energy
innovation
austria

1/2012

Current Developments and Examples of Sustainable Energy Technologies

Bioenergy Technology of Tomorrow

Pioneering R&D Findings from Austria

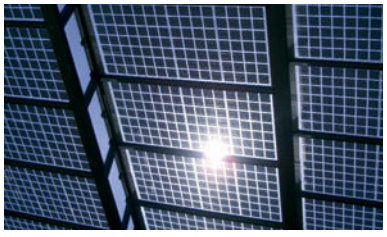
National and international energy policy goals require a restructuring of the present energy supply setup with regard to technical, economic, legal and social aspects. The aim is a sustainable energy system based on highly efficient technologies low on emissions and capable, on a long-term basis, of securing a reliable, low-cost and environmentally friendly supply of energy. Bioenergy technologies are in a position to play an important role in future energy scenarios.

BioCRACK Input & Output, Source: OMV

Bioenergy
Technologies of the Future for a Sustainable Supply of Energy

Using solid biomass, photovoltaics, solar thermal energy and heat pumps has allowed Austria to reduce CO_2 emissions in 2011 by more than 10.5 million tonnes. According to directive 2009/28/EC the share of energy consumption from renewable sources in Austria is to be increased fur-ther to a level of 34% by 2020. The European Commission's "20-20-20" targets not only represent a great challenge for energy policy but also generate considerable opportunities for Austrian industry, especially innovative developers and manufacturers of technology.

Austria has extensive know-how in the field of using renewable sources of energy, plus many years' experience in research, technological development and industrial implementation. By increasing public spending for energy research fourfold in the period from 2007 to 2010, Austria extended the scope of R&D activity considerably. In 2011 public expenditure for energy research reached 120.8 million Euro. Within the framework of research programmes of the Ministry for Transport, Innovation and Technology and of the Climate & Energy Fund, projects are continually supported in the relevant areas where Austria is strong, to secure a national technological lead long-term.

Austria is integrated into numerous research networks of the International Energy Agency through the ministry's IEA Research Cooperation, and at present participates in 7 of the current 12 tasks of the "IEA-Bioenergy" research programme.

Technologies to exploit renewable sources of energy have proven to be a fairly reliable economic factor even in times of economic upheaval. The renewable energy sector of the economy has performed very favourably during the last few years. In the areas of solid biomass (fuels, boilers and stoves), photovoltaics, solar thermal power or heat pumps Austrian companies generated about 3.3 billion Euro of revenue with more than 27,000 employees in 2011. Austrian technology manufacturers are present and successful in international markets, e. g. two out of three biomass boilers installed in Germany come from Austria.

Today the energetic exploitation of solid biomass represents one of the main pillars of renewable energy usage in Austria. The gross domestic consumption of solid biofuels went up from 142 PJ in 2007 to about 169 PJ in 2011. By using biogenic fuels greenhouse-gas emissions equalling about 9.6 million tonnes CO_2 were avoided in 2011.

New bioenergy technologies will play a key role in future energy scenarios. That is why Austrian scientists and companies are intensely concerned with researching and testing innovative technology approaches to using biomass efficiently and in environmentally friendly ways.

Biomass is solar energy stored in the form of energy crops, wood or residual materials such as straw, organic waste or manure. Due to the chemical proximity of biomass to today's conventional energy sources (oil, natural gas and coal), it is basically possible to make the same products out of renewable raw materials as out of fossil energy scources.

Aided by modern technology, solid, liquid or gaseous biomass can be used to generate heat and electricity or made into chemical products, e. g. synthetic biofuels or hydrogen. Biomass has a great potential for the future to replace fossil energy sources in many industrial processes. ◘

Research Location Güssing
Energy Region of Tomorrow Built on Bioenergy

Since the 1990s Güssing has evolved into a trend-setting energy region through a comprehensive energy-efficiency programme (thermal insulation, use of LEDs) and the broad implementation of renewable energy sources (e. g. district heating and photovoltaics) to generate heat and electricity, also attracting great attention internationally as a leading environmentally friendly region with its more than 30 demonstration facilities.

