Proposal of a Product-Label for small scale Biomass Furnaces

Directive 2005/32/EC for Energy using Products[1] was the starting point to establish consistent EU-wide rules for improving the environmental performance of energy using products through ecodesign. For products which have significant sales and trade in the EU, specific implementing measures are ascertained or are under development. The procedure to ascertain these implementing measures is the same for all groups of products[2]. Since September 2007 the preparatory study on the product group of "Solid Fuel Small Combustion Installations" is ongoing (LOT 15 http://www.ecosolidfuel.org). In Austria Bioenergy 2020+ and Joanneum Research performed a national mirror-project BioHeatLABEL concerning biomass furnaces. This project is funded by the Austrian national "Klima- und Energiefonds" (Climate and Energy Fund) in the frame of the programme "Neue Energien 2020" (New Energies 2020)

Objective

The Aim of BioHeatLABEL is to develop categories and classes of eco-efficiency in order to derive a proposal for a product label for small scale biomass furnaces. The evaluated products include a ready to use furnace biomass including optional automatic fuel transportation from an interim storage container and additional required components which influence the efficiency and environmental impacts (e.g. draft limiter). Not included is the flue gas system, the entire heating systems with storage, distribution and heat supply or combinations with other heat sources. This label should appraise which performance of the small scale biomass furnace is possible if the manufacturers' instructions are met and the furnace is operated as intended.

The Product Label for small scale biomass furnaces should meet the following demands:

- Easy to understand and scientifically sound comparison of efficiency and environmental impacts
- Stimulation of manufacturers and importers to develop and sell environmental friendly products
- Basis for politician to make decisions with respect for the funding and subsidies for the best performing products and the banning of products which are out of date
- Promotion and technological encouragement of thermal use of biomass in small scale furnaces in order to support reduction of greenhouse gases in an environmental friendly way

[1] Also Ecodesign directive, in October 2009 replaced by directive 2009/125/EC "establishing a framework for the setting of ecodesign requirements for **energy-related** products"

[2] See http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm

Basics

For several aims of energy policy a product label for small scale biomass furnaces can be an effective tool. Both the efficient use of resources as well as the increased use of renewable resources should be supported. For the reduction of energy demands, consumer oriented measures are necessary.

The general demands for a product label for small scale biomass furnaces are the same like the ones in LOT 1 Eco-design Boilers[3]: A product label should be

- Fair, ambitious and demanding while providing a playing field for manufacturers in terms of technological progress
- Recognisable and coherent over the range of products, redundant style like A-G and rainbow colour-scheme for information about energy and environment
- Avoid text, by using symbols, icons, well-known classifications
- Technical information should be on the “fiche” as much as possible, performance indications should be based on the function that the consumer wants
- Reward the use of renewals with factual information and subject to the same validation as conventional products
- Should be applicable in incentive-schemes: subsidies, loans, tax-deductions
- Should be coherent with, and possibly applicable in other existing and future legislation, notably the EPBD and notably Eco-design measures for related products

Many existing labels concern products which need electricity for operation but no other kind of energy. Products with low electricity consumption are evaluated as economical and environment friendly. This classification is not applicable for biomass furnaces.

Since most products for heat production need different kinds of energy an eco-index was suggested for comparison in the preparatory study of LOT 1. This eco-index is calculated with a theoretical model. The result is the seasonal efficiency of the entire heating system. For the consumption of electricity a primary energy conversion factor of 2,5 is in use. This eco-index is a measure for energy resources use and carbon emissions which may be true for oil, gas and heat pump boilers on average. The fixed determination of a factor between electricity and both oil and gas shows significant deficits when comparing systems with different fuels. For instance the seasonal efficiency of a condensing gas boiler is much higher than those of an old fashioned log wood boiler, but also the emissions of green house gases and use of limited resources. Since this eco-index only evaluates the conversion of fuels to useful heat it is not a quantity which correlates absolutely to green house gas emissions. Renewable emissions of carbon dioxide are not accounted for. Calculating the eco-index only with fossil and nuclear energy demand would not assure the efficient use of renewable resources. Furthermore, the energy demand for fuel pre-treatment and transportation is missing which is necessary for a holistic evaluation.

[3] See LOT 1 final report Task 7 , Policies, scenarios, impact & sensitivity analysis
http://www.ecoboiler.org/public/ecoboiler_task7_final.pdf

The current available data about small scale biomass furnaces for classification in a product label are efficiency and emissions from standard test operation. For certain product groups there exist European standards: EN 13229 for open fireplaces, EN 13240 for closed fireplaces, EN 15250 for slow heat release stoves, EN 12815 for cookers, EN 14785 for pellet stoves and EN 3030-5 for automatically and manually fuelled boilers.

