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Feasibility Study for new Ecolabels For the Product Group: Wood pellet firings

by

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16. Abstract

This assessment is a feasibility study according to ISO 14024. It deals with the question whether an ecolabel is suitable for wood pellet heating systems and how concrete criteria for an ecolabel for wood pellet heating plants could be specified. The study begins with a comprehensive market analysis in order to identify possible plants for which an ecolabel would make sense. In the main part of the study, the environmental relevance of the chosen plants is analysed. For this analysis, plant manufacturers were interviewed and a comparison between wood pellet heating systems and heating systems which use gas, oil or wood was carried out. On the basis of this analysis, it was possible to derive a number of criteria which were discussed with company representatives and other experts in this field

As a result of this dialogue and the investigation process as a whole, the introduction of an ecolabel for wood pellet heating plants can be recommended. Wood pellet heating systems are characterized by their high level of automatation and the use of standardized fuels with constant high qualitiy. Thus, they reach high combustion quality with low emission rates, and risks of misuse are minimized. They may contribute to the increased use of renewable energies and thereby to the achievment of climate protection goals.

The proposed certification principles comprise requirements regarding (a) the efficient energy use (efficiency factor under partial load and nominal load, plant's supplementary energy consumption), (b) emission values for CO, NO_x, dust and organic substances, (c) the offer of additional services, as well as (d) requirements with regard to the operating instructions. The transcription of the label is proposed as "Ecolabel ... because low emission and energy-efficient".

17. Keywords

feasibility study, eco-label, blue angel, wood pellet, biomass, small scale combustion plants

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16. Kurzfassung

Beim vorliegenden Gutachten handelt es sich um eine Machbarkeitsstudie nach ISO 14024. Es behandelt die Frage, ob ein Umweltzeichen für Holzpelletfeuerungen gerechtfertigt ist, und welche Anforderungen diese im Vergabefall erfüllen sollten. Im Rahmen der Untersuchung wurde zunächst eine umfassende Marktanalyse durchgeführt, um daraus die Anlagen zu identifizieren, die für ein Umweltzeichen in Frage kommen. Im Hauptteil der Studie erfolgte eine vertiefende Analyse der Umweltrelevanz der ausgewählten Anlagen. Hierzu wurde eine Herstellerbefragung durchgeführt und ein Systemvergleich mit Gas- und Ölheizkesseln sowie mit herkömmlichen Holzfeuerungen auf Holzhackschnitzel- und Scheitholzbasis vorgenommen. Auf der Basis dieser Analyse wurden Vorschläge für Vergabegrundlagen für Holzpelletheizkessel und Holzpelletraumheizer abgeleitet, die in einem Fachgespräch in einer breiten Runde von Experten und Herstellern vorgestellt und diskutiert wurden.

Aus der Studie und dem Fachgespräch konnte ein deutliches Votum für ein Umweltzeichen für die untersuchten Holzpelletfeuerungen abgeleitet werden. Holzpelletfeuerungen zeichnen sich durch ihren hohen Automatisierungsgrad und den Einsatz eines genormten Brennstoffes mit gleichbleibender hoher Qualität aus. Dadurch erreichen sie zum einen eine hohe Verbrennungsgüte mit sehr geringen Emissionen, zum anderen werden Fehler durch unsachgemäße Bedienung minimiert. Sie können zudem einen wichtigen Beitrag zur verstärkten Nutzung erneuerbarer Energien leisten und so zur Erreichung der Klimaschutzziele beitragen.

Die vorgeschlagenen Vergabegrundlagen umfassen Anforderungen an rationelle Energienutzung (Wirkungsgrad bei Nennlast und Teillast, Hilfsstrombedarf), Emissionswerte von CO, NO_x, Staub und organischen Stoffen, Angebot von Dienstleistungen sowie Anforderungen an die Bedienungsanleitung. Als mögliche Umschrift eines Zeichens für Holzpelletfeuerungen wird empfohlen: „Umweltzeichen ... weil emissionsarm und energieeffizient“.

