bericht report

bioenergy2020+

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Bioenergy RES Hybrids in Austria

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Report

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1 Background

1.1 Definition

Within this report bioenergy RES hybrids are defined as a combination of bioenergy technologies with other renewable energy sources (RES). The link between the two technologies is usually applied directly, but a virtual link by grid technologies is also possible

1.2 Background

The member states of the European Union declared their will to change the energy system from a fossil fuel driven one towards a renewable one in several international agreements (e.g. Kyoto Protocol[1], Paris agreement[2]. Within the European countries the goals are specified in dependence of the wealth and the development status of each single country[3]. The ratification process for the Paris agreement is actually on the way and the long term goal for 2050 is to enter a low-carbon economy[4].

The status of renewables in Austria as part of the European Union in 2014[5] shows a share of renewables of 33% of the whole energy sector. Compared to 2013 this is an increase of 0.8%.

Electricity was produced by renewables with a share of 69.2%. Due to the specific geographic position of Austria more than 80% of the renewable electrical power is generated by hydropower. Other technologies show an increasing share.

The main part of renewable heat (~80%) is produced by the combustion of biomass. A quarter of this share is produced by district heating plants.

1.3 Why Bioenergy RES hybrids

To reach the transmission of the energy system is expected to face a mix of challenging aspects in future to reach the ambitious goals:

[1] KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, United Nations, 1998: http://unfccc.int/resource/docs/convkp/kpeng.pdf

[2] Paris Agreement, United Nations, 2015: http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

[3] http://ec.europa.eu/clima/policies/strategies/index_en.htm

[4] http://ec.europa.eu/clima/policies/strategies/2050/index_en.htm

[5] Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschft: Erneuerbare Energie in Zahlen 2015 – Die Entwicklung erneuerbarer Energie in Österreich Datenbasis 2014: http://www.energieklima.at/fileadmin/content/publikationen/1Broschuere_eEiZ_2015.pdf

- Electrical power:
    - Increased amount of demand in winter times due to increasing salaries of heat pump systems for domestic heating[6]
    - Unsteady and decentralised production due to increased share of photovoltaics and wind power
    - Increased demand due to transition of the transport system to electrical energy
- Heating and cooling:
    - Lower heat demand of buildings due to better insulation forced by regulations
    - Increased cooling demand due to better insulations and increasing temperatures as a consequence of climate change

Especially the challenges within the electrical grid force the development of a new balancing system within the grid. Besides reservoir power stations bioenergy is up to now the only kind of renewable technology, which is able to store energy with a long term aspect. By this characteristic bioenergy has the potential to be the main stabilising element in the renewable energy (RE) supply system.

Furthermore biomass is often available only at limited quantities. So the combination with other renewable technologies will reduce the pressure from biomass availability.

1.4 Aim of the report

The current status of bioenergy RES hybrid systems is given within this report. Products on the market, implemented special solutions as well as ongoing developments are presented and a brief outlook regarding the market potential is given.

This report is part of Bioenergy RES hybrids, project 7 under Task 41 of the IEA Bioenergy Agreement. IT was prepared by BIOENERGY 2020+ in order of the Austrian Ministry for Transport, Innovation and Technology.

[6] Biermayr et al., Innovative Energietechnologien in Österreich – Marktentwicklung 2015, Austrian Ministry for Transport, Innovation and Technology, 2016: https://nachhaltigwirtschaften.at/resources/nw_pdf/201606_marktentwicklung_2015.pdf?m=1469659717

2 Current and projected conditions for bioenergy RES-hybrids in Austria

2.1 Status of energy sectors

In Table 1[7] the shares of renewables in 2014 within different energy sectors are given.

Table 1 Share of eligible renewable energy in Austria in 2014

Total share of renewable energy	**33.0 %**
• Share of renewable in electricity	69.2 %
• Share of renewables in district heat	45. 3 %
• Share of renewable energy in the final energy consumption of transport (incl. electr. energy)	8.6 %
• Share of renewable energy in the final energy consumption of industry	40.2 %
• Share of renewable energy in the final energy consumption of the service sector	45.1 %
• Share of renewable energy in the final energy consumption of households	52 .3 %
• Share of renewable energy in the final energy consumption of agriculture	51.4 %

The share of renewables in the field of electricity production is already relatively high. So Austria is one of the leading countries in regenerative electrical power production. The main share is produced by hydro power plants. The total amount of renewable electrical energy was 176,5 PJ[7] in the year 2014.

The amount of renewable heat (biomass, district heating, lye, solar thermal, ambient heat and geothermal heat) was 177,5 PJ[7] in 2014. The main part of this energy (approximately 80%) was provided by solid biomass.

The smallest share of renewables is actually given in the field of transportation fuels. In the year 2014 24,4 PJ[7] of biofuels are added to the fuelmix. This share is delivered by 617.673t of biogas, 87.872t of bioethanol, 15.259t of plant oils and 601t of biogas.

[7] Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschft: Erneuerbare Energie in Zahlen 2015 – Die Entwicklung erneuerbarer Energie in Österreich Datenbasis 2014: http://www.energieklima.at/fileadmin/content/publikationen/1Broschuere_eEiZ_2015.pdf

2.2 Projected use of renewable energy sources[8] in Austria

Within the last years the share of renewable energies continuously rose. According to the Austrian national action plan renewable energies[9] will have a minimum share of 34% in 2020, which is 358PJ. The potential is even much higher, up to 50% renewables in 2020.