Data about electricity, fuels and materials are available by Eup-EcoReport („Methodology Study Eco-design of Energy-using Product"[4]), GEMIS 4.5 (Globales Emissions-Modell Integrierter Systeme[5]) and Ecoinvent[6]. With these sources the cumulative energy demand for provision of fuels and materials as well as the cumulative emissions of green house gases and other air pollutants are given.

[4] see http://ec.europa.eu/energy/demand/legislation/doc/2005_11_28_finalreport1_en.pdf

[5] see http://www.umweltbundesamt.at/ueberuns/produkte/gemis/ or http://www.oeko.de/service/gemis/de/index.htm

[6] see http://www.ecoinvent.org/

Proposal for Product-Label

In order to facilitate an easy comparison for consumers and to fairly handle all sub groups of biomass furnaces a uniform label with uniform evaluation parameters and class limits is suggested. Since it should be a label for the whole European Union facilitating free movement of goods, the input data for labelling can only be uniform mean values of the EU, e.g. primary energy factors or cumulated emissions for electricity or fuels.

In addition to the type of biomass furnace (stove or boiler) as well as the name of the manufacturer and model the label should contain the following main information (Figure 1, explanation of the indicators see below):

- Indicator for Energy Consumption – Efficiency of the appliance
- Indicator for Consumption of Resources – Eco-Efficiency evaluating primary energy demand
- Indicator for Emissions – main environmental impact during operation phase

Classes A to G represent the variations in stock, class A at the same time state of the art. Classes A^+ and A^{++} give manufacturers room for technological product differentiation and further improvements.

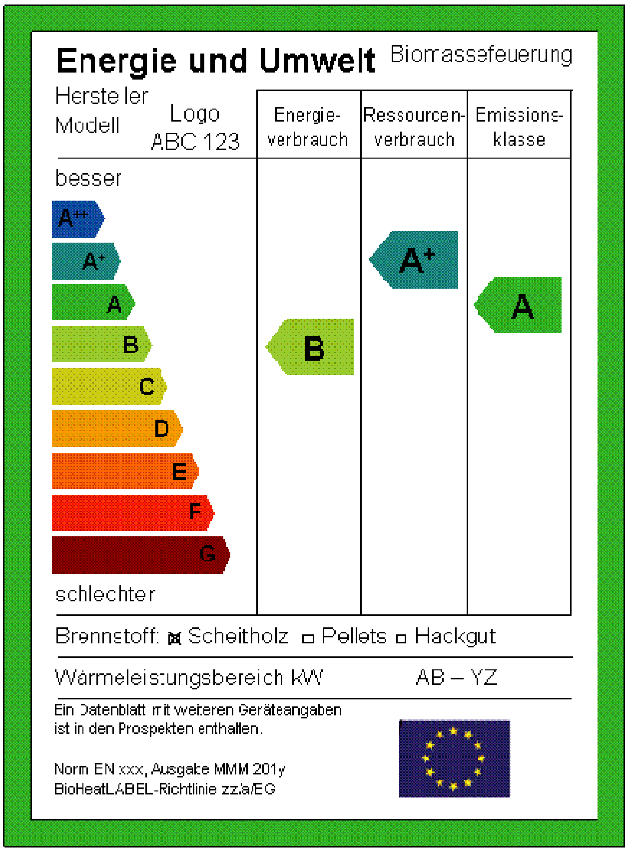

Figure 1: Proposal of a product-Label for small scale biomass furnaces

The **Indicator for Energy Consumption** is determined by the seasonal or **real life efficiency** of the biomass furnace. The real life efficiency is the ratio of delivered useful heat output to the heat input for a entire heating season (heat input based on its net calorific value of the fuel). Since the real life efficiency is not measured in a standard test operation, assumptions have to be made. Based on literature data and the expertise of Bioenergy 2020+ and partners, the difference between standard test efficiencies and real life efficiencies are well known. The average real life efficiency of state of the art biomass boilers is the standard test efficiency minus 12 %. The average real life efficiency of state of the art biomass stoves is the standard test efficiency minus 5 %. The suggestions for the class limits for the indicator of energy consumption are listed in Table 1.

Table 1: Proposal for class limits for the indicator for energy consumption

Class for Energy Consumption	Necessary Seasonal Efficiency
A^{++}	90 %
A^{+}	85 %
A	80 %
B	75 %
C	70 %
D	60 %
E	50 %
F	30 %
G	10 %

The **Indicator for Consumption of Resources** is determined by an Eco-Efficiency evaluating primary energy demand. In order to allow comparison of systems with different fuels a holistic approach is suggested by evaluating the **whole life cycle of the biomass furnace**: Total consumption of primary energy[7] for production of the biomass furnace, operation (including cumulative amounts for fuel or electricity) and disposal. The energetic Eco-Efficiency is defined using the energy yield coefficient (see Equation 1) and the fraction of the renewable primary energy consumption (Equation 2). Equation 3 allows the calculation of the Eco-Efficiency as product of energy yield coefficient and fraction of the renewable primary energy consumption (times 100 to get reasonable numbers). A high Eco-Efficiency means both high efficient conversion of primary energy to useful energy and a high amount of renewable resources used. These two conditions guarantee careful use of resources and maximum reduction of greenhouse gases. Without use of renewable resources the Eco-Efficiency is zero.

