Design Specifics of High Efficiency Biomass Power Plants for fresh wood from forestry exemplified at the 23 MWe Biomass Power Plant Simmering / Vienna – Austria

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1. Summary

The utilization of biomass is the option within renewable energy production with the biggest rate of growth in the coming years. Main focus will be the energy recovery from residues of agriculture and forestry. As the resources of available biomass for producing energy are limited, maximum utilization of the fuel is very important. The technologies applied have to be efficient, stable and cost-effective. WIEN ENERGIE has considered this at their 23 MWe biomass power plant project in Simmering / Vienna, Austria

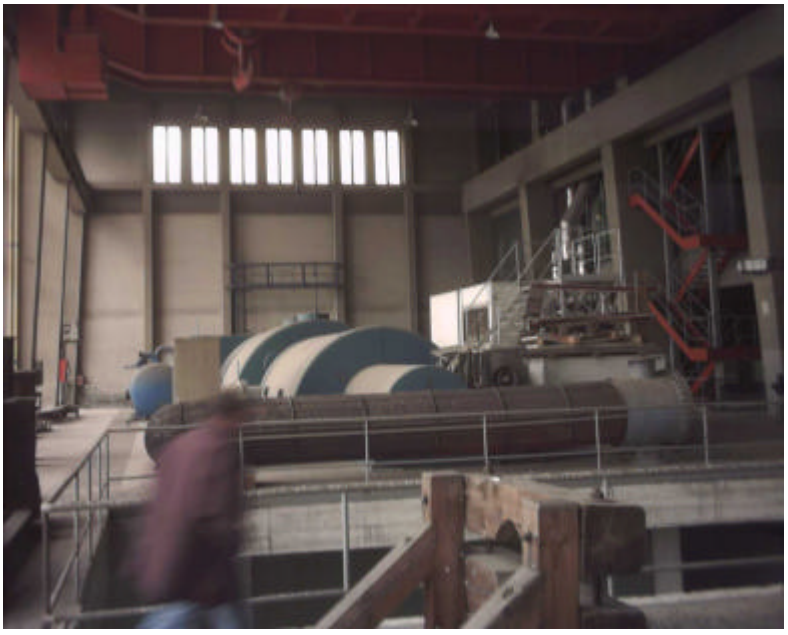
2. Introduction

WIEN ENERGIE, the Austrian Federal Forest Association (ÖBf) and District Heating Vienna will build the plant on part of an existing old power plant site in Simmering. Some existing base plates and parts of the old power plant can be used for the new plant. The arising power plant in Simmering will be one of the world´s biggest biomass power plants exclusively fed with fresh wood from forestry. The investment will be approx. 52 Mio. EURO. Siemens Power Generation is main contractor for the turnkey supply of this plant. The steam generator will have a max. thermal output of approx. 64.6 MW. The steam generator will be a CFB (Circulating Fluidized Bed) - Boiler with reheat system. It will be supplied by Foster Wheeler/Finland.
The plant will produce 23.4 MWe electricity in summer and 15.06 MWe plus 37 MWth for district heating in winter. It has a fuel consumption of approx. 600.000 m³/a (approx. 23.4 t/h) forest residual wood chips. The plant will provide electricity to approx. 45,000 households and heat to approx. 12,000 households.
By using the optimized CFB combustion technology together with a reheat system the plant will attain a very high efficiency. The combustion technology is also very flexible regarding the moisture of the fresh wood.
Boiler erection will start at the end of April 2005.