17. Schlagwörter

Machbarkeitsstudie Umweltzeichen, Blauer Engel, Holzpellets, Biomasse, Kleinfeuerungsanlagen

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1 Introduction

Wood is the oldest source of energy of mankind. In Germany it is only used in small measure for the heating of buildings. During the past years interest in the use within the private and small commercial sector clearly increased. The use of wood for the purpose of small scale combustion can contribute to the utilisation of weak timbers, wood shavings and sawdust from sawmills and carpentries. At the same time it enables as a native and regional source of energy a larger independence from imports of primary energy.

Particularly in Switzerland and in Austria fuel engineering with small wood heating systems crucially developed further in the last years. Thus, new wood combustion plants - regarding the utilisation of energy and the pollutant emission - are able to compete with oil and gas firing. The development of wood pellets was substantial for the increasing attractiveness of wood heating systems. Since about five years wood pellets are licensed in Germany also as fuel for small firing plants. They may be poured and thus are suitable for supply by tank cars and for automatic combustion. They offer a comfort which is comparable to heating systems of oil and gas-claimant. The small water content and the fineness of grain of the wood pellets enable an optimal combustion with low emissions and small amounts of ash.

According to § 4 of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz - BImSchG) wood combustion plants up to 1 MW firing thermal output require no approval, nevertheless for those the 1. BImSchV (1. Federal Immission Control Ordinance, Regulation on Small-scale Combustion Plants) applies. It sets limit values for carbon monoxide (CO) and dust. Smallest plants with fewer than 15 kW are not subject to the emission request of the 1. BImSchV. For the small capacity range thereby no special emission request exist. Besides, there are no regulations which set up environmental request regarding the energy efficiency of the system. This gap can be closed with the help of an ecolabel for wood pellet firings. Thereby on the one hand larger transparency of the market for consumers can be achieved, on the other hand incentives for ecological product improvements for manufacturers can be set. Target of this feasibility study is a suggestion for an ecolabel (Type I) according to DIN EN ISO 14024 (Environmental Labels and Declaration – Type I Environmental Labelling). An ecolabel according to DIN EN ISO 14024 is a voluntary, multiple-criteria-based third-party programme. The licence for carrying the ecolabel will be assigned through an independent institution on base of certain requirement criteria. The ecolabel is granted to those products that are favourable within a product category from environmental aspects. This requires the consideration of the entire lifecycle (DIN EN ISO 14024, 3.1). Ecolabels of this category represent thereby as voluntary independent product information an instrument of product policy which aims at the following targets:

- to strengthen the environmental policy conforming to market principles,
- to inform the consumers about typical problems related to particular products,
- to set incentives for competition and
- to accelerate the technical progress (cf. UBA 1990, p.4)

The ecolable “Blauer Engel” is assigned particularly for “consumer-oriented” series products and services. It represents a customer-oriented label which primarily addresses final consumers. Moreover, it is used in public procurement. According to the primary target group, the assessment on wood pellet

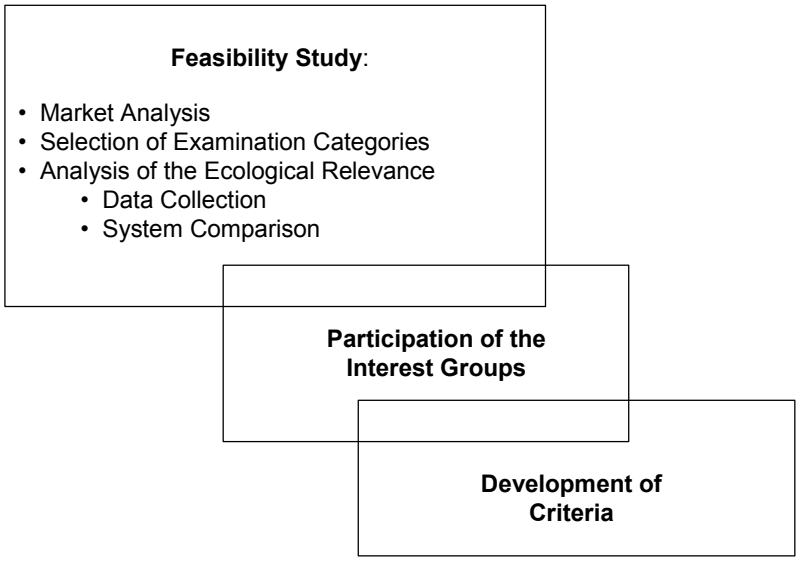
heating systems is limited on the capacity range up to 50 kW. In this range they can be used in single- and family homes.