$$\text{Energy Yield Coefficient} = EYC = \frac{\text{cumulative Energy Production}}{\text{cumulative Primary Energy Demand}}$$ **Equation 1**

$$\text{Fraction of renewable Primary Energy} = F_{ren} = \frac{\text{renewable Primary Energy Demand}}{\text{total cumulative Primary Energy Demand}}$$ **Equation 2**

$$\text{Eco-Efficiency} = EYC \text{ x } F_{ren} \text{ x } 100$$ **Equation 3**

Example for calculating the Eco-Efficiency for a state of the art pellet stove (BAT) with the following assumptions (see also Annex):

- Cumulative specific primary energy consumption for delivering fuel 1,285 MJ/MJ
- Standard test efficiency 93 %, real life efficiency RLE 88 %
- Fraction of fuel of total primary energy consumption 98 %
- Fraction of renewable primary energy for heat supply from pellets 90 %

$$EYC_{\text{BAT Pellet stove}} = EYC_{\text{fuel}} \text{x} RLE \text{x} 0{,}98 = \frac{1}{1{,}285} \text{x} 0{,}88 \text{x} 0{,}98 = 0{,}67$$

$$F_{\text{ren Heat from pellets}} = 0{,}90$$

$$\text{Eco-efficiency}_{\text{BAT Pellet stove}} = 0{,}67 \text{ x } 0{,}90 \text{ x } 100 = 60$$

[7] 100 %-Rule like in Gemis, see Fritsche U. R., Schmidt K.: Handbuch zu GEMIS 4.5 (Globales Emissions-Modell Integrierter Systeme), Öko-Institut e.V., Darmstadt, August 2008

Since state-of-the-art biomass furnaces are able to reach an Eco-Efficiency of approximately 50 to 60 (see annex) and have a technological potential to reach values of about 70 the class limits in Table 2 are suggested.

Table 2: Proposal for class limits for the Indicator for Consumption of Resources

Class for Consumption of Resources	Necessary Eco-Efficiency
A^{++}	68
A^{+}	63
A	57
B	50
C	42
D	33
E	23
F	12
G	0

The **Indicator for Emissions** is determined by the emissions measured in standard test operation. To reach a certain class the emissions of carbon monoxide, volatile organic compounds and dust have to be lower than the threshold values in Table 3. The emissions during operation are one of the most important environmental impacts of biomass furnaces. Life cycle analysis show that the emissions caused by the use of auxiliary electrical power are only some % and the emissions caused by production and disposal of the furnace are maximum 10 to 20 % of the total emissions.

Table 3: Proposal for class limits for the Indicator for emissions

Emission-Class	Threshold Value (mg/MJ Fuel)		
	Carbon monoxide	**Volatile organic compounds**	**Dust**
A^{++}	40	4	4
A^{+}	80	8	8
A	150	15	15
B	300	30	30
C	600	45	45
D	1200	60	60
E	2400	120	120
F	4800	240	240
G	9600	480	480

Any other technical Data will be presented uniformly in the **Technical Fiche**:

- Nominal and minimum heat output in kW (like on the label)
- Allowed fuels and applicable fuel-standard, automatic or manual fuel feed
- Standard test efficiency at nominal and minimum heat output
- Numerical value of Eco-Efficiency, energy yield coefficient and the fraction of the renewable primary energy consumption
- Emissions per net calorific value of the fuel and in relative comparison to class A, both for nominal and minimum heat output
- Fuel consumption for a nominal heat load profile (e.g. 1500 hours per year at nominal load, with the information that the real consumption depends on the use)
- Demand of electrical power in all operating conditions
- Applicable Standard and information, that different standards are not comparable totally
- Obligatory required additional components for the label including information about system design (e.g. size of the buffer storage)

Annex: Examples for Applying the proposed Label

The proposal of a product-label for small scale biomass furnaces was exemplarily applied to the following product groups of biomass furnaces: 9 **Base Cases of LOT 15 (BC-EU**, these represent the average European small scale biomass furnaces in stock) and 6 Base Case and the corresponding best available technology as defined in the project BioHeatLABEL at Bioenergy 2020+. For the **Base Cases Bioheatlabel (BC-AT)** average Austrian test results since the year 2000 were used, which represents the advanced products on the Austrian market. For the **Best Available Technology BAT** the best test results were used, upgraded with condensing technology for pellet and wood chip boilers and with expected dust emissions taking secondary dust reduction into account.