One of the reasons for success is the close links and cooperation between industry, equipment suppliers and research institutions. After the founding of the European Center for Renewable Energy (EEE) in 2002, Güssing became a research location with a European reputation. In 2009 the research center "Technikum" with a focus on biomass gasification and synthetic fuels was opened as part of the COMET programme. The Technikum in Güssing is one of several locations for the "Bioenergy 2020+" competence centre, where, amongst others, the Vienna University of Technology, Graz University of Technology and Joanneum Research are involved.

Bioenergy Technologies in Practice

One of the most important innovations is the Güssing biomass power station with 8 MW_{th}, powered since 2001 by DUAL FLUID steam gasification technology developed specially at the Vienna University of Technology to process ligneous biomass. In the case of DUAL FLUID gasification the gasifying and combustion processes take place in two separate fluidized-bed reactors; in the gasification section the fluidizing medium is steam, in the combustion section air. The output is nitrogen-free producer gas low in tar with a calorific value of 12 MJ/m^3.

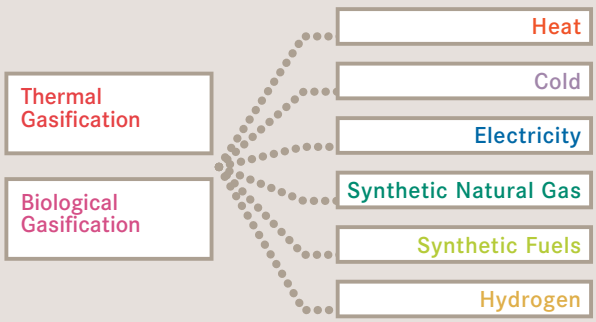
Due to the producer gas's advantageous characteristics there are many possible usages: simple conversion to electricity and heat in gas engines or turbines, producing renewable synthetic natural gas (BioSNG) or hydrogen, finally high-grade synthetic products such as Fischer-Tropsch diesel fuel, kerosene and petrol (BTL - Biomass to Liquid, 2nd-Generation Fuels).

Various ways of exploiting the possibilities are currently being examined as part of on-going international projects; some have already been successfully demonstrated. In 2008 wood-based producer gas from a biomass power station was converted to synthetic natural gas for the first time worldwide. Beside wood chips, it is basically also possible to use other carbonaceous raw materials for this process. Apart from thermal gasification, Güssing also practices biological gasification of carbonaceous raw materials in bio-gas facilities. Various materials from the region (e. g. agricultural residual materials, straw, etc.) are drawn on for this. There are plans for supplying energy via a local biogas grid and further increasing the number of natural-gas filling stations.

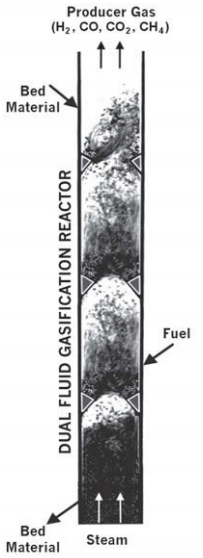
Biomass power station in Güssing (Austria)

The new technologies tested in Güssing form the basis for future energy supply hubs which meet all needs regarding heat, electricity and fuels from resources available in the region, without competing with the food industry for materials. Research and Development create added value and help to protect the environment. ◘

TECHNOLOGY



Ways of exploiting producer gas made from biomass
Source: EEE



DUAL FLUID test facility
Cold model (on right)
Detail of gasification reactor (on left)

Source: Institute for Chemical Engineering, Vienna University of Technology

G-volution I and II
Efficient Use of Biogenic Residual Materials

The DUAL FLUID technology, first used in Güssing (Austria), is already being used on an industrial scale in several places today to convert homogenous, uncontaminated wood chips (Oberwart/9 MW and Villach/15 MW, both in Austria, Senden/Neu-Ulm/14 MW in Germany and Göteborg/32 MW in Sweden).

