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## **MODEL REGION GÜSSING**

**SELF-SUFFICIENT ENERGY SUPPLY BASED ON  
REGIONALLY AVAILABLE RENEWABLE RESOURCES  
AND SUSTAINABLE REGIONAL DEVELOPMENT**

**bm**

Austrian Federal Ministry for Transport,  
Innovation and Technology

## GÜSSING – A MODEL REGION WITH FORWARD LOOKING ENERGY SUPPLY

■ Güssing is the capital of a district with approximately 27,000 inhabitants and is situated in a region with some deficits concerning infrastructure. In 1988, this region was still one of the poorest in Austria according to statistics. On account of the geographically unfavorable location near the border, major trade or industrial businesses did not exist at that time and the whole district did not have any transportation infrastructure at all (neither railroad nor highway). This resulted in a scarcity of jobs, 70 % weekly commuters, and a high rate of migration to other regions. In addition, there was the problem of substantial capital outflow from the region caused by energy bought from outside (oil, power, fuels), while existing resources (e.g. 45 % forest land) remained largely unused.

In 1990, experts developed a model, which provided for a complete abandonment of fossil energy. The objective was to supply, in a first step, the town of Güssing and subsequently the whole district with regionally available renewable energy sources thus providing the region with new forms of added value. The model comprises the aspects heat generation, fuels, and electric power.

First steps toward implementation consisted in targeted energy saving measures in Güssing. As a result of the energetic optimization of all buildings in the town center, expenditure on energy was reduced by almost 50 %. Then, the realization of numerous demonstration

energy plants in the town and the region helped to promote the implementation of the model step by step. Examples include the successful installation of a bio-diesel plant using rape oil, the realization of two small-scale biomass district heating systems for some parts of Güssing, and, finally, a district heating system based on wood fuel supplying the town of Güssing.

Energy self-sufficiency was finally realized in 2001 when the biomass plant Güssing was installed; it relies on a newly developed biomass-steam gasification technology. At present, Güssing produces more energy (heat, fuels, and electric power) from renewable resources than is consumed in the town on an annual basis. This benefited the region an added value of Euro 13 million (calculation based on 2005 figures) per year.

The implementation of the innovative energy concept set off a sustainable regional development process, which transformed the formerly “dying region” within 15 years into a region with a high living standard and excellent quality of life. In recent years, Güssing has been awarded honors as the “environmentally most friendly town” and



“most innovative municipality” in Austria. One of the first infrastructure improvements, i.e. the installation of the district heating system Güssing (1996) made the town on the border already an interesting location for the establishment of businesses. A special scheme promoting the establishment of enterprises in the area brought 50 new enterprises with more than 1,000 direct and indirect jobs in the renewable energy sector for the region. Güssing since has developed into an important location in the fields of parquetry production, hardwood drying, and environmental technologies.

The realization of the biomass plant Güssing and the establishment of the **RENET Austria (Renewable Energy Network Austria)** competence network gave rise to the launching of numerous national and international “renewable energy” research projects in Güssing. The **“European Center for Renewable Energy”** (Europäisches Zentrum für Erneuerbare Energie EEE) coordinates all demonstration plants, projects, research emphases as well as programs for training and further education in this field. The manifold research activities here have also contributed to the attractiveness of the region and to the creation of additional high-quality jobs.

Work within the **“Energy Systems of Tomorrow”** subprogram aims to further disseminate this successful model. The objective consists in the further development of the strategies and technologies tried out in the town of Güssing and in applying them in the whole district. By 2010, this area should also have attained self-sufficient energy supply and, thus, numerous concomitant positive effects for the economy in the region.

*In 1999, the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) launched the “Sustainable Development” research and technology program, which aims to effectively support approaches towards sustainability in economic activities through research. Various research and development projects as well as demonstration and diffusion measures, which give new impetus to innovation in Austria’s economy have since been supported within the scope of a number of subprograms. The “Energy Systems of Tomorrow” subprogram aims to encourage innovative and trend-setting technologies and concepts in the field of renewable energy sources that are capable of safeguarding energy supply on a long-term basis.*

# SUSTAINABLE ENERGY CONCEPTS BASED ON REGIONAL RENEWABLE RESOURCES

■ The flagship and most important innovation of the Güssing model is the biomass plant, which uses a special **fluidized bed steam gasification technology**. The process developed at the Vienna University of technology (Univ. Prof. Dr. Hofbauer) offers some advantages as compared to conventional combustion processes, especially in combined heat and power applications. For the realization of the project several partners cooperated within the competence network RENET: REPOTEC plant technology, Vienna University of Technology, EVN, and the Güssing district heating utility.

