU-funded R&D projects** and has also performed the coordination in several projects, which underlines the high international reputation of BIOS as well as the intensive international networking and cooperation.

BIOS BIOENERGIESYSTEME GmbH has already carried out **more than 400 national and international R&D respectively planning projects** (see reference list attached).



Major national and international development and demonstration projects for new biomass combustion and combined heat and power technologies

- **Development of a new and efficient technology for biomass district heating plants in Tamsweg (Salzburg). Demonstration project supported by the EU.** The innovations include a new biomass pre-drying technology using waste heat from flue gas condensation, a new low-NOx combustion technology and a flue gas condensation technology directly integrated into the district heat extraction for efficient heat recovery.
- **Development and demonstration of the first biomass CHP plant in the EU using the ORC process and fuzzy logic control for Stadtwärme Lienz (Tyrol).** Important innovations include the first-time implementation of a heat recovery system in a thermal oil plant to increase the electrical efficiency, the use of a fuzzy logic for process control optimisation and an efficient multi-stage flue gas cleaning system by combining a multi-cyclone, wet electrostatic precipitator and a flue gas condensation plant. This project was **funded by the EU within the framework of the EU Demonstration Programme and received the Austrian Energy Globe Award.**



Picture of the ORC plant and the turbine - Lienz biomass CHP plant

- **Worldwide first development and demonstration of a biomass CHP plant based on an 8-cylinder Stirling engine** in cooperation with MAWERA (Hard, Vorarlberg) and the Technical University of Copenhagen. The project was funded under the EU R&D programme.



Pilot plant of the biomass fired Stirling engine

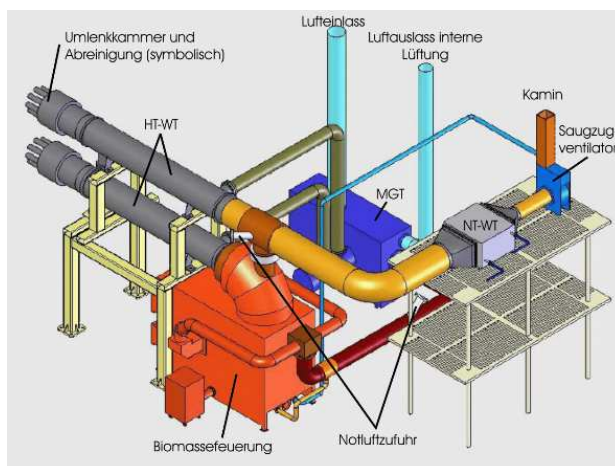
- **Development and demonstration of the EU's first biomass CHP plant using the screw-type steam engine process at the Hartberg biomass heating plant**

Project supported by the EU Demonstration Programme.



Screw-type steam engine (730 kWel) in the Hartberg biomass CHP plant;
Cooperation project with the University of Dortmund (Germany)

- **Development of a micro gas turbine fired by biomass.** EU development and demonstration project realised in cooperation with MAWERA (AT), Ansaldo (IT) and the University of Florence.



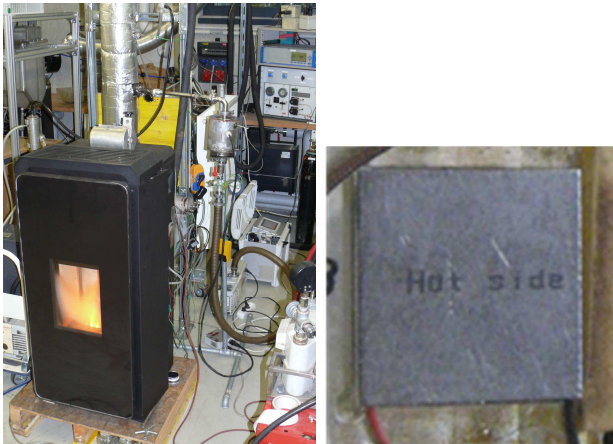
Biomass CHP plant with a 100 kWel micro gas turbine indirectly fired with biomass

- **EU-SUNSTORE - Development of a district heating supply based on solar energy, large heat storage, heat pump and biomass CHP.** EU demonstration project, which was realised in Marstal (DK) and achieves a solar coverage rate of about 50%.



Picture of the large-scale solar plant and the large heat storage tank with foil cover and the biomass heating power plant in Marstal (DK)

- **Development of a thermoelectric generator for pellet stoves.** ERANET-Bioenergy project in cooperation with the Austrian logwood and pellet stove manufacturer RIKA as well as German and Swedish partners. **The thermoelectric generator was successfully developed and tested, enabling energy-autonomous operation of the pellet stove.**



Picture of a thermoelectric element and the wood-burning stove pilot plant with thermoelectric generator on the test stand at BIOS

- **Development of innovative processes for wood ash utilisation** as part of the 4-year "Collective Research" project of the FFG in cooperation with the **Styrian Chamber of Agriculture**, the Austrian Association of the Wood Industry and the University of Natural Resources and Applied Life Sciences, Vienna. Within the scope of the project, innovative methods of wood ash utilisation for composting and soil stabilisation in the construction of forest roads and roadways were developed and tested.



