Wood energy in Switzerland

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Introduction

In December 1998, the Wood Energy Association in Switzerland (VHe in German, ASEB in French) was celebrating its 20 years of existence. Wood energy is taking an increasing role in this country for several interrelated reasons and in particular:

- There is nearly no fossil fuel electricity production in Switzerland (hydraulic = 54%, nuclear = 43%, thermal = 3%). For environmental and political reasons, the nuclear proportion should decrease in the future. At the same time, the country is preparing the introduction of a CO2 tax which will give an economic advantage to wood fired installations. For complete energy statistics about Switzerland see

  http://www.admin.ch/bfs/stat_ch/ber08/eufr08.htm and

  http://www.admin.ch/buwal/e/themen/partner/energie/ek26u02.pdf

- Switzerland has been very active in the promotion of sustainable development and, in particular, renewable energy. In 1997, 22% of the wood consumption was devoted to energy production, which represents 2.4 millions m3 (18 TJ) and 3.2% of the total energy consumption. After hydraulic power,wood is thus the second most important source of renewable energy.

This article is based on the monthly bulletin of the VHe/ASEB (www.vhe.ch) and on articles of Gaegauf C.K et al. from the Laboratories for Sustainable Energy Systems in Langenbruck

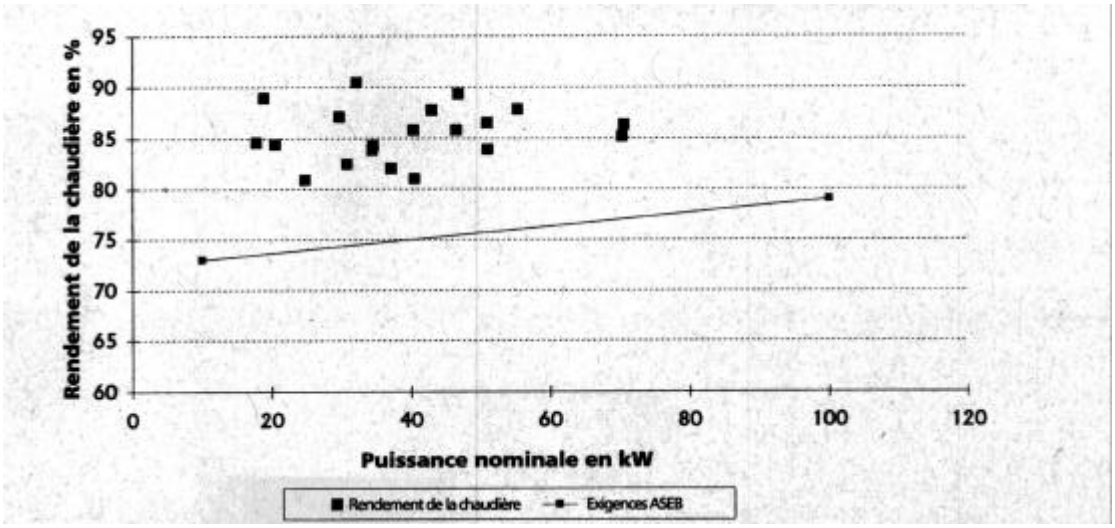
Certification aspects

The VHe/ASEB has put a certification process in place for automatic wood fired boilers up to 300 kW. This certification is based on the most severe category of the CEN 303-5 of the european standard.