The following assumptions are the basis for the calculations:

- The real life efficiencies for the BC-EU were taken from http://www.ecosolidfuel.org/docs/base-case_definition_v2.pdf (estimated net fuel use efficiency). The real life efficiencies for the BC-AT is 65 % for log wood stoves, 78 % for pellet stoves, 68 % for log wood boilers with natural draught, 75 % for log wood boilers with fan assisted draught, 79 % for pellet boilers and 78 % for wood chip boilers. The real life efficiencies for the BAT-products are test standard efficiency at nominal load minus 5 % for stoves and minus 12 % for boilers.
- Life cycle analysis show that at least 98 % of the cumulative primary energy consumption of a biomass furnace is the fuel. Therefore for calculating the Energy Yield Coefficient the reciprocal value of the specific cumulative primary energy consumption for delivering the fuel was multiplied with the real life efficiency and reduced by 2 %.
- For the fuels the following values for the specific cumulative primary energy consumption was used[8]: Log Wood 1097 MJ/GJ, Wood Chips 1135 MJ/GJ, Pellets 1285 MJ/GJ
- For the heat supply with the fuels the following Fraction of renewable Primary Energy was used[9]: Log Wood 96 %, Wood Chips 93%, Pellets 90 %
- In order to determine the Indicator for Emissions values from an internal working paper of LOT 15 about Task 6 were used and for the corresponding BC-EU mg/MJ fuel calculated. For the BC-AT and BAT the values of the available test results were used.

[8] http://www.ecosolidfuel.org/docs/BIO_EuP_Lot15_Task_5_v1_200906.pdf

[9] Source as proposed from LOT 15 http://www.ecoinvent.org/ „Holzenergie. Final Report Ecoinvent No. 6-IX“, Christian Bauer, Paul Scherer Institut, Villingen, und Swiss Centre for Life Cycle Inventories, Dübendorf, 2007. For Pellets 90 % instead the calculated 81 %, because Gemis 4.5 delivers for wood pellets a Fraction of renewable Primary Energy of 92-94 % and data from Bioenergy 2020+ show 91 %. Using „Evaluation of Biomass Combustion based Energy Systems by Cumulative Energy Demand and Energy Yield Coefficient“, Thomas Nussbaumer und Michael Oser, IEA Bioenergy Task 32 / Swiss Federal Office of Energy (SFOE), one can calculate a Fraction of renewable Primary Energy considering drying the raw materials with fossil fuels of 77 % and a Fraction of renewable Primary Energy using renewables for drying of 92 %.

Table 4: Examples for the proposed indicators for the considered product groups (Values in brackets are the real efficiency and the Eco-Efficiency)

BC-EU[10]	**Energy Consumption**	**Consumption of Resources**	**Emission-Class**
BC 1 Open Fireplace	**G** (18)	**F** (15)	**F**
BC 2 Closed Fireplace/ Stove	**F** (47)	**D** (40)	**F**
BC 3 Cooker	**F** (46)	**D** (39)	**G**
BC 4 SHR-Stove	**D** (60)	**B** (51)	**F**
BC 5 Pellet Stove	**D** (64)	**C** (43)	**B**
BC 6 Conventional Boiler	**E** (55)	**C** (46)	**E**
BC 7 Downdraft Boiler	**D** (65)	**B** (55)	**D**
BC 9 Pellet Boiler	**C** (70)	**C** (48)	**D**
BC 10 Industrial Boiler	**C** (70)	**B** (56)	**D**
BC-AT	Energy Consumption	Consumption of Resources	Emission-Class
Log Wood Stove	**D** (65)	**B** (55)	**D**
Pellet Stove	**B** (78)	**B** (53)	**A**
Log Wood Boiler natural draught	**D** (68)	**A** (58)	**D**
Log Wood Boiler fan assisted draught	**B** (75)	**A^{+}** (64)	**A**
Pellet Boiler	**B** (79)	**B** (54)	**A**
Wood Chips Boiler	**B** (78)	**A** (62)	**B**
BAT	Energy Consumption	Consumption of Resources	Emission-Class
Log Wood Stove	**B** (76)	**A^{+}** (64)	**C**
Pellet Stove	**A^{+}** (88)	**A** (60)	**A^{++}**
Log Wood Boiler natural draught	**C** (72)	**A** (61)	**C**
Log Wood Boiler fan assisted draught	**A** (81)	**A^{++}** (69)	**A**
Pellet Boiler	**A** (84)	**A** (57)	**A^{++}**
Condensing Pellet Boiler	**A^{++}** (90)	**A** (61)	**A^{++}**
Wood Chips Boiler	**A** (82)	**A^{+}** (65)	**A^{++}**
Condensing Wood Chips Boiler	**A^{+}** (89)	**A^{++}** (71)	**A^{++}**

[10] Base Case 8 is considered in LOT 15 not with biomass.