Actually a process (Grünbuch Österreich) is on the way to reset long term goals for Austria. In general countries agreed within the Paris agreement to stop CO_2 emissions in the second half of the 21st century. This could be the basis for further political decisions.

Exemplarily the main expected potential for two technologies are given.

2.2.1 Solid biomass

The main conclusions from the current Austrian Roadmap BioHeating and Cooling[10] is that an increase of biomass in the energy mix from 20% (2010) to almost 50 % of total energy consumption for space heating and hot water production in 2035 is expected. Afterwards a slight decrease in biomass consumption for heating purposes is expected.

2.2.2 Electricity sector - Photovoltaics

Conclusions from the Austrian technology roadmap for photovoltaics[11]:

- 100% renewable electricity need an increase of electricity produced by photovoltaics from 1 TWh in 2015 to 30 TWh in 2050
- Therefore an yearly installation of 600 MW from 2017-2030 and 820 MW from 2030-2050 are necessary

[8] Biermayr et al., Innovative Energietechnologien in Österreich – Marktentwicklung 2015, Austrian Ministry for Transport, Innovation and Technology, 2016: https://nachhaltigwirtschaften.at/resources/nw_pdf/201606_marktentwicklung_2015.pdf?m=1469659717

[9] Kopetz et al., Nationaler Aktionsplan für erneuerbare Energien, österreichischer Biomasseverband, 2010: http://www.biomasseverband.at/fileadmin/mediaDB/Bibliothek/Publikationen/NAP-Broschuere.pdf

[10] Wörgetter et al. FTI Roadmap BioHeating and Cooling, Austrian Ministry for Transport, Innovation and Technology, Vienna, 2012: https://nachhaltigwirtschaften.at/resources/nw_pdf/1254_fti_roadmap_bioheating_and_cooling.pdf?m=1469660261

[11] Fechner et al., Technologie-Roadmap für Photovoltaik in Österreich, Austrian Ministry for Transport, Innovation and Technology, 2016: http://www.pvaustria.at/wp-content/uploads/1615_technologie_roadmap_photovoltaik.pdf

3 RES and RES-hybrid technology market players in Austria

3.1 Active research institutes in the field of RE technologies

In this chapter the main players regarding renewable energies, which can contribute to research in the field of BioResHybrids are presented.

3.1.1 BIOENERGY 2020+ GmbH

BE2020 is a K1-competence centre within the COMET-program of the Austrian Federal Government. The object of the company is the research, development and demonstration in the sector „energetic use of biomass.

At three different sites actually around 90 employees are engaged, most of them having finished an university education. Actually BE2020 is in cooperation with more than 50 national and internationals companies, as well as a lot of national and

Some selected research activities, which are actually handled by BIOENERGY 2020+:

- Energy efficiency improvement by the means of active flue gas condensation. Active flue gas condensation is defined as the use of heat pumps to decrease the flue gas temperature to increase the condensation level. This was done as a study for small scale and medium scale boilers in the project **ActiveCond**. In the project **FHKW_Plus** the process was evaluated at the district heating plant in Tamsweg and actually an open sorption process is evaluated in the project **ErgoS**
- Within **BiNe** and **BiNe2+** the focus is on the possibility to feed in excess heat from decentralized units (e.g. small scale private boilers, private solar thermal heat,…) into heating grids. This heat can be utilized in two ways. Either it is used to increase the heat capacity of the grid without expanding the central heating plant or it is used to turn off in summer times the central boiler to increase the overall efficiency of the grid. In both cases it is necessary to develop new business models including the “Prosumer”.
- In **Kombine** the control system for an integrated Biomass/solar thermal system was improved to increase the overall efficiency of the system. (Cooperative research with Austrian Institute of Technology)
- The combination of a tiled stove with heating pump to expand the system to a design an alternative central heating system for houses.
- In the project **winddiesel** hydrogen is added to synthesis gas from a biomass gasifier. The hydrogen is produced via electrolysis by using excess wind power. The focus of the work is the development of a slurry reactor, suitable to be operated between 30% and 100% load.

3.1.2 BIOS Bioenergiesysteme GmbH

BIOS BIOENERGIESYSTEME GmbH is active in research, development, planning and optimisation of processes and plants designed to generate heat and power from biomass.

Selected activities in the field of BioResHybrids are:

- In the framework of the FP7 European Project "**SUNSTORE4**",[12] the district heating grid in Marstal (Denmark) is demonstrating the integration of a 100% renewable energy plant, based on solar energy and biomass energy (willow wood chips from energy crops), including a compressor heat pump using CO2 as refrigerant and electricity production from biomass through an ORC unit. Based on this experience, the SUNSTORE4 project aims to assess the feasibility of such a plant in other EU countries.
- In the project **BIOconSolar KWK** the combination of a concentrated solar power plant with a biomass combined heat and power plant using ORC-technology is evaluated by the development of a simulation model for the single parts of the system. This model is the basis for a techno-economic optimisation of the system incl. dynamic simulations, economic and ecological evaluation and determination of side constraints for an economic application.