A prerequisite for carrying the ecolable is that all requirements of the certification principles are fulfilled. Therefore, it is crucial to develop criteria which are on the one hand strict enough to set incentives for improvements and on the other hand allow at least some products to become labelled. It is objective of the ecolable to highlight the - under environmental aspects - best products of a product category which use the best available technology.

The project follows the principles of DIN EN ISO 14024. In the context of the assessment we will study which wood pellet firings are applicable for an ecolable and which requirements are to be fulfilled in the case of assignment. The substantial favourable and ecologically relevant characteristics of wood pellet firings are their almost CO_2-neutral heat production. Additionally, compared to conventional wood heating systems (log wood), their energy-efficient automatic mode of operation causes lower emissions. Assessing the environmental relevance of heat producing plants, their energy-efficiency and the pollutant emissions are to be considered. Therefore, the emphasis of the environmental evaluation is on energy use and emissions.

The procedure follows the specification of the DIN EN ISO 14024. The assessment covers two larger parts which construct one on the other according to DIN EN ISO 14024: First a feasibility study, afterwards the development of requirement criteria for an ecolable.

Figure 1: Structure of the Assessment



In the following, first the principle and the basis of wood pellet firing are described. Afterwards, the results of the market analysis are represented. This results into a recommendation for wood pellet firings which should be analysed (chapter 3.4). For the evaluation of the environmental relevance of the system questioning results and literature are analysed and a comparison with conventional oil, gas and wood heating systems is made. The participation of interest groups took place in a discussion with manufacturers and organisations. The central results of the discussion are displayed in chapter 5. In chapter 6, requirements for an ecolable are developed. Chapter 7 summarises the results.

2 Principles and Fundamentals of Pellet Firings

Wood pellet firing systems are particularly designed burn systems, which use untreated wood as fuel in the form of pellets. Wood pellets consist of compressed wood; they are usually made of wood residues or sawdust from woodworking operations.

2.1 Wood Pellets

In Germany, the use of wood pellets as fuel is permitted since 1996 also for small firing plants with a nominal load of fewer than 15 kW. Already in the 1970´s, wood pellets were manufactured in the USA and Canada. In the 1980´s, they were introduced into North America. Since the 1980's wood pellet firings are increasingly used in private households. In Europe, wood pellets were utilised for heating systems for the first time in Sweden and Denmark, also in the 1980´s. For their use in private households, pellet burners were developed. In Austria, (imported) wood pellets and pellet room heaters which were developed following the US-American models are on the market since the 1990´s. Based on log wood and wood chips firings, the Austrian heating manufacturers built additionally special pellet boilers in the last years (bmvit 2000, Krapf 1999, Haas/Hackstock 1998). In Germany the industrial wood pellet production started as recently as the late 1990´s.

Wood pellets are a standardised fuel in accordance with DIN 51731 "Requirements for Compressed Wood from Untreated Wood" (Anforderungen an Presslinge aus naturbelassenem Holz). This standard divides the wood pellets in size classes, makes demands at the tubing density, the water and ash content, and the heating value. It prescribes limit values for certain trace elements. Wood pellets usually have a diameter of 6 or 8 mm and belong thereby to the size class HP 5. This class covers a length of 5 cm and a diameter from 4 to 10 mm. According to DIN the heating value of the pellets has to amount to 4.9 to 5.4 kW/kg dry weight. They must not contain additional substances and have to be stabilised only by the wood itself and the press process (Krapf 1999). Due to their size and form, the pellets are able to be poured and thus are suitable for an automatic filling of the firing and for the transport by tank cars as well as direct injecting.

In Austria, the standard valid for wood pellets is the ÖNORM M 7135 "Requirements for Compressed Wood from untreated wood and crust, pellets and briquettes" (Anforderungen an Presslinge aus naturbelassenem Holz und naturbelassener Rinde, Pellets und Bricketts). This requires a diameter from 4 to 20 mm, a max. length of 100 mm, a solid density of at least 1 kg/dm^3, a maximum of 12% water content and 0.5% ash content (related to the dry matter) as well as a heating value of at least 18 MJ/kg dry matter. No additional substances may be added. The standard contains limit values on nitrogen, chlorine, and sulphur. The German (DIN) and the Austrian (ÖNORM) standard for wood pellets are almost similar except for the ash content. Here, a clearly smaller limit value is fixed in the Austrian standard.