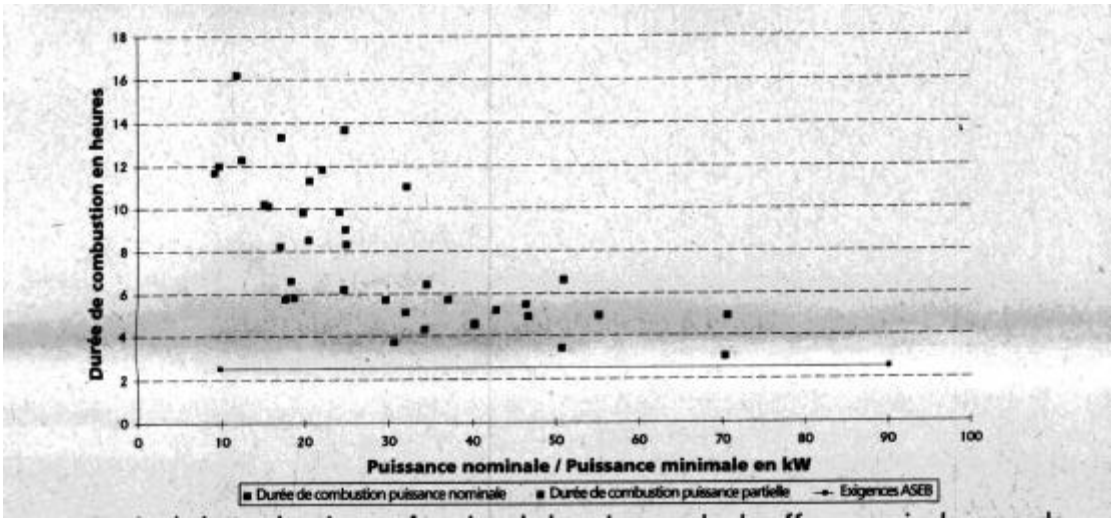
Boilers are not only tested at nominal load but the also have to comply with emissions standards at 30% load. Boilers fed manually with wood logs do not yet meet the standards at 30% loads and must thus be equipped with heat storage elements for excess heat production. The storage capacity is on the order of 750 liters for a 20 - 70 kW boiler with a turn-down of 50%.

So far, 11 series of boiler types, each comprising 30 models, have received the label. In December 98, 9 companies were selling these boilers in Switzerland: CIPAG, CTC, Heitzmann, Köb, Liebi, Lorenz, Schmid, Sigmatic, Tiba.

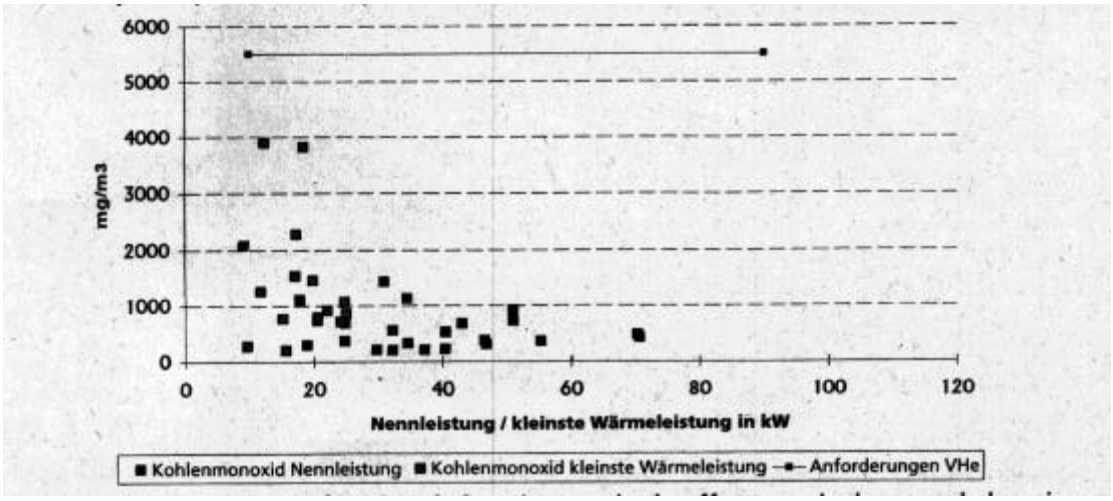
The characteristics of these boilers are given in the following.