3.1.3 Austrian Institute of Tehcnology

The Austrian Institute of Technology (AIT) is Austria's largest Research and Technology Organization. In the field of Renewable Energies they have working groups with the following expertise:

Energy Infrastructure

- Photovoltaics
- Smart Buildings
- Smart Grids
- Sustainable Thermal Energy Systems

Integrated Energy Systems

- Complex Energy Systems
- Green Processes
- Smart Cities and Regions

Selected projects:

[12] http://sunstore4.eu/

- In **Kombine** the control system for an integrated Biomass/solar thermal system was improved to increase the overall efficiency of the system. Cooperative Research with BE2020
- The aim of the EU-funded **STRATEGO** project is to close the gap bet- ween European and national policies. The project considers more than 20 towns, communities and regions in Belgium, Austria, the Czech Republic, Croatia, Romania, Germany, Italy and the UK. Part- ners from Denmark and Sweden contribute their valuable experience from national developments. In Austria, AIT scientists will work together with Swedish partners in four selected regions - Vienna, Graz, Großschönau and Lower Austria.

3.1.4 AEE Intec

AEE INTEC is working in the field of research of natural scientific and technical basics of thermal solar power, development of low and lowest energy building as well as their efficient energy supply systems. Furthermore one area is operating in the field of energy efficiency in industry.

Selected projects:

- In the project **urban district heating extended** – flexibilization and decarbonization of urban district heating systems – the focus is on the development of innovative heating supply systems. This is done by the integration of long term heat reservoirs, heat pumps, solar thermal, waste heat and the use of simulation tools.
- In the project **REsys** (Control Strategies for efficiency increase of complex hybrid energy systems) a real hybrid energy system will be simulated by the combination of thermal and electrical models. The resulting model will be validated by the means of real measurements. Finally the developed control strategy will be tested at the real system.

3.1.5 Energiewerkstatt

The Energiewerkstatt is an engineering office for renewable energy. The primary focal points are the utilisation of wind energy in complex terrain and cold climate. Furthermore Energiewerkstatt has expertise in extracting biogas from meadow grass in the form of bio-methane..

3.2 Universities

A lot of universities in Austria are doing research in the field of renewable energy. Furthermore a lot of them are members of IEA Tasks and implementing agreements.

3.3 Associations in the field of renewable energies

The most important associations in the field of renewable energies are listed in Table 2.

Table 2: associations in the field of renewable energies

Lobbying Group	Homepage	Main Focus
Renewable Energy Austria (Erneuerbare Energie Österreich)	http://www.erneuerbare-energie.at	Umbrella organization of the most important players in the field of renewable energies
Austrian Biomass Association (Österreichischer Biomasseverband)	http://www.biomasseverband.at	Energetic use of biomass along the whole value chain
Pro Pellets Austria	http://www.propellets.at	Pellets production, trade and combustion
Photovoltaic Austria	http://www.pvaustria.at/	Photovoltaics
Austrian Energy (Österreichs Energie)	http://oesterreichsenergie.at/	Electricity
Small-scale Hydropower Austria (Kleinwasserkraft Österreich)	http://www.kleinwasserkraft.at/	Small-scale hydropower
Austrian Wind Energy Association (IG Windkraft)	https://www.igwindkraft.at/	Wind power
Austria Solar	http://www.solarwaerme.at/	Solar thermal power
Association for compost and biogas (ARGE Kompost &Biogas)	http://www.kompost-biogas.info/	Recycling management of organic compounds

3.4 Companies in the field of RE technologies

A lot of companies in Austria are amongst the world leaders in renewable energy systems. Most of them are members of the before listed associations. A lot of them will also be named in the following chapter, where an overview about the current status of hybrid technologies in Austria is given.

4 Status of hybrid technologies in Austria

Within this chapter already available Austrian hybrid products are described. Moreover future products which are under development and soon come to the Austrian market are shown too.

The classification is done by technologies combined with biomass.

4.1 Biomass + solar thermal

The combination of a pellet boiler with solar thermal panels is a common installation in Austria since the second half of the 1990´s. Nevertheless these installations are mainly co-installation of the two technologies with not too much optimization between the two technologies. In the last years two pellet boiler companies developed products, where these two technologies are matched to each other.

Furthermore there are also installations of solar thermal panels in several heating grids and ongoing research is focussing on the control concept for this combination.

4.1.1 Pellesol[13] (Ökofen GmbH)

An overview of the product is given in Figure 1, which is an optimized buffer tank for a pellet/solar thermal combination. It already includes two circulation pumps for the heat distribution and a warm water module. Furthermore the connectivity to the heating system is integrated

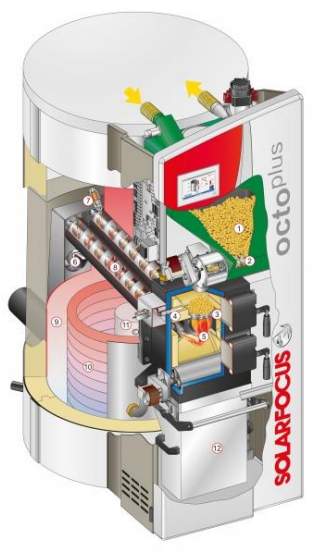
Figure 1: Pellesol buffer tank

[13] www.pelletsheizung .at

4.1.2 Octoplus - Solarfocus[14]

The basic principle of this product is that the boiler is integrated into the buffer tank. By this measure radiation losses of the boiler to the ambient are reduced.