The plant, which started operation in 2001 has a rated fuel capacity of 8 MW and produces 2,000 kWh electric power as well as 4,500 kWh heat for district heating at a feed rate of 2,300 kg wood per hour. The plant currently operates for 8,000 hours per year.

The vital component of the plant, i.e. the fluidized bed gasifier consists of two fluidized bed systems that are connected with each other. Biomass is gasified, together with steam, at a temperature of approx. 850°C in the gasifying zone. Using water vapor instead of air as gasifying medium results in a nitrogen-free, low-tar product gas with high calorific value. Part of the residual char is conveyed, by the circulating bed material (sand), which also serves as heat storing medium, to the combustion zone and is burned there. The heat transferred to the bed material is needed to maintain the gasification reactions. The flue gas is then separated and the heat contained therein is used in the district heating system.

The product gas has to be cooled down and cleaned for use in the downstream gas engine. Heat recovered in the cooling process is, again, used for the district heating system. A special

technology permits to recycle all residuals, which means that the gas cleaning process generates neither waste nor effluent.

The gas engine converts chemical energy contained in the product gas into electricity. Again, waste heat from the engine is fed into the district heating system. This approach results in very high efficiencies: electric efficiency ranges between 25 and 28 %, overall efficiency (power and heat) is approx. 85 %.

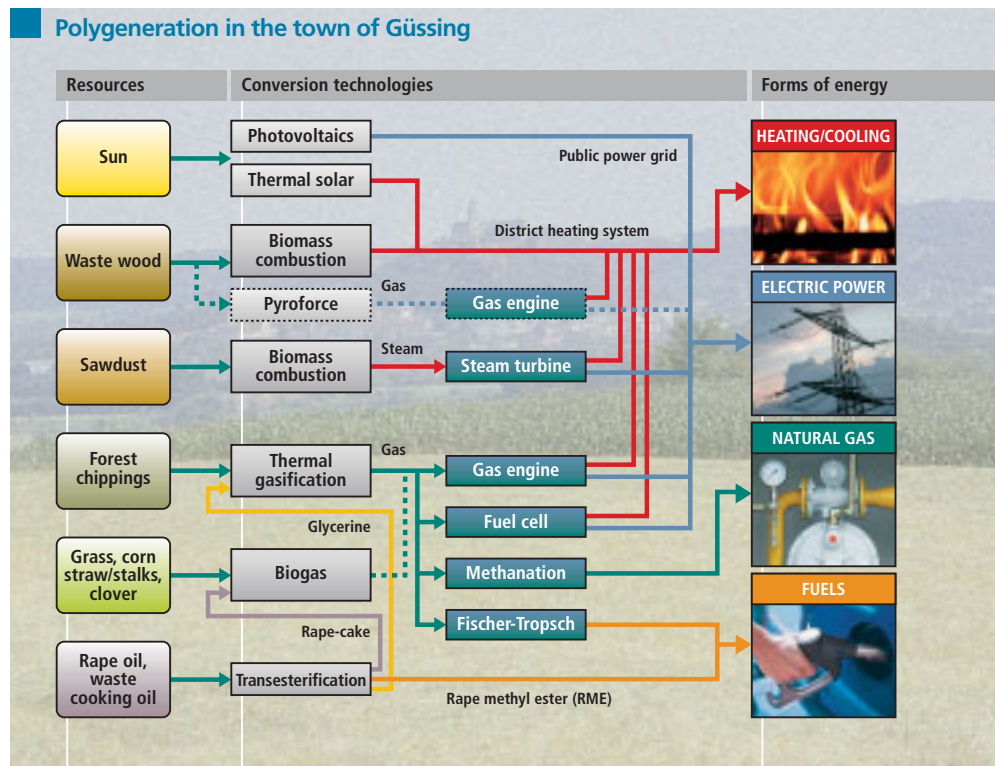
**On account of the favorable properties of the product gas (no nitrogen, high hydrogen content), there is a broad range of possible uses, such as the generation of fuel gas, synthetic gas, gasoline and diesel, methanol as well as hydrogen.**