In order to be able to make use of low-grade, locally available raw materials a lot of research effort at the Vienna University of Technology is being put into developing this successful technology further towards fuel flexibility and increased efficiency. Within the framework of the G-volution I and II projects, scientists at the Institute for Chemical Engineering are designing and building a novel pilot plant which will convert industrial residual materials and agricultural waste into a high-grade natural gas substitute of high calorific value. Developing this new fluidized-bed concept will result in a system which guarantees, beside a broad range of fuels, improved overall efficiency and perfect preconditions for large-scale facility output.

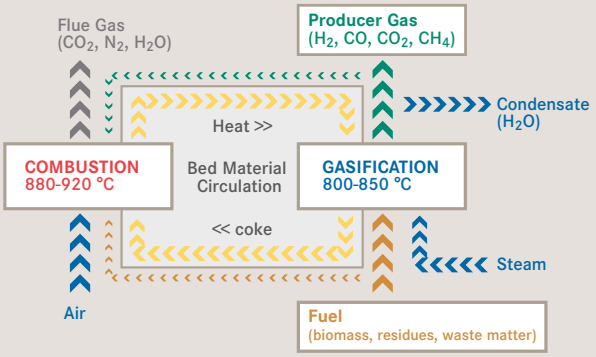
The focus is particularly on low-cost fuels available in abundance, such as wood shavings, tree bark, waste/discarded wood, sewage sludge, loppings, black liquor, waste straw/reeds/plants, as well as other biogenic residual or waste materials. These fuels represent a particular challenge for the gas production concept. Amongst other things, great amounts of fine and coarse ash colect which have to be removed continually from the system.

The new design has in the meantime been patented as an innovation in the field of fluidized-bed technology. The trial results from a cold model serve as the basis for constructing the Technikum “hot unit”, which will produce the desired producer/synthetic gas under true working conditions at 850 °C. The project sequence is to be conducted in cooperation with TECON Engineering GmbH, a partner from industry.

The new test facility will contribute to making increasing use of biogenic residual materials in future. The aim is in particular to offer an alternative to companies which have to rely on fossil fuels due to technical constraints relating to production or processes. It is thereby primarily envisaged to appeal to companies producing iron, steel and petrochemical products. ◘

TECHNOLOGY

The **DUAL FLUID Concept** consists of two fluidized beds which are integrated with a hydraulic connection beneath. Thereby one of the two fluidized beds delivers the energy necessary for the gasification process by burning some of the biomass.



Schematic of DUAL FLUID fluidized-bed process

Source: Institute for Chemical Engineering, Vienna University of Technology

The heat generated is fed into the gasification fluidized bed via the bed material. The gases from both reaction chambers do not mix. The DUAL FLUID gasification technology thus permits the production of nitrogen-free producer gas. In conventional designs with two fluidized beds the gasification reactor is implemented as a stationary bubbling bed and the combustion reactor as a circulating fluidized bed. But the bubbling fluidized bed design has the disadvantage that above the bed there is an empty space which contains only gas and no catalytically active bed material.

The novel design of the gasification reactor replaces the empty space with geometrically defined counterflow zones for increased gas/solid contact. Increased interaction of bed material and flowing gas(es), and the systematic use of catalytically active solids improves the quality of the producer gas. The amount of steam used in gasification is also optimized to improve the efficiency of the system.

Univ.-Prof. DI Dr. Hermann Hofbauer, Institute for Chemical Engineering, Vienna University of Technology, on Austrian research and development in the field of bioenergy.

What potential do you see for bioenergy with regard to our future energy supplies?
Bioenergy is stored solar energy which can be used at any time, independently of whether the sun is shining or the wind blowing. Wind and solar power are subject to fluctuation over time and thus need to be combined with suitable energy storage technologies. Due to this important advantage bioenergy is going to rank prominently in a future and sustainable energy system.

How active are Austrian scientists and companies in this field?
My perception is that both Austrian research institutions and companies concerned with bioenergy are quite active – so it has always been possible to put our ideas across to companies which then participate in development and launch successful products on the market.