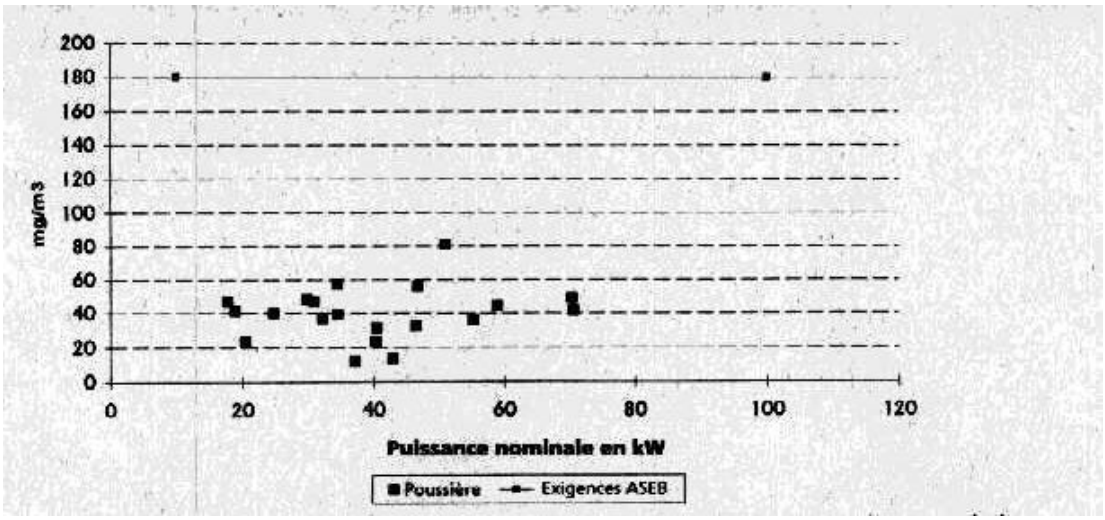
Boiler efficiency vs. nominal load: the determining factor for certification is the direct boiler efficiency calculated on the basis of water heating time. This method contains an inherent inaccuracy of +/-3%. It can be seen that most of the boilers are 6% above the minimum requirement.



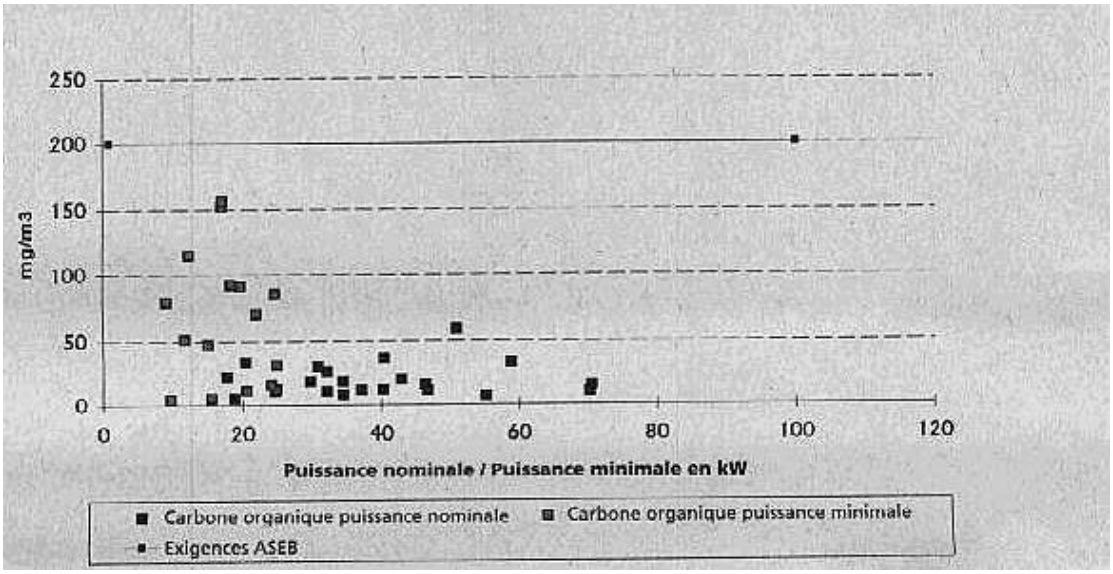
Combustion time vs. nominal load resp. minimal load: the minimum combustion time allowed is 2h30 which is relatively low compared to what good boilers can reach. Most of the boilers have a combustion time of 4-6 h. at nominal load.