The energetic use of wood pellets is not completely without impact on climate, since energy has to be spent on their production and transport. With pellets from dry wood splints or wood dust, the energy input for the pellet production is with approximately 3% of their energy content, with damp and uncut wood the energy input for the production can rise up to between 5 and 20% of the energy content (Krapf 1999).

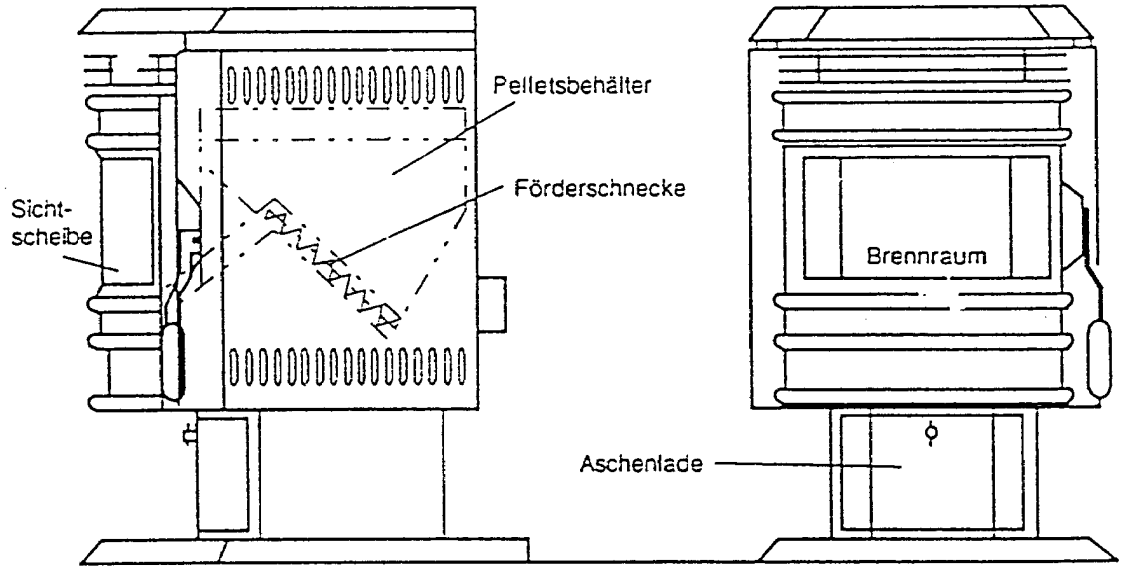
2.2 Types of systems

Wood pellets can be used in central heating systems, pellet furnaces (pellet room heaters) and in long-distance heating systems. Apart from systems, which are suitable for wood pellets exclusively, systems exist on the market in which beside pellets further solid fuels, for example log wood or wood chips, can be used. In the context of this feasibility study systems up to a nominal load of 50 kW are regarded.

- **Wood Pellet Furnaces (Wood Pellet Room Heaters)**

Pellet furnaces or pellet room heaters are set up within the living area. They heat the room of location by means of radiation and convection warmth. They contain a small, integrated storage vessel, which is filled usually manually and from which the pellets are automatically transported into the combustion chamber. Pellet furnaces can operate with a water-based or non water-based system. The water-based firings are suitable for the heating of further rooms. Due to the low heating performance of the pellet furnaces, they are suitable in particular for the heating of dwellings as well as low energy houses and passive houses or for single family houses in combination with a solar plant.