Figure 2: boiler Octoplus



1. Intermediate container for pellets with suction turbine
2. Pellet auger with single axis rotary valve
3. Stainless steel grate
4. Automatic ignition
5. Downfiring combustion technology / pellets gasification
6. Induced draft fan
7. Lambda sensor
8. Heat exchanger cleaning system
9. 550/800 liters of storage volume
10. Solar register
11. Layer charging lance
12. Autom. ash extraction

4.1.3 Solar thermal + heating grids

In general the combination of solar thermal and biomass powered heating grids is a technology which is already used in Austria since several years. One example is the Styrian city of Gleisdorf[15], where 6 low energy houses and one office building have been constructed within the EU project *Large Scale Solar Heating Systems for Housing Developments*. Besides building optimizations the integration of large scale solar thermal heat was in the focus of the project.

Figure 3: panel integration in winter garden

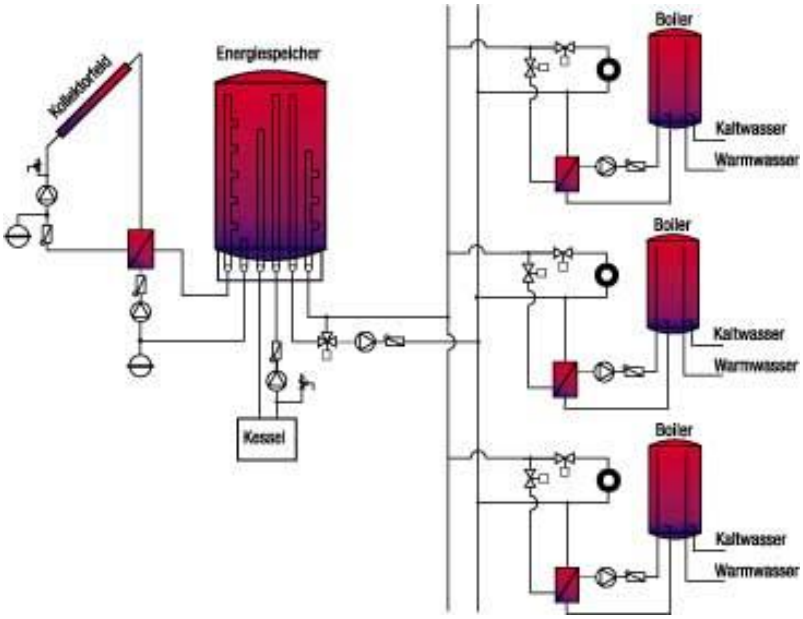
[14] www.solarfocus.at

[15] http://www.aee.at/aee/index.php?option=com_content&view=article&id=681&Itemid=113

213m² of solar thermal panels have been integrated into the winter gardens of the buildings. Further installations are a biomass boiler and a 14m³ buffer tank made from steel. The size is chosen to function as a monthly buffer. The whole concept guarantees a 100% renewable heat supply. Both heat sources have a share of about 50%.

The supply of the single buildings is made out of the buffer tank. Decentral hot water tanks in the buildings are loaded with a high grid temperature of 65-70°C during a phase of 2 hours in the nights. The hydraulic concept is given in Figure 4.

Figure 4: hydraulic concept - Gleisdorf



4.1.4 Research - BioConSolar

BIOS Bioenergiesysteme GmbH worked together with the Technikum Wien GmbH on the combination of CHP (Concentrating Solar Power) with biomass in a CHP-facility. Electricity is generated by an ORC-process (see). The national project ran from March 2012 till February 2014 in the frame of “Neue Energien 2020 5. Ausschreibung”.

Figure 5: Scheme BIOconSolar KWK principle own picture Schidler[16]

[16] Schidler, S.: BIOconSolar – Ein Nachhaltigkeitsassessment; 9. Internationale Energiewirtschaftstagung an der TU Wien (IEWT), Wien (AUT) 2015.

The aims of the project were[17]

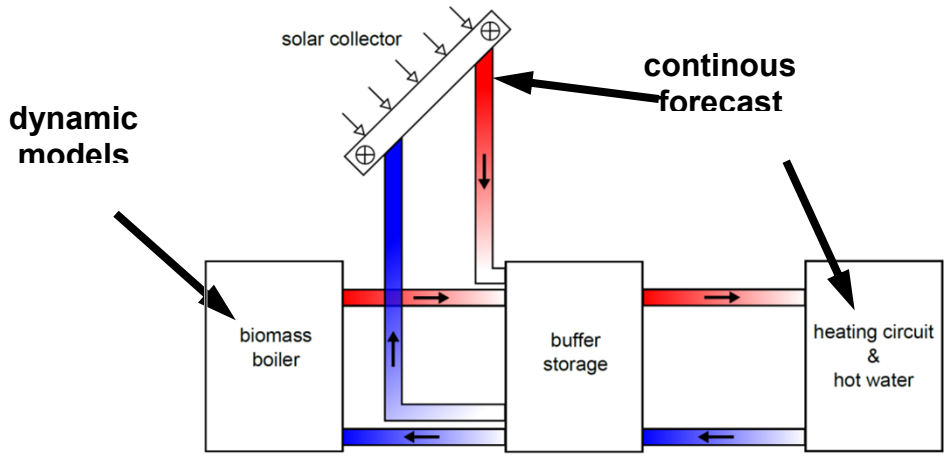
- development of a dynamic simulation model for solar-biomass hybrid system for technical and economical optimization of such a system
- economic feasibility study to determine the essential framework conditions as well as ascertaining application potentials
- ecological assessment and determination of sustainability of a biomass and CSP hybrid CHP-facility with ORC

Further information on the assessment also for the CHP application in Salzburg with an electrical power output of 1.5 MW are available in [Sterrer, 2013][18].