How well integrated is Austria into international research activities?
Austria's researchers are extremly active and sucessful internationally, and have set up networks of their own during the last few decades. This is the foundation for successful participation in various EU programmes. A significant starting-point for the development of these networks has been the IEA Research Cooperation network, which Austria has been a part of for almost 40 years now.

Which opportunities does participation in IEA-Bioenergy offer to researchers and companies?
Energy research is on the international agenda and does not stop at the Austrian border. By participating in IEA-Bioenergy we can recognize international developments in good time and participate in shaping them. Subsequently research topics can be positioned properly in Austria and strengths developed which are then brought to bear when we participate in international research projects. In some bioenergy areas Austria has actually led the way internationally in the past.

Which areas of research have the greatest potential for development?
A future sustainable energy system will be based on intelligent coordination of several renewable energy sources, with primarily local producers feeding into this system. Currently, for example, dual energy grid systems (e. g. electricity and natural gas) are under discussion which require efficient methods for conversion ("Power to Gas"). These areas have the greatest potential for development in my view: a potential which needs to be evaluated and harnessed in future.

BioH2 4Refineries Hydrogen from Biomass for Industry

Hydrogen could become an important energy source in future if suitable low-cost processes for producing it from renewable raw materials are developed. Today gaseous hydrogen is part of many industrial processes, for instance in oil refineries, and it is usually extracted from fossil raw materials (raw petrol or natural gas). Hydrogen made from biomass reduces refineries' CO_2 emissions from fossil materials considerably and thereby makes refinery processes significantly more environmentally friendly without affecting fuel quality.

Within the BioH2 4Refineries project the partners OMV, Repotec, Bioenergy2020+ and Vienna University of Technology are currently developing a process which makes the production of high-purity hydrogen from biomass possible on an industrial scale. The new technology is based on the biomass DUAL FLUID gasification technology described above. Apart from wood chips, short-cycle energy crops can also be used as biogenic raw material. With a broad range of raw materials it is expected that the approach will become economically viable.

As regards the production process developed, a model has been devised at the Vienna University of Technology for calculating the energy balance and mass balance for the new hydrogen production facility. The first results demonstrate the capacity of the new process: from a biomass input with a calorific value of 50 MW it is possible to generate 30 MW of ultra-pure hydrogen for refinery applications. Additional heat from the process can be used on site to generate process steam.

The hydrogen produced from biomass complies with modern refineries' strict requirements. So far environmentally friendly fuels have been produced by mixing biofuel with conventionally produced fuel to improve the CO_2 balance. With the new process it is possible to integrate biogenic raw material into fuel production without affecting the quality of the fuel produced adversely.

Research work done so far has laid the groundwork for further steps in implemention. With construction of a demonstration facility in progress, further promising results can be expected. ◘

Source: OMV

BioCRACK pilot plant
OMV refinery in Schwechat (Austria)

"The BioCRACK facility is an absolute industry first. We at OMV have undertaken not to interfere with the food industry production chain. By directly processing wood residues we are the first to succeed in making state-of-the-art biofuels without drawing on agricultural produce. The innovative BioCRACK process opens up new perspectives for a more efficient use of refineries worldwide and a more economical handling of the valuable resource mineral oil."

Dr. Gerhard Roiss
CEO of OMV

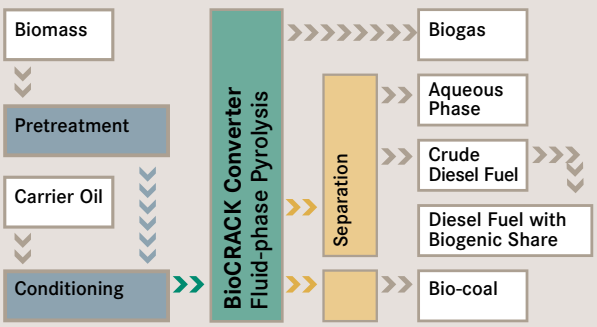
BioCRACK Pilot Plant
Producing 2nd-Generation Biofuels

EU directives require that the share of renewable energy in the fuel sector be increased to 10% by 2020. This target is not achievable with established biofuels, as the need for more agricultural land would basically result in direct competion with food production. So there is a quest for new technologies with which to produce second-generation fuels from agricultural and forestry by-products. In the "Biomass to Liquids"(BTL) process biomass containing lignocellulose (e. g. wood chips or straw) is converted into environmentally friendly diesel fuel. As these processes emit less CO_2, second-generation fuels also show an improved ecological bottom line.