CO emissions vs. nominal load resp. minimal load: even with very low heating power (45 - 60% of nominal load), most of the measured emisssions are more than 50% below the threshold of 5500 mg/m3.



Dust emissions vs. nominal load resp. minimal load: measured values are clearly below the limit of 180 mg/m3.



Organic carbon vs. nominal load resp. minimal load: results are comparable to CO and dust emissions.

The emission values are all given on a dry basis and with an oxygen concentration in the flue gas of 10%.

Until now, automatic boilers (fed with wood logs or pellets) have not yet been certified. Some manufacturers have argued that a 30% minimum load is too low and make it difficult to comply with emission standards. However, one of the foreign manufacturers has shown that those limits are realistic for automatic boilers. The EN 303-5 has now become mandatory for all boilers sold in Switzerland, which de-facto, will meet the VHe/ASEB standard. There is now a need for an international quality standard for wood fired boilers. The establishment of such a standard will be a challenge for the coming years.

Heating with wood granules

In Switzerland, only 800 tons of wood granules have been produced in 1997, against 40'000 tons in Austria. Quality standards for the granules do not exist in Switzerland, but do exist in Austria (ÖNORM M 7135). This standard sets characteristics such as density, minimum calorific value (4.9 kwh/kg), maximum water content (12%), maximum ash content (0.5% dry basis) and size. Regarding operating costs, granules are quite attractive compared to other fuels as shown below (in CHF).

	Gas heating	Fuel heating	Granules heating
Individual house, 5 kW	(12500 kwh)	(1250l)	(2500 kg)
- energy consumption	720	400	625

- storage tank maintenance	-	100	-
- burner maintenance	200	250	75
- chimney maintenance	60	160	160
- heating control	50	50	-
Total	**1030**	**960**	**860**
Individual house, 5 kW	(12500 kwh)	(1250l)	(2500 kg)
- energy consumption	940	560	938
- storage tank maintenance	-	100	-
- burner maintenance	200	250	75
- chimney maintenance	60	160	160
- heating control	50	50	-
Total	**1250**	**1120**	**1173**
Individual house, 5 kW	(12500 kwh)	(1250l)	(2500 kg)
- energy consumption	1440	800	1250
- storage tank maintenance	-	100	-
- burner maintenance	200	250	75
- chimney maintenance	60	160	160
- heating control	50	50	-
Total	**1550**	**1360**	**1485**

Despite these advantages, granules heating is not widespread in Switzerland. Most of the granules are imported and cost between CHF 220 and CHF 550 per ton. A production and consumption increase would be required to push the prices down in the future.

R&D projects

Many R&D projects on Biomass are reported in the home page of the Swiss Federal Office of Energy and will not be reported here:

http://193.5.216.31/bfe/forschu/7bnghn.pdf

One of the centers active in the field of wood combustion is the Laboratories for Sustainable Energy Systems in Langenbruck

http://www.access.ch/private-users/oekozentrum/

Recent projects which have been carried out are summarized below (Gaegauf C.K., et al.)

Investigations and optimisation of wood burning appliances

Wood burning appliances such as cookers, inserts and stoves have a considerable potential to substitute fossil fuels. This positive aspect using wood as CO_2-neutral energy source faces negative impacts, if wood burning appliances do pollute the environment with products of incomplete combustion (PIC). The main target of the project was the development of design criteria and operating parameters for combustion chambers (CC) in wood burning appliances to meet the increased requirements regarding efficiency and environment-friendliness. If the parameters are known which do reduce PIC in the combustion processes, designers as well as users are in the position to improve the environmental impact of appliances. All measurements has been done with a new method to analyze transient combustion processes, which allows an incremental approach for the calculation of the various parameters. Beside gaseous components also particulate matter (PM) has been analyzed in the flue gas. It has been found, that a CC with a ratio of 14 liters per kilogram wood gives good combustion. The top down fire showed less PIC than bottom up fire in the CC.