4.1.5 Ongoing research – superordinate control systems

Current optimizations of the integration of solar thermal/biomass combination focus on the control system. This is done by simulation tools, which are built of modules for the single technologies, which are linked to each other in the simulation. The main input into the models are a continuous forecast of the heat demand (heating circuit & hot water) as well of the heat input into the solar collectors. The result is a continuous prediction of the optimal boiler operation
to minimize primary energy consumption (biomass & electricity)

Figure 6: concept superordinate control



[17] Sterrer, R.: Theoretische Potenzialanalyse für KWK-Hybridanlagen auf Basis Biomasse und Solarthermie; Presentation at the 4. Central European Biomass Conference (CEBC); 17. Jänner 2014, Graz (AUT).

[18] Sterrer et al.; Theoretical analysis of the combination of CSP with a biomass CHP-plant using ORC-technology in Central Europe; SolarPaces 2013; Energy Procedia, Vol. 49; 2014; p.1218-1227

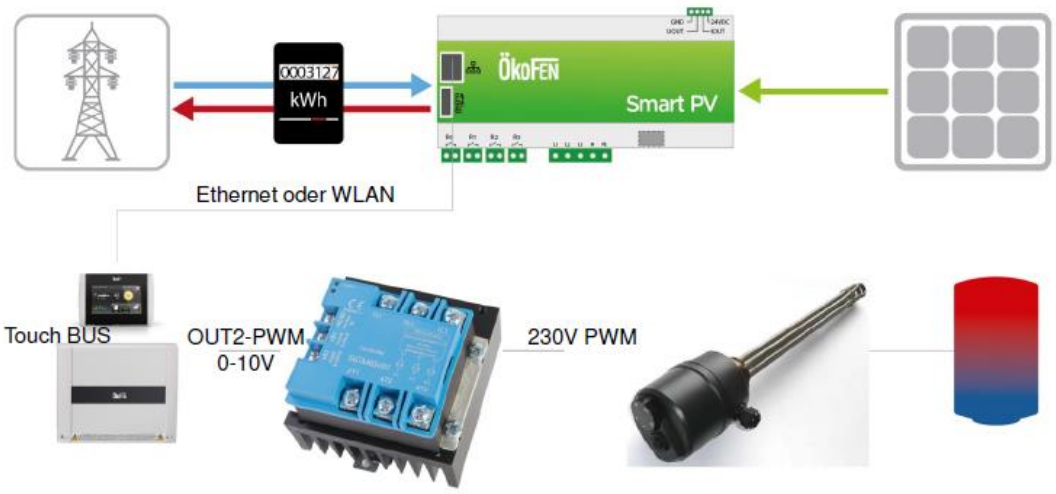
4.2 Biomass – Renewable Electricity

4.2.1 Biomass - Photovoltaics

In such a system photovoltaics is primary responsible to deliver electricity to the house and the biomass boiler provides heat for heating purposes. The link between the two systems is the warm water storage tank. This heat is provided by either biomass combustion or an electrical heating element.

A product on the market is the smart PV module by ÖkoFEN. This module monitors the current electricity demand of the building. If there is an excess production of electricity this power is utilized in the heat storage tank. Furthermore the module is connected with a weatherforecast and prevents starting the boiler in cases of expected PV energy.

Figure 7: Smart PV: basic conncectivity and elements



4.2.2 Biomass – Wind Power

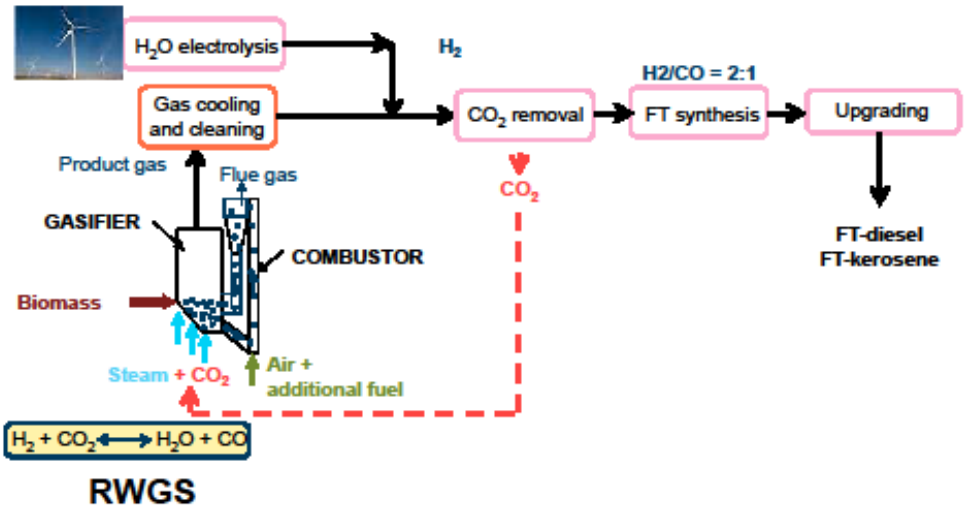
Within the project Winddiesel[19] the focussed product is a Fischer-Tropsch Diesel. The process scheme is given in Figure 8. Biomass is used to generate synthesis gas via gasification. After cooling and cleaning steps the gas is unified with hydrogen, which is produced by electrolysis. The energy for the electrolysis is provided by cheap wind power.