In July 2012 the first BioCRACK pilot plant worldwide (developed together with BDI – BioEnergy International AG) was commissioned at the OMV refinery in Schwechat. The facility employs a new patented fluidizing process to convert solid biomass straight to diesel fuel. The "BioCRACK Technology" makes it possible to achieve a biogenic share of up to 20% of the fuel at source, i. e. the refinery process, through co-processing of petrochemical by-products and using solid biomass. In this technically simple and low-cost process, which is integrated into the traditional oil refinery process, biomass (wood and straw) is heated up to more than 400 °C together with heavy mineral oil. So far heavy mineral oils have mainly been used to make petrol, but in the new facility they can now also be used to produce diesel fuel.

Inside the refinery in Schwechat the BioCRACK test facility is connected directly to other facilities where the chemical product resulting from the BioCRACK process is refined to diesel fuel complying with European standard EN590. The final product is a conventional diesel fuel composed of pure hydrocarbons, suitable for all engine types and with a high biogenic share. In the course of the process no waste is generated, as biogas, bio-coal and other by-products can be used as a source of energy or refined into higher-grade products. ◘

TECHNOLOGY



BioCRACK: Technology and Products
Source: OMV and BDI - BioEnergy International AG

Torrefaction
"Roasted" Biomass with High Energy Value

With scientific support from the Austrian Research Institute for Chemistry and Technology (ofi), an Austrian consortium consisting of ANDRITZ, Polytechnik Feuerungsanlagen GmbH and Wild & Partner is developing a new process to heat treat biomass in order to optimize its chemical and physical characteristics.

Torrefaction (from Latin "torrere" to roast, parch) denotes a thermochemical process during which a pyrolytic decomposition of the raw material takes place at relatively low temperatures between 250 and 300 °C in the absence of air. Biomass consists mainly of water, cellulose, hemicellulose and lignin. During torrefaction low-energy biomass components enter the gas stage. At first water is driven off, then hemicellulose decomposes, as does lignin to some extent.

The aim is to increase energy density with respect to mass and volume, and thus the calorific value of the raw material. The mass is reduced by about 70% whereas 90% of the calorific value is retained within the solid substance. The energy density of torrefied pellets comes to 15-18 GJ/m^3 (conventional wood pellets 11 GJ/m^3), and the calorific value can be increased by up to 20%. Apart from that they have further advantages.

Torrefaction facility/ACB reactor

Advantages of Torrefied Pellets

- high energy density
- improved calorific value
- improved combustion characteristics
- lower biological activity
- good grindability, which reduces energy consumption in processing
- improved resistance to weathering permits open-air storage

Due to their high energy density and storability, transporting torrefied pellets even over long distances is more economical than with conventional pellets. Torrefied pellets therefore have the potential to be marketed worldwide as a mass-produced commodity for industrial applications.

Technically, torrefied biomass could be used where today coal or conventional pellets are utilised (industrial boilers, steelworks, agriculture). This innovative product is primarily suitable as a substitute for coal and could contribute considerably to a reduction of fossil CO_2 emissions when used as a supplementary fuel in coal power stations.