The various research projects currently conducted in Güssing address topics such as the generation of hydrogen, fuel cells, the production of methane and fuels, cooling and district heating systems and aim to test and implement new technologies. The overall objective

consists in the development of energy centers meeting the demand of the region, and which are able to produce heat, electricity, gaseous and liquid energy carriers from a variety of energy-rich biogenic raw materials and residue matter using an approach called **polygeneration**. The quantities produced of the various resources will depend on the needs and the size of the respective region. The relative proportion of the various by-products cannot be changed infinitely, it is true, but modifications should be possible within certain limits.

The experience gained in the biomass plant Güssing gave rise to a number of research projects, which were realized in cooperation with various Austrian and international partners in the fields of science and industry (e.g. Volkswagen, Daimler Chrysler, Volvo, EDF, and BP). Some of the projects have already been realized in Güssing, others are at the stage of planning or on the verge of implementation. The strategy for the period between 2007 and 2013 aims to implement the concept of "polygeneration".

Source: EEE – Europäisches Zentrum für Erneuerbare Energie Güssing GmbH



## SELECTED RESEARCH PROJECTS:

### ■ Energy Center Güssing

The “Energy Systems of Tomorrow” subprogram aims to promote the development of energy centers meeting the demand of the region, which are able to produce heat, electricity, gaseous and liquid energy carriers from a variety of energy-rich biogenic raw materials and residue matter. Biomass gasification is a suitable basis for the production of various energy products from biomass. The appropriate combination of various processes is to facilitate the generation of heat, electricity, synthetic natural gas (BioSNG), and synthetic fuels (Bio FIT fuels). Fundamental research by means of laboratory-scale experiments has already defined various process designs. A technological and economic evaluation of the potential of these developments has already shown promising results. A second phase of the project aims to further develop and optimize individual process steps in realistic simulations. Work concentrates on process steps for which there are no suitable solutions on the market. One focus is on the Fischer-Tropsch synthesis for fuel production, because the need for research in this field is still higher than that for methanation. Research results will permit a scale-up to demonstration plant size.

### ■ Bio-SNG

#### (Biological Synthetic Natural Gas)

Research on the generation of methane has been conducted in cooperation with PSI (Paul Scherrer Institute, Switzerland). The first step in this process consists in separating part of the synthetic gas ( $\text{CO} + \text{H}_2$ ) generated by means of fluidized steam gasification. In a second step, methane is synthesized from this Bio-SNG. The methanation reactor itself is a stationary fluidized bed operating in a pressure range from 1 to 10 bar. A 1 MW demonstration plant producing up to 100 m<sup>3</sup> of Bio-SNG per hour will be directly attached to the Biomass CHP plant in Güssing.



### ■ Fischer-Tropsch Synthesis

This technology for the production of diesel fuel and gasoline from biomass is being tested in a research coordinated by Volkswagen Company and involves more than 30 international partners; the program focuses on the synthesis of vehicle fuels from biomass gasification processes. In the fluidized bed gasification process at the Güssing CHP plant, part of the gas stream is separated, further processed and fed into a Fischer-Tropsch reactor. This reactor was designed for a rated output of approx. 0.5 to 1 L/h; the pilot plant has been operating since 2005. This research is being supported by the EU's “RENEW” project.

### ■ Mixing Wood Gas and Biogas Bio-Fuel Production

At present, other researchers at Güssing are investigating the possible combination of thermal and biological gasification. They aim to develop a concept for the installation of a biogas plant with a pipeline to the existing thermal gasifier; they also work on the fundamentals for the requisite cleaning and mixing plants with the goal to develop marketable products (gas, gasoline, and diesel fuel).

### ■ Optimization and Further Development of Biomass CHP Plants

Research in the biomass plant Güssing also includes the further development of feedstock conveyance, the variation of the bed material, and the use of additives for targeted control of gas quality. Other goals consist in extending the range of usable feedstock, simplifying gas cleaning, and the optimization of the gas engine in order to reduce capital and operating costs. This research is being supported by the EU's “Big Power” project.