Biomass burner with low emissions of particulates

The target of the project is the development of a biomass burner designed to burn wood chips for boilers in the range of 50 - 500 kW thermal output, which already decreases the particulate matter (PM) formation within the thermochemical conversion process. The main feature of the burner design is the combustion chamber to create a vortex to achieve complete combustion. The combination of vortex and air staging techniques reduces the PM formation. First tests with a bench scale burner showed a emission reduction of particles with diameter around 100 nm of a factor 100 compared to a commercial burner. The particulate emissions were measured by a differential mobility analyser (DMA) using a scanning mobility particle sizer (SMPS) software.

Further investigation will be done with a process demonstration unit (PDU). The unit combines a pre-combustion chamber, a hot gas cyclone and the vortex burner as secondary combustion chamber.

New Method to Determine Efficiency and Emissions of Solid Fuel Burning Appliances

Various combustion and fuel parameters of batch-wise fired solid fuel burning appliances such as

- burn rate
- fuel composition (carbon, oxygen and hydrogen), water content and heating value
- draft and temperature in the flue

change a lot during a burn cycle.

To improve the combustion process and the efficiency in all phases of a burn cycle (start up, intermediate and burn out phase) the combustion parameters need to be known at all time. With the measurement of

- heat release
- emission mass flow
- burn rate

the emissions of an appliance are known at any operating point and the efficiency and emissions factors can be calculated for the entire burn cycle.

The basic layout for the test method has been defined by the International Organisation of Standardisation (ISO) and comprises a calorimeter room and a dilution tunnel.

Calorimeter Room

The calorimeter room is an insulated chamber where the appliance is installed. The room is vented with air in order to extract the heat released by the appliance. The calorimeter is equipped with additional electrical resistance heating. A temperature control always keeps the calorimeter at the same temperature level by varying the power of the electric heating. This compensated heat load method allows the determination of the appliance heat release by power difference calculation. The compensation method copes with accuracy problems due to heat losses and thermal inertia of the calorimeter room construction. In the calorimeter there is a weighing scale installed for the measurement of the burn rate. The calorimeter room combines the following features:

- determination of the power output of an appliance over the burn cycle
- total heat release of a burn cycle.
- direct measurement of efficiency

Dilution Tunnel

In the dilution tunnel flue gases and ambient air are mixed at constant flow conditions (Constant Flow Sampling, CFS). The gaseous and particulate emissions are measured in the dilution tunnel.

- Mass flow of emissions are known at any point of the burn cycle
- Emission factors can be indicated based on correct mean value calculations

Figure 1
Test rig with calorimeter room and dilution tunnel to determine power output efficiency and emissions of solid fuel burning appliances at the *Laboratories for Sustainable Energy Systems*, Switzerland
Photo Heiner Grieder, CH-4438 Langenbruck