Figure 2: Pellet Furnace



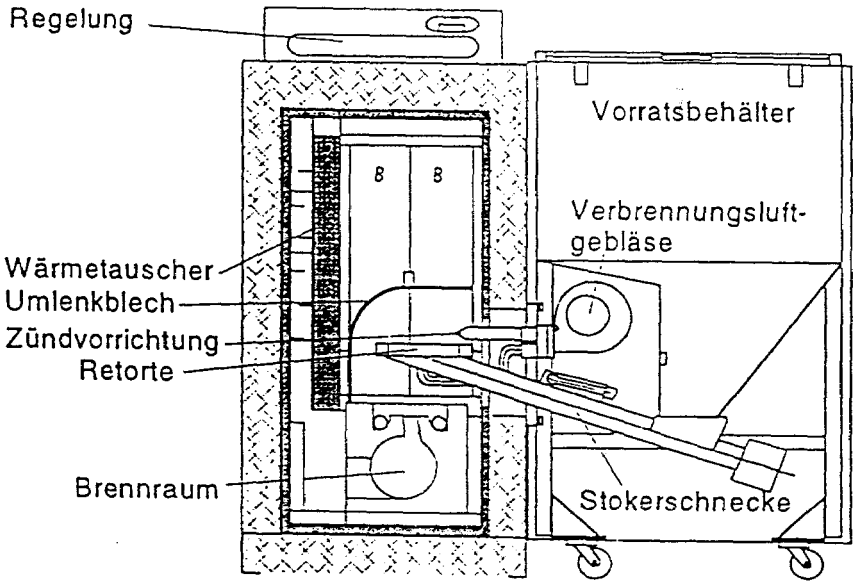
Source: Krapf 1999

- **Wood Pellet Boiler**

Pellet boilers are set up in the cellar or in the heating room and are suitable for central heating systems for single and two family houses (7 to 20 kW) or multi family houses and smaller local heat systems (20 to 50 kW). The pellet boilers are automatically fed, either from an underground storage or a container. They have an automatic firing device and are regulated by an electronic control. Some systems have an automatic ash disposal, with which the ash is removed for example with an auger from the combustion chamber and compressed. Thereby, a manual emptying of ash is limited to few times during the heating season. Some boilers are equipped with a mechanism for automatic heat exchange cleaning, either fully automatic or by a cleaning lever. The heat exchangers must be cleaned regularly,

if a continuously good heat transfer at the heat exchanger surfaces and thus a permanently efficient operation of the system are to be ensured. Thus, apart from better comfort, an automatic cleaning can lower also the pellet consumption.

Figure 3: Pellet Boiler with Storage Vessel



Source: Krapf 1999

➢ **Wood Pellet Burners**

On the Scandinavian market pellet burners are common. They might be installed in an existing boiler. Alternatively, they can be acquired in combination with a special boiler as central heating. According to an European study, in 1998 9,000 pellet burners, 100 pellet boilers and 1,500 pellet furnaces were used in Sweden (bmvit 2000). In contrast, in Germany, according to the results of a questioning of providers of wood pellet firings only a very small share (<1%) of burners were sold (CARMEN 2000).

2.3 Firing Types

➢ **Underfeed Stoker**

By means of an auger (Stocker auger), the pellets are transported from below into the combustion chamber. The combustion takes place in a fuel bowl or a fire hollow, which consists of firestone, ceramics, concrete or the like. This is also called retort. In the combustion chamber the fuel is dried, degassed and gasified under addition of primary air. The primary air is injected directly into the fire hollow. The developing gases ascend and are burned with the help of a secondary air supply. Underfeed stoker are well adjustable and usually self-ignited. They are suitable particularly well for a fully automatic operation, are relatively economical and can be used only for dry fuels. The pollutant emission is small. Resulting ash is usually removed by means of an auger from the combustion chamber (cf. Marutzky/Seeger 1999, Flaig et. al. 1998, FNR o. J.).

➢ **Throw Firing**

By means of an auger, the pellets are transported into the combustion chamber and fall into this from above through a chute. Two different principles exist: (1) the bowl fuel principle, with which the pellets

fall into a fuel bowl (also called burner pot) with holes in the bottom for the primary air supply and lateral secondary air ducts, and (2) the tilting grate firing, with which the pellets fall onto a grate, on which the combustion takes place. The primary air is then supplied from underneath the grate. The gas burns only after leaving the primary combustion chamber, in the so called gas combustion chamber. The throw firing is used particularly in small pellet firings (cf. Marutzky/Seeger 1999, Flaig et al. 1998, FNR o.J.).