### ■ Fuel Cell Technology

On account of its low nitrogen and high hydrogen content, the product gas generated in the process used in Güssing is very well suited for the use in fuel cells. Currently researchers concentrate on gas cleaning processes and have already performed first tests with fuel cells. These tests are being realized in cooperation with the Austrian Bioenergy Center and the University of Trondheim, Norway.



## P E R S P E C T I V E S

# SELF-SUFFICIENT ENERGY SUPPLY FOR THE DISTRICT OF GÜSSING – EXTENSION OF THE MODEL

■ Meanwhile, Güssing has won also international recognition as an energy and biomass center. There is consensus to further develop the successful model in the future. The next aim will consist in extending the model and to cover the whole district of Güssing by 2010.

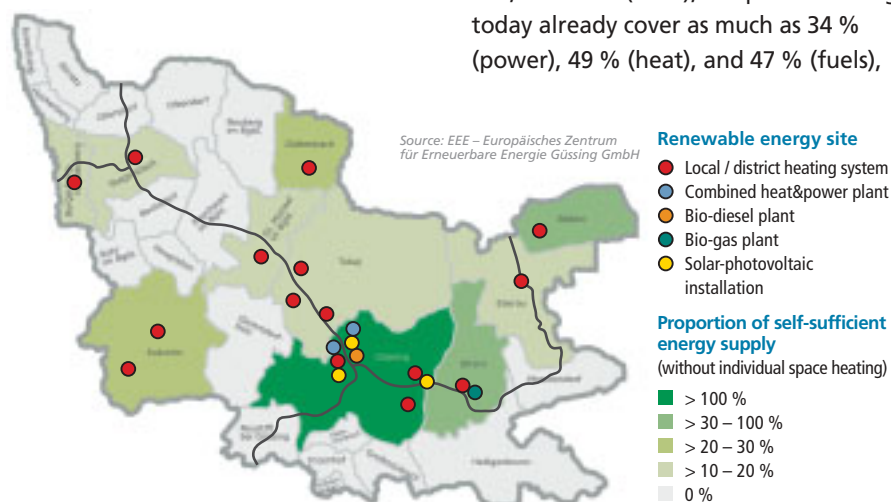
Within the “Energy Systems of Tomorrow”, project participants are developing a concept, which, after implementation will ensure energy supply for the entire district, which relies on renewable energy sources exclusively. This requires to ascertain the energy demand in the region and to identify demand distribution as well as the individual demand sectors. An important factor in self-sufficient energy supply refers to the availability of the necessary land

sources actually used today. The analysis of the energy saving potential and existing resources has also been conducted at the level of municipalities or parts of villages. These findings served to identify suitable technologies and to develop energy supply scenarios for the district; researchers also calculated the potential for CO<sub>2</sub> reduction. In order to ensure an efficient supply with biomass, a special logistics concept has been developed, in analogy to the one for the town of Güssing.

Research work done so far has shown that, in principle, **self-sufficient energy supply** for a region the size of the district of Güssing is actually feasible. At present, the overall energy demand of the district amounts to 564,777 MWh (2005); the plants existing today already cover as much as 34 % (power), 49 % (heat), and 47 % (fuels),

suitable conversion technologies shows that full use of the forestland would offer the largest land reserves. Depending on the scenario, the remaining land reserves would range between 13,000 ha and 14,000 ha; this means that, even with self-sufficient energy supply implemented, some 30 % of the district’s surface area remain as reserve for additional demand in the future. A complete shift to renewable energy sources would reduce CO<sub>2</sub> emissions in the region by some 85 %, i.e. to 15,530 tons per year.

These findings were used in the follow-up project to identify potential sites and possible approaches toward implementation, to perform cost / benefit analyses, and to develop financing models. Implementation of the concept is expected to afford numerous synergies – as was the case in the town of Güssing – that can have a positive effect on the development of the region. Shifting energy supply from fossil to renewable energy sources could create added value on the order of Euro 39 million. Other objectives include an improvement of the situation on the job market, new opportunities of training and further education, and enhanced self-confidence of people in the region. New opportunities could arise in the fields of tourism, cultural activities and sports. These sustainable stimuli could create a model region and a role model for other areas, which might adopt such concepts as well.