Pilot plant in Frohnleiten (Austria)

Following successful basic research, the project team was able to start test operating the first ACB(Accelerated Carbonized Biomass) pilot plant with a capacity of 1 t/h in Frohnleiten (Steiermark, Austria) in 2011. ◘

IEA Research Cooperation International Know-How Transfer

"The targets set for IEA Research Cooperation will certainly be met. Furthermore, putting the targets into perspective with regard to the financial means employed, the IEA Research Cooperation Programme probably has the greatest leverage of all Austrian FTI funding in the field of energy."

a.o.Univ.-Prof. DI DR. Christoph Mandl
Project chair IEA Research Cooperation Evaluation, 2012

The International Energy Agency (IEA) was founded in 1974 as an autonomous OECD organisation with headquarters in Paris. The IEA currently has 28 members; Austria is one of the 16 founding member countries and thus has almost 40 years of experience within this international cooperation framework. This international network gives Austria the opportunity to participate in a worldwide R&D programme. One of the IEA's key functions is the improvement of energy supply infrastructure across the globe through development and propagation of new energy technologies and efficient end-use technologies.

Austrian experts from research, politics and industry are currently engaged in 17 of 42 IEA research programs ("Implementing Agreements"). International exchange enables them to strengthen their fortes and position themselves in the market. In the field of bioenergy and solar power Austria has even taken a technological lead. An evaluation of the programme conducted for the Federal Ministry for Transport, Innovation and Technology in 2012 established the positive effects on Austrian research and industry.

IEA Bioenergy-Research Programme involves close cooperation between Austrian experts and international specialists. The actual R&D and market-related activities are conducted at the project level as part of the tasks. During the current period, 2010 - 2012, Austria takes part in the following tasks:

- Task 32: Combustion and Co-Combustion of Biomass
- Task 33: Thermal Gasification of Biomass
- Task 37: Energy from Biogas and Landfill Gas
- Task 38: Greenhouse Gas Balances of Biomass and Bioenergy Systems
- Task 39: Market Launch of 1st and 2nd-Generation Biofuels
- Task 40: Sustainable International Bioenergy Trading – Securing of Supply and Demand
- Task 42: Bio-Refineries

energy innovation austria presents current Austrian developments and results from research work in the field of forward-looking energy technologies. The content is based on research projects funded by the Austrian Federal Ministry for Transport, Innovation and Technology and the Climate & Energy Fund. **www.nachhaltigwirtschaften.at** **www.klimafonds.gv.at**

INFORMATION

Research Location Güssing
Europäisches Zentrum für erneuerbare Energie Güssing GmbH
Contact: Christian Keglovits
c.keglovits@eee-info.net
www.eee-info.net, www.oekoenergieland.at

G-volution I and II
Vienna Technical University, Institute of Chemical Engineering
Research Platform: Future Energy Technology
future.energy+166@tuwien.ac.at, www.vt.tuwien.ac.at
Contact: DI(FH) Johannes Christian Schmid
johannes.schmid@tuwien.ac.at

BioH2 4Refineries
Vienna Technical University, Institute of Chemical Engineering
Research Platform: Future Energy Technology
future.energy+166@tuwien.ac.at, www.vt.tuwien.ac.at
Contact: Dr. Reinhard Rauch
reinhard.rauch@tuwien.ac.at

BioCRACK facility OMV Refinery Schwechat
OMV Aktiengesellschaft
Contact: Dr. Walter Böhme
walter.boehme@omv.com, www.omv.com

BDI - BioEnergy International AG
Contact : Dr. Edgar Ahn (CSO)
bdi@bdi-bioenergy.com, www.bdi-bioenergy.com

ACB Torrefaction
ACB Entwicklungsgesellschaft mbH
Contact: DI Klaus Trattner
klaus.trattner@andritz.com, www.andritz.com

INFORMATION ON IEA ACTIVITIES
www.nachhaltigwirtschaften.at/iea
www.ieabioenergy.com
www.iea.org

IMPRINT
Published by Federal Ministry for Transport, Innovation and Technology (Renngasse 5, 1010 Vienna, Austria) in cooperation with the Climate and Energy Fund (Gumpendorferstr. 5/22, 1060 Vienna, Austria)
Edited and designed by Projektfabrik Waldhör KG, 1010 Vienna, Am Hof 13/7, www.projektfabrik.at