[19] Zweiler R.; Fachgespräch Bioenergieforschung, Vienna, 2014

Afterwards CO_2 is removed from the gas and the gas enters the Fischer-Tropsch reactor. Parts of the removed CO_2 are returned to the gasifier to generate the demanded product gas quality.

Current work focuses on the development of a slurry reactor, suitable to be operated between 30% and 100% load.

Figure 8: Basic Priciple - "Winddiesel"[20]



4.3 Biomass – heat pump

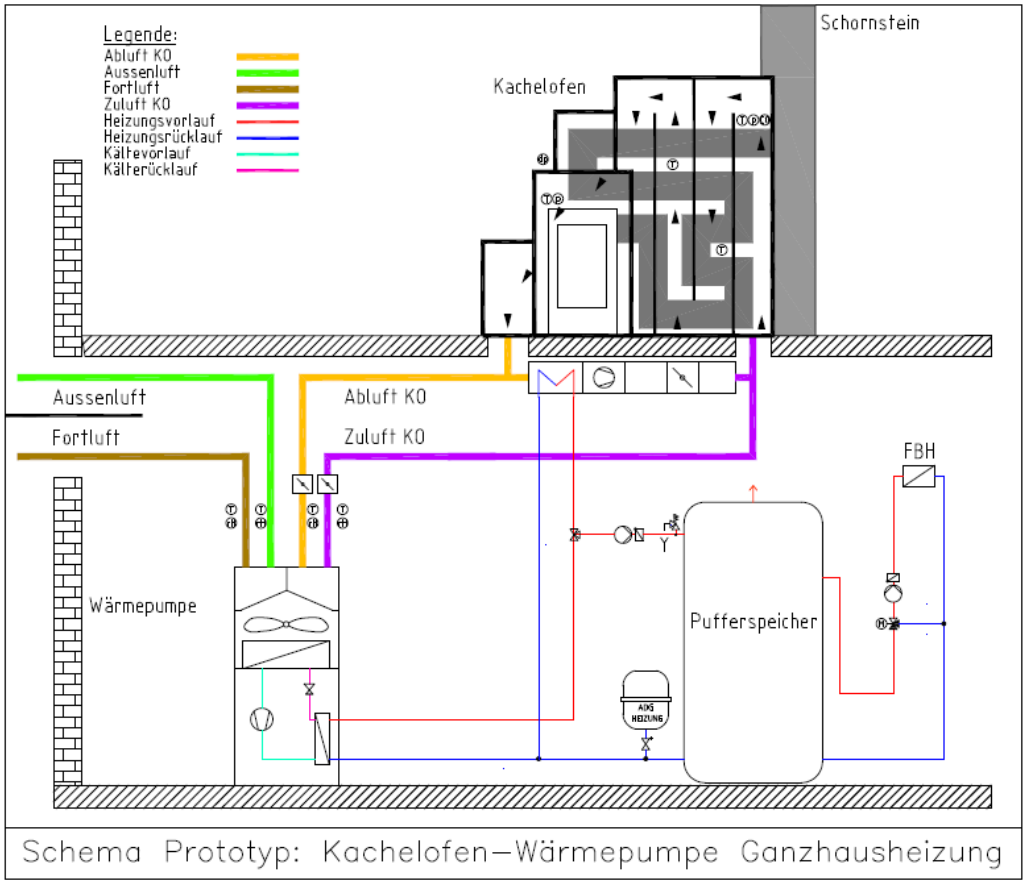
The combination of the technologies biomass combustion with heat pump has actually a wide range of applications. It is used in small scale boilers, as well as in heating plants and in special products. An overview about the Austrian activities is given in the following chapter.

4.3.1 “Tiled stove – heat pump” for central heating

The Austrian consortium out of Bioenergy 2020+ GmbH, Ortner GmbH and Systemtechnik GmbH developed a tiled stove – heat pump combination. The integration of the heat pump into the hypocaust allows the tiled stove to act as a central heating in detached houses. In the following picture a scheme of the developed hybrid system which is already registered for patent is shown.

[20] Zweiler R.; Fachgespräch Bioenergieforschung, Vienna, 2014

Figure 9: Tiled stove - heat pump combination[21]



4.3.2 Herz BioWP

For higher heat demands (e.g. micro-grids, district heating) Herz provides also a combination of an heat pump with a biomass boiler. The system is called BioWP and actually the market introduction is on the way. Further possible applications are buildings with heat demand or different temperature levels within building and applications with heating and cooling demand.