### Sites and proportion of self-sufficient energy supply in the district of Güssing

area for energy crops. Thus, the first part of the project aimed to ascertain, at the level of municipalities, whether the available land area is sufficient to cover energy demand. This provided for a quite accurate assessment of focal points of demand and an evaluation of potential sites. The sum of the land area balances at the level of individual municipalities will result in a land area balance for the whole region.

In a next step, researchers analyzed the energy demand in the region and ascertained the capacity of renewable ener-

respectively of the demand with renewable energy sources. Project participants modeled five different scenarios that permit 100 % of the demand to be covered with energy from renewables only. A look at potential resources and

### Potentials for self-sufficient energy supply in the district of Güssing

According to calculations done in 2005 the energy saving potential amounts to 71,400 MWh, which corresponds to 12.6% of the overall energy demand in the district of Güssing. Thermal insulation measures alone hold a potential for energy saving equal to 32,705 MWh.

Energy production currently uses 27 % of the forestland and 0.2 % of agricultural land in the region. This means that some 104,914 ha forest and 20,718 ha agricultural land are still available for the production of energy carriers. It is planned to produce at least 64,828 MWh electric power, 67,625 MWh fuels, and 104,914 MWh heat from this land area.

## THE EUROPEAN CENTER FOR RENEWABLE ENERGY GÜSSING



■ The European Center for Renewable Energy (Europäisches Zentrum für Erneuerbare Energie EEE), founded in 1996, serves as central coordinator for the "Model Güssing" project and the numerous sub-tasks involved. EEE headquarters are situated in the "Güssing Technology Center Focusing on Environment Technologies", which was established in cooperation with the Land (Federal Province) Burgenland. In order to facilitate the dissemination of experience in the field of renewable energy sources, a network including regional, national, and international partners has been founded. A great number of cooperation projects serve to develop sustainable regional concepts for the use of renewable energy sources and to implement concrete projects. The Biomass-Energy-Network rests on five pillars:

### ■ Demonstration Plants

Within a radius of 10 km around Güssing there are more than 30 plants using various technologies; visiting the plants is possible anytime.

### ■ Research & Development

The RENET Austria research network is an important driving force and ensures that – in addition to conventional energy technologies – Güssing will remain a place where innovative technologies are tested and presented to the public.

### ■ Training and Further Education

A comprehensive program with events and seminars offers information about innovative technologies and projects. In addition, there are special projects and educational programs designed for schools. The various measures aim at raising awareness for renewable energy and to ensure continual development and quality assurance in the field of biomass plants.

### ■ Services

On account of its experience concerning the development of energy concepts, the Center may also offer advice and act as agent for potential customers and manufacturers of plant equipment.

### ■ Green Energy Tourism

At present, some 400 people come to Güssing each week to visit the numerous demonstration plants (biomass, biogas, solar and photovoltaic installations). Green energy tourism has become an additional economic sector of great importance for the region. The EEE offers special training for certified tourist guides to enable them to organize guided tours in the various plants. In addition, networking with cultural and sports organizations results in various joint activities (e.g. eco-energy marathon). The "ÖEL" project (The Eco-Energy Region) created an eye-catching label for tourism in the region.

## PROJECT PARTNERS

- Energieautarker Bezirk Güssing
- Modelle zur Erreichung der Energieautarkie im Bezirk Güssing

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### ■ Energiezentrale Güssing

Energiezentrale zur Umwandlung von biogenen Roh- und Reststoffen einer Region in Wärme, Strom, Substitute Natural Gas und flüssige Kraftstoffe I+II

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### Other Partners:

RENET Austria Kompetenzknoten Güssing GmbH, Repotec, Solar Projects GmbH, IN.TE.MA

## INFORMATION PUBLICATIONS

The final reports on the abovementioned studies will be published in the bmvit series "Reports on Energy and Environment Research".

Already published:

Energieautarker Bezirk Güssing (82/2006)  
Energiezentrale Güssing (79/2006)

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