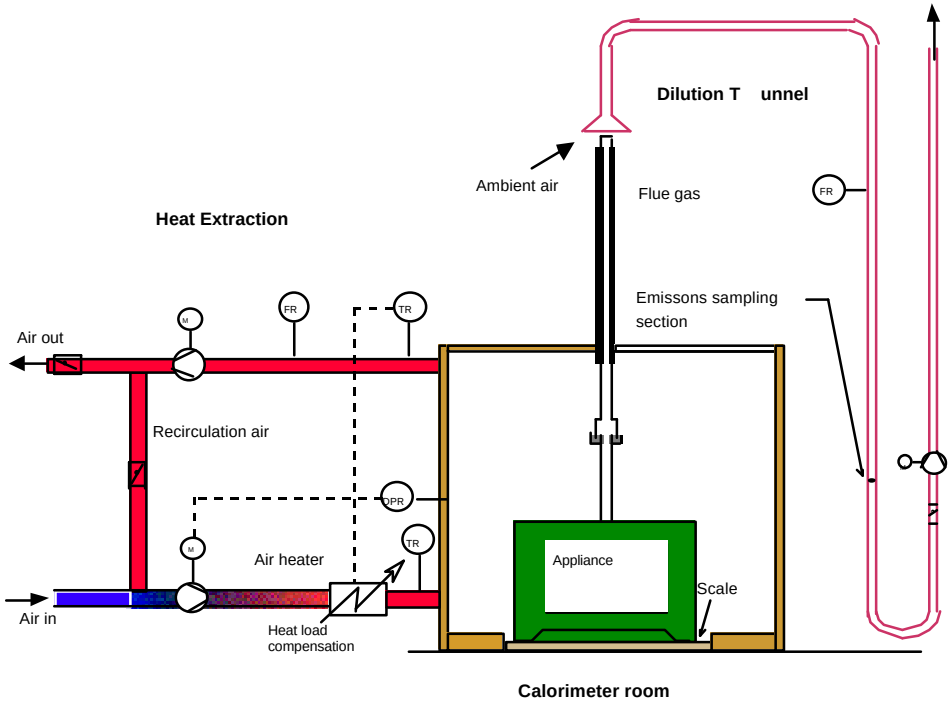


Figure 2
Flow sheet of calorimeter room and dilution tunnel

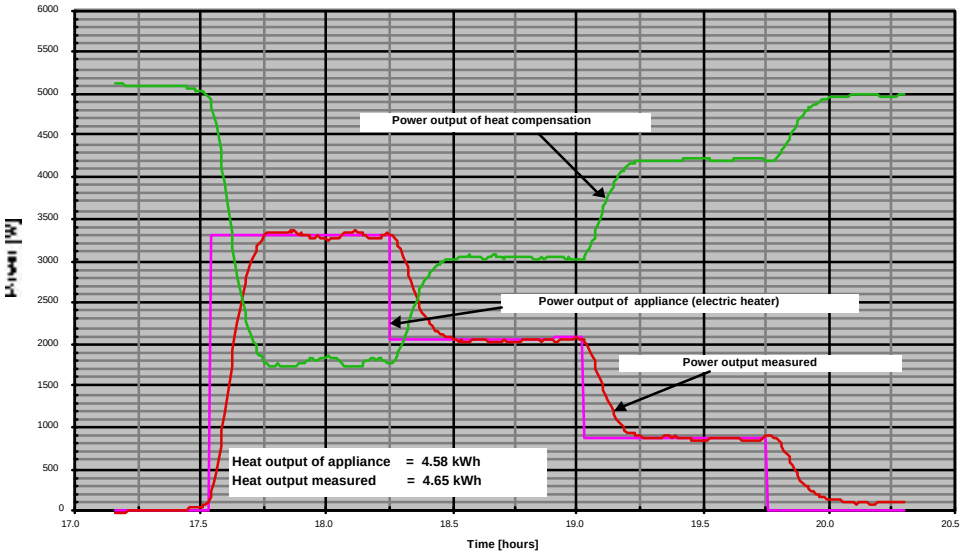


Figure 3
Calibration of calorimeter room by means of an electrical resistance heating

Another laboratory active in the , linked with the ETH in Zurich is:

Verenum, Ingenieurbüro für Verfahrens-, Energie- & Umwelttechnik

Contact person: Dr. Thomas Nussbaumer

http://www.admin.ch/bbw/abstracts/joule-thermie/j950859-2.html

An on-going Joule project is "Reduction of Nitrogen Oxide Emissions from Wood Chip Grate Furnaces" jointly with Joanneum Research (A), the coordinator, Chalmers University (S), ETH Zürich (CH), TU Wien (A), VTT Energy (SF), Abo Akademi (FIN), Kvaerner (S), Awina (A), Universität Zaragoza (E).

A project description is available at:

http://www.eva.wsr.ac.at/opet/opet-b6.htm

Conclusion

There is a great potential for the development of wood energy in Switzerland and for cooperation with other countries in this field. There is however a recognized lack of scientific and technical experts in combustion and in particular wood combustion. This will surely evolve favorably with the implementation of the new educational system (Hautes Ecoles Spécialisées) and with the introduction of a CO2 tax which should allow the creation of R&D teams and new companies.