Within this system the heating pump is also used to provide heat during summer times and furthermore it acts as a back up system.

[21] ecoplus. Niederösterreichs Wirtschaftsagentur GmbH (ed.): Fact Sheet – Kooperationsprojekt Kachelofen-Wärmepumpe: Ganzhausheizung; http://www.ecoplus.at/de/ecoplus/cluster-niederoesterreich/bau-energie-umwelt/projekte.

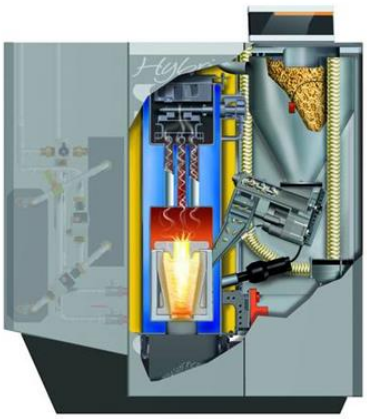
Figure 10: Herz BioWP - basic principle[22]

4.3.3 Guntamatic – Hybrid Flex

With the hybrid flex system Guntamatic offers a product, which switches automatically between two ways of generating heat: a biomass boiler and a air/water heat pump. The system is suitable especially for houses with floor heating systems.

In principle the biomass boiler provides heat during winter times with high heat consumption and the heat pump provides the heat during times of low heat consumption.

Figure 11: Hybrid Flex by GUNTAMATIC[23]



[22] M.Fesharaki, Herz Hybrid-System „BIOWP“, 19. Österreichischer Biomassetag, Bruck/Mur, 2015

[23] http://www.guntamatic.com/nc/pellet-waermepumpe/hybrid/

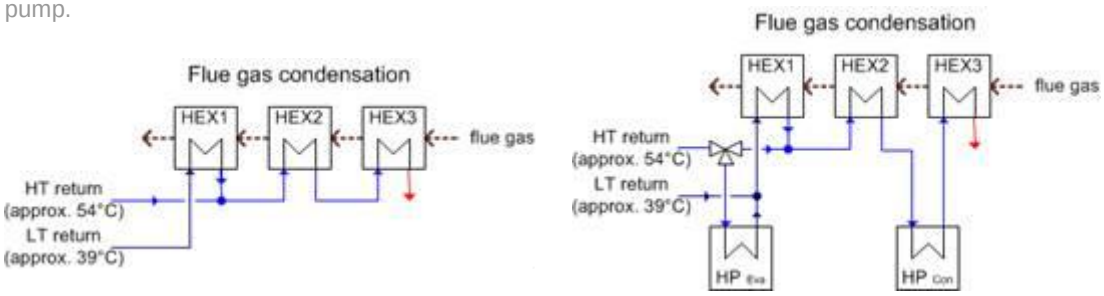
4.3.4 Heat Pumps in biomass based heating grids

The integration of heat pumps into biomass based Austrian heating grids is becoming a standard technology in the last years. There are several ways of using this technology:

The heat pump can be integrated as a single heat producer using ambient energy (air, water or soil) as a heat source – like in the project BiNe 2+, which will be presented later on. This concept could also be extended to several sources of waste heat.

A second option is the integration of the heat pump into the recirculating water. This concept was studied at the combined heat and power plant Tamsweg[24]. The basic principle is given in Figure 12. On the left side the situation before the installation of the heat pump is given. Three bundles of heat excangers (HEX) are streamed in countercurrent by the return flow of the heating grid. As the return flow is divided in two parts on two different heat levels, it´s inlet is split to different bundles. By this measure the amount of condensed water is increased. The implementation of the heat pump into the system is shown on the right side of Figure 12. The evaporating part of the heat pump is integrated in the first heat exchanger bundle to lower the temperature of the return flow. The energy is shifted to the water circuit just before the hottest bundle (HEX 3). Overall the efficiency of the power plant

Figure 12: Sketch of the condensation system before (left) and after (right) the integration of the heat pump.



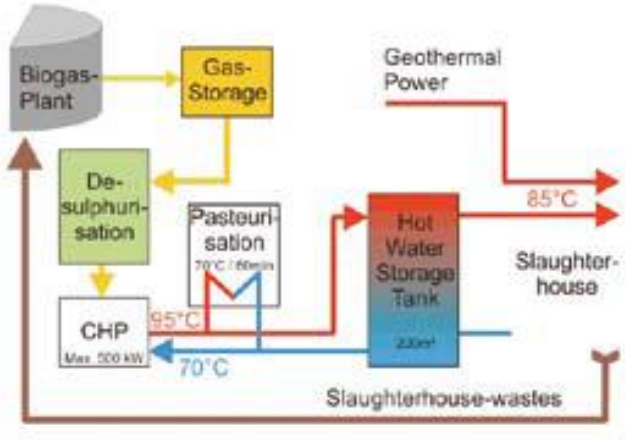
A third option is also implemented in an Austrian district heating plant. In Flachau the heat pump is integrated with an own cooling circuit, which is situated in the flue gas flux after this has already passed one or several direct condensing bundles. On the other side the return water also passes the direct condensing bundle in a first step and the condensing part of the heat pump in a second step

[24] Hebenstreit et al.; Heat pump enhanced heat recovery from flue gas of wood chips combustion, INFUB, Porto, 2015

4.4 Biogas and geothermal

In the St. Martin slaughter facility the slaughterhouse waste (ABP = animal by-product) is used for biogas production. This biogas is utilized in a CHP-plant for partial self-supply with electricity and heat. The remaining heat demand is covered with geothermal power, the electricity surplus is fed into the national grid. All in all about 4.7 MWh of electricity and 7 MWh of heat are generated per day by slaughterhouse waste. In Figure 13 the principle scheme and energy flows of this system are displayed.