Construction of a new road section with wood ash as stabilising material in Styria

Current new worldwide developments at BIOS – selected examples

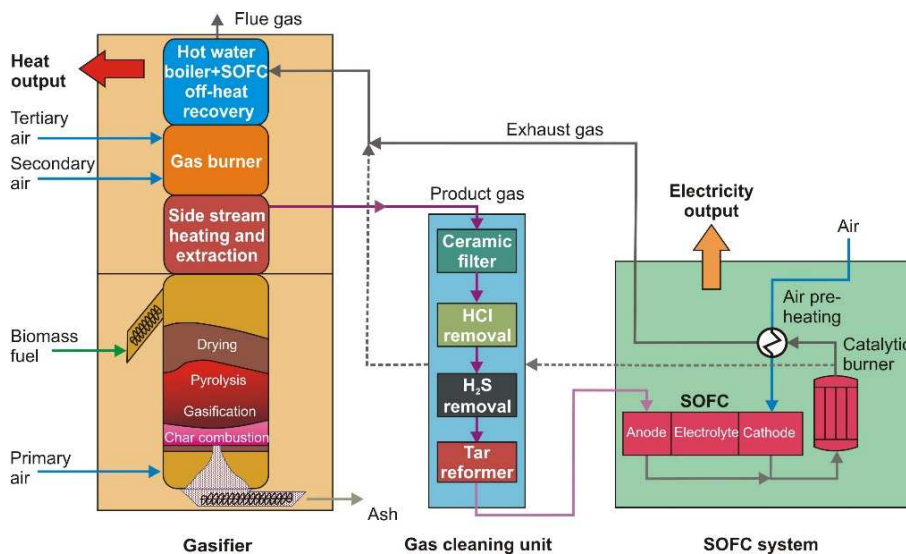


EU Horizon2020 Project „FlexiFuel-SOFC“ (<http://www.flexifuelsofc.eu>):

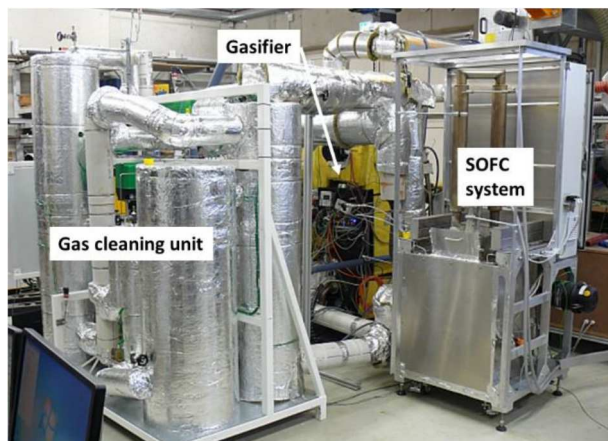
Development of a new and highly efficient micro-CHP system based on biomass gasification and a Solid Oxide Fuel Cell (SOFC). The project involves the coupling of a biomass fixed bed gasifier, a novel gas cleaning system and an SOFC. The biomass updraft gasifier should be able to work very fuel-flexible, the coupling with the innovative gas cleaning and the fuel cell should ensure a highly efficient system, which achieves electric efficiencies of over 40% (related to the fuel cell) and by extraction of the waste heat an overall efficiency of over 90% (related to the energy supplied with the fuel). Furthermore, the system should be practically free of pollutants. It has been developed for small-scale plants (25 to 150 kW thermal output) and **is thus intended to supply residential buildings with highly efficient and practically emission-free energy in the future on the basis of renewable energy.**

FlexiFuel-SOFC is an EU research project realised by BIOS in cooperation with Windhager Zentralheizung Technik GmbH, AT, TUD (Delft University of Technology, NL), HYG (Hygear BV, NL), Fraunhofer (Fraunhofer Institut IKTS, DE), AVL List GmbH, Graz, AT, WIKUE (Wuppertal Institut für Klima, Umwelt, Energie GmbH, DE) and UU (University Utrecht, NL).

Within the 4-year project a first pilot plant has been built at BIOS, which has been successfully operated for several hundreds of hours. **The SOFC's nominal electrical output of 6 kW_{el} has been achieved in pure biomass operation, which is a world premiere.** Below is a scheme and a picture of the test plant in the BIOS innovation centre.



Schematic representation of the new CHP technology based on biomass gasification, hot gas cleaning and an SOFC fuel cell



Picture of the Flexi-Fuel SOFC test plant in the BIOS innovation centre



EU Horizon2020 Project „FlexiFuel CHX“ (<http://www.flexifuelchx.eu>):

Development of a highly efficient and fuel-flexible small-scale biomass combustion technology with extremely low emissions based on extreme air staging and integration of flue gas condensation. The project will develop a new biomass combustion technology based on the principle of extreme air staging (updraft gasifier coupled with a highly efficient gas burner and a boiler with integrated flue gas condensation). This will result in practically complete burnout, **extremely low dust emissions (practically at the detection limit)** and very **high efficiencies of over 100%** (based on the heat value of the supplied fuel). The technology has been developed for small-scale plants (25 to 100 kW thermal capacity) and represents a technological milestone in terms of efficiency and emission reduction **for small-scale biomass combustion plants.**

FlexiFuel-CHX is an EU research project realised by BIOS in cooperation with Windhager Zentralheizung Technik GmbH, AT, Evoplan (CH), CIEMAT (ES), Technical University of Munich, WIKUE (Wuppertal Institut für Klima, Umwelt, Energie GmbH, DE) and UU (University Utrecht, NL).

Pilot plants have been set up and tested with different solid biogenic fuels at BIOS, Windhager and at CIEMAT in Spain. It has been shown that the extremely low emissions and high efficiency levels can be achieved for a wide range of fuels. A scheme of the new technology and pictures of the fuels that can be used are presented below.



Picture of the Flexi-Fuel-CHX-Technology, as well as different applicable biomass fuels (almond shells, wood chips, pellets, olive stones)