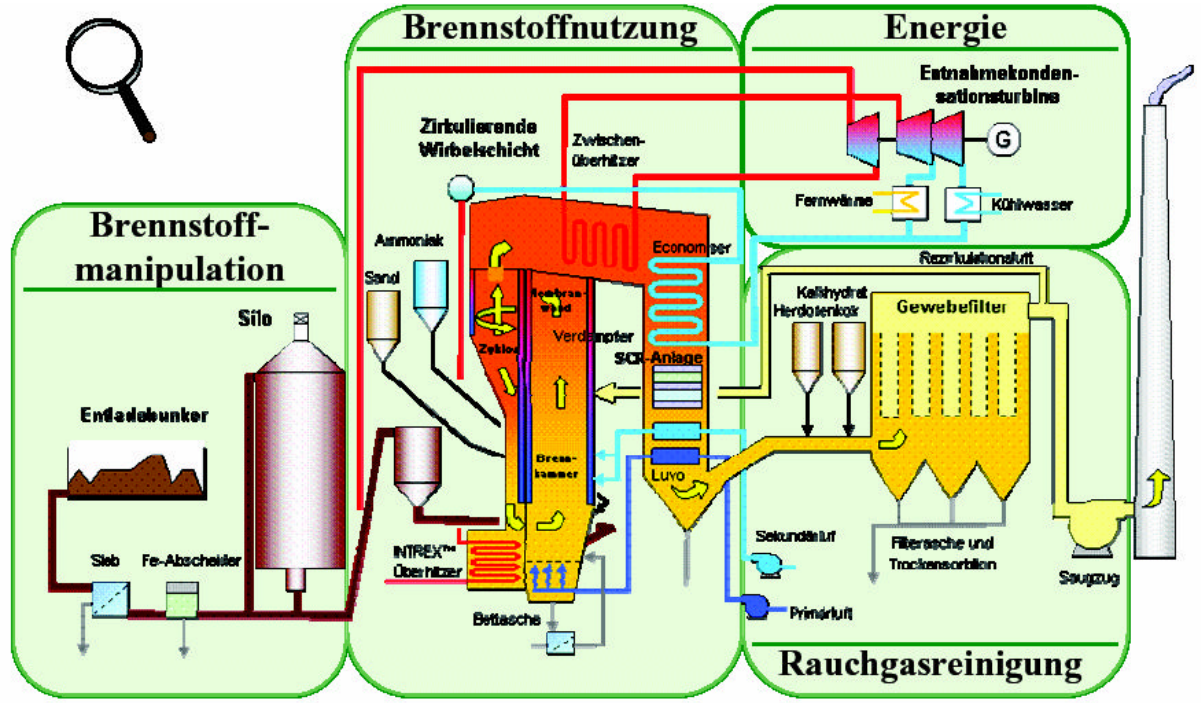
3. Plant Overview

The main focus of the plant is electricity generation throughout the year (base load power plant, design point operating hours > 8.000 h/a) and in winter supply of district heat with the highest possible number of operating hours at full load and with high availability.
The power plant will be erected on the existing Simmering power plant site and some existing buildings can be used. Some of the existing buildings, for example the old boiler house and turbine house, were demolished by the customer (picture 1). The base plates of the old boiler and of the old steam turboset can be reused for the new components (picture 2). The old components like feed water tank, the boiler feed water pumps, main condenser, condensate pumps and cooling water pumps and part of the piping system are replaced by new ones.

Picture 1: Demolition of the old boiler and turbine house



Picture 2: Existing turbine base plate will be reused
The general overview of the power plant concept is shown in picture 3.



Picture 3: Flow scheme of the biomass power plant Simmering
Andreas, you should have a key for this diagram in English if the picture text is in German
The main systems of the power plant are the fuel input (bunker), the fuel storage (silo) and the fuel transport systems, the steam generator (CFB boiler), the flue gas cleaning (dry sorption) and the power island (extraction condensing turbine).
In the following chapters the main data of the systems are presented.

3.1 Fuel Handling

3.1.1 Fuel Specification

The biomass which will be burned in Simmering is mainly fresh wood chips. The kind and percentage of different fuels that will be burned is shown in table 1.

Pos	Fuel	Key. No. acc. ÖNORM S 2100	Portion
1.	**4. Fresh wood**		
1.1.	Wood chips from forestry		75 Ma. % - 100 Ma. %
2.	**5. Bark**		
2.1.	Bark	17101	0 Ma. % - 10 Ma. %
3.	**6. Untreated waste wood**		

3.1.	Chips from untreated wood	17102	Together 0 Ma. % - 15 Ma. %
3.2.	Waste wood	17201	
3.3.	Wood wool, uncontaminated	17203	
3.4.	Garden and park waste	91701	
4.	**7. Natural Gas**		
4.1.	Natural gas H		Auxiliary firing, for start-up of the plant

Table 1: Fuel specification

Mainly fresh wood (water content approx. 40%) is burned during the year. The fuel mass flow in the design point is approx. 184.000 t/a. But the plant also needs to be designed for each fuel mixture that is specified in table 1. In the fuel mixture a maximum waste wood fraction of 30.000 t/a (water content approx. 15%) will be burned. The proportions of relevant chemical elements in the fuel are shown in table 2.