Figure 13: Energy-Flow chart and principle scheme of the biogas plant to the slaughtering facility[25]



4.5 Multicombination System – Bidirectional Heating Grids

Conventional heating grids are characterized by a central heat production and consumers along the network. This situation is shown in the upper part of Figure 14. In more complex grids it could be built up by several distributed producers, but still, in classical setups there is a clear distinction between heat producers and consumers Buildings, which are not part of the network, usually have their own heat supply, which has an overcapacity in most cases. Examples therefore are:

- solar thermal collectors during sunny days in summer time
- biomass boilers in warmer winter periods and in transition time
- small- and medium-scale industry often hesitates to participate in heating grids.

[25] BIOGAS IN THE SOCIETY - Information from IEA BIOENERGY TASK 37 Energy from biogas and landfill gas: “Biogas from slaughterhouse waste: towards an energy self-sufficient industry”, Dec 2009

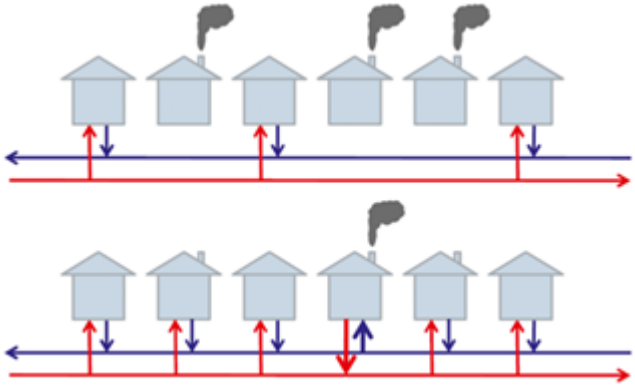
To integrate such buildings into the grid a bidirectional heating grid could be the solution (Figure 14 lower part). So additional heat for the grid is generated by prosumers (**Pro**ducer and Con**sumer**).

By this measure the following main improvements can be achieved

- replacement of peak load boilers
- summer operation mode of the heating grid with this sources instead of an inefficient main boiler

The technical and economical evaluation of such a system is actually under development in the project BiNe2+ (FFG-No: 848930), which is funded by the Austrian climate and energy funds (KLIEN) and the Austrian funding agency (FFG). The implementation of new decentralized heat producers into an existing heating grid is done in Großschönau, where a heat pump, a biomass boiler for chipped wood and an existing solar collector field will be connected to the grid.

Figure 14: basic layout of conventional(upper part) and bidirectional (lower part) heating grids[26]



[26] Lichtenegger et al.; Bidirektionale Einbindung dezentraler Einspeiser in Wärmenetze: hydraulische, wärmetechnische und regelungstechnische Aspekte; qm Heizwerke, Salzburg 2016

5 Summary and future perspective for bioenergy RES-hybrids in Austria

The Austrian technology and innovation roadmap “bioheating and cooling” estimates a further increase of biomass in the energy mix from 20 % in 2010 to almost 50 % of the total energy consumption for space heating and hot water production in 2035. This corresponds to a biomass based annual final energy consumption of approximately 130 PJ.[27] Assuming that the major part of future installations can be equipped with hybrid technologies providing 15-25 % of annual final energy consumption (reference: biomass/solar hybrid system) a potential of roughly 20-30 PJ can be estimated. Currently around 8 PJ are provided by 500 Mio square meters of thermal solar collectors installed in Austria.[28] Additional contributions can be expected from the increase of other hybrid solutions for medium and large scale applications (e.g. active flue gas condensation with heat pumps).

Finally in Table 3 a very brief summary of chapter 4 is given including a division by scale.

Table 3: ResHybrids in Austria - overview market status

	Domestic/household	**Big scale**
On market / implemented	Biomass / solar thermal	Biomass / heat pump
	Biomass / heat pump	Biomass / Solar thermal
	Biomass / PV	Special solutions (e.g. Slaughterhouse/Biogas)
Ongoing developments / Outlook	Model predictive control	Utilization of excess electrical energy (Power to Gas, Power to Liquid)
	Integrated control systems	Integration of Prosumers into heating grids
	Increase market penetration	Increase of market penetration

[27] Wörgetter et al. FTI Roadmap BioHeating and Cooling, Austrian Ministry for Transport, Innovation and Technology, Vienna, 2012: https://nachhaltigwirtschaften.at/resources/nw_pdf/1254_fti_roadmap_bioheating_and_cooling.pdf?m=1469660261

[28] Biermayr et al., Innovative Energietechnologien in Österreich – Marktentwicklung 2015, Austrian Ministry for Transport, Innovation and Technology, 2016: https://nachhaltigwirtschaften.at/resources/nw_pdf/201606_marktentwicklung_2015.pdf?m=1469659717