Element	**Portion**
Sulfur (S)	0,15 wt-% dr
Chlorine (Cl)	0,10 wt-% dr
Nitrogen (N)	1,00 wt.-% dr
Sodium (Na)	400 mg/kg dr.
Kalium (K)	3.500 mg/kg dr.
Bulk density	150 – 500 kg/m³

Table 2: Parts of the elementary analysis of the fuel

3.1.2 Fuel Transport/ Storage

The fuel is transported by trucks to the power plant and unloaded into a bunker. The wood chips are transported via moving floors and conveyors into a storage silo (capacity 7.500 m³).
Before the wood chips are stored in the silo there is a magnetic separator that removes iron parts and an oversize treatment that eliminates oversized material. So it is assured that the stored fuel meets the demands of the firing system.
From the storage silo the appropriate biomass is transported into the daily silo of the steam generator (capacity 50 m³).

3.2 Steam Generator

The steam generator will be supplied by Foster Wheeler and is a CFB (Circulating Fluidized Bed) – Boiler with a reheat. The steam generator is designed for a thermal load of 64.6 MWth and the live steam operating data are 120 bar/ 520°C and 16 bar/ 520°C in the hot reheat. The final superheater is an INTREX superheater, a special design feature from Foster Wheeler. For bed material natural sand is used. For reduction of NOx a SNCR (Selective Non-Catalytic Reduction) in combination with a SCR (Selective Catalytic Reduction) is applied. The reheat system can increase the efficiency of the plant considerably.

During winter operation with heat extraction the plant will reach a total efficiency of approx. 83%. During summer no heat extraction is in operation and the plant will produce a power output of approx. 23.4 MWe_{gross} with an electrical efficiency of 36%.

Thermal boiler output	*Max. 64.6 MWth*
Fuel	*Fresh wood chips, bark, untreated waste wood, natural gas (start-up burner)*
Turbine output in summer	*23.4 MWel on the generator terminal*
Turbine extraction	*31 – 48 t/h at 3 bar*
Live steam parameters	*23.4 t/h, 120 bara, 520°C (inflow turbine)*
Total efficiency	*Max. 83 %, (brutto electrical approx. 36,4 %)*

Table 3: Overall technical data of the Simmering plant

3.3 Flue Gas Treatment

The nominal flue gas flow is approx. 100.000 Nm³/h. By dosing calcium hydroxide (Ca(OH)2) and filtering through a bag house filter, the emissions of dust, acid gases like SO2 and HCl are reduced below the imposed limits. The limits for clean gas emissions are shown in table 4.

Emissions (half hour average values at 13% O2)	**mg / Nm³**
Dust	10
CO	100
NOx	50
Corg	20
SO2	50
HCl	10
HF	1
Dioxine, Furane	0.1 ng/Nm³
NH3 at 0% O2	10 mg/Nm³

Heavy metals emissions are reduced by the dosing of activated coal.

3.4 Balance of Plant

The Balance of Plant (BoP) consists mainly of the live steam system, cold and hot reheat system, condenser, main condensate system with LP-Preheater and feedwater system with HP-Preheaters, steam air-preheater system, district heating system (single stage) and condensate drainage systems (see also picture 3).

3.5 Steam Turboset

During summer the turboset is operated in 100% condensing mode and produces a nominal electrical power of 23.4 MWe (generator output). The necessary auxiliary power of the plant is 2.17 MWe. The maximum produced electrical power of the plant is approx. 24.5 MWe.
During winter the turboset is operated in extraction/condensing mode and produces a nominal

electrical power of 15.06 MWe and a thermal power of 37 MWth for district heating. During the winter season the plant runs at its highest efficiency (approx. 83%).

4. Conclusion

As fresh wood is a rather valuable and expensive fuel the Simmering biomass power plant was designed for very high efficiency. The CFB boiler technology with reheat system, LP-and HP-Preheating systems guarantees a maximum fuel utilization for saving resources of fresh wood. The operation of the plant reduces Vienna´s CO2 emissions by 144.000 t/a CO2 and saves approx. 60.000 t/a coal.