➢ **Grate Firing**

A further possibility for the burn of pellets is the grate firing. Here the grate moves and carries the fuel from the input, which is fed by fuel stocks, up to the grate. Meanwhile, it pyrolyses, gasifies and dries completely. Primary air is supplied below and secondary air above the grate. In comparison to the thrust firing the grate firing is less adjustable, since larger amounts of fuel are in the combustion chamber. Because of the complex equipment technology, grate firings are usually only used starting from a system size of 1 MW (cf. FNR o.J.)

2.4 Control Engineering for Wood Pellet Firings

Control engineering for small wood pellet firings can in principle be differentiated into performance and burn regulations. Usually, combined performance and burn regulations are used.

➢ **Performance Regulation**

The performance regulation adapts the heat production of the pellet firing to the required heat as a function of weather and time of day. For this, the debit temperature of the boiler or the inlet temperature is measured in combination with the difference between inlet and return temperature. The performance of the pellet firing can be regulated by means of air and fuel supply.

➢ **Burn regulation**

The purpose of the burn regulation is to prevent the emission of pollutants in the exhaust gas and to increase the efficiency of the pellet firing by a decrease of unburned gases. The variables are the fuel and the air supply. Directly measured are, however, the concentration of unburned gases (exhaust gas regulation), the combustion chamber temperature (burn temperature control), the air-to-fuel ratio (Lambda) or the amount of air (air sensor).

- Lambda regulation: By means of a Lambda probe the air-to-fuel ratio (Lambda) is controlled and optimised if necessary by regulation of the air supply. For this the optimal Lambda value for is determined, at which the CO emission are at a minimum.
- Air sensor: The air sensor technology regulates the combustion over a defined relation of air and fuel amount.
- Burn temperature control: The regulation by burn temperature uses the connection between the completeness of the combustion and the combustion temperature, which for the respective system must be likewise determined. The debit temperature, at which the CO emission are smallest, is aimed at by air and fuel supply.
- Exhaust gas regulation: The unburned gases (CO and/or hydrocarbons) are measured directly in the exhaust gas. Additionally, often the air-to-fuel ratio (Lambda) is measured. In the monitoring system an automatic minimum value regulator is inserted. It tries continuously to minimise

the measured value through a modification of the fuel and air supply. Automatic controllers with pre-set target values were developed, since the combustion can be constantly led into excess air or air shortage conditions. The exhaust regulation is in particular meaningful with changing fuel characteristics (e.g. water content).

2.5 Storage and Delivering Systems

➢ Storage

Pellets can be stored in a large storage vessel or a stock room, so that the system must not be filled daily. Storage vessels can be integrated into the pellet firing. Also detached containers which seize the requirement of one week or a months are possible, as well as storage tanks or bag silos. In order to contain the annual requirements, a stockroom is needed, usually a cellar room. An alternative to the storage of the pellets in the house, is an earth tank which must usually likewise be filled once a year. In the Scandinavian area silos, in particular for larger systems, are a preferential stocks possibility.

The size of the stockroom should – according to a rule of thumb – contain a cubic meter per kW heating load. Basically, stocks should be dimensioned in such a way that approx. 1.2 to 1,.5-times the annual need of wood pellets can be stored. This corresponds with a single family house and a pellet consumption of approx. 3.5 t/a to a stockroom volume of approx. 4 m³. For fuel oil an annual consumption of approx. 2 m³ would be set for the same amount of heat (see BIZ 2001). With storing the pellets, the fire protection regulations are to be considered. In Germany, the storage of fuels is covered by the regulation on firing plants and fuel storage (Verordnung über Feuerungsanlagen und Brennstofflagerung - FeuVO). This FeuVO is defined by each Federal State. Since for wood pellets in the FeuVO no special regulations exist, the regulations for solid fuels are usually applied. However, as there are no uniform regulations, the requirements to pellet stockrooms can differentiate depending upon responsible chimney sweepers. In some Federal States, special arrangements for smaller stock quantities exist. Thus, in Bavaria, Baden-Württemberg, Lower Saxony, North Rhine-Westphalia and Thuringia no regulation on the storage of wood pellets applies if the maximum amount of 15 t is not exceeded; in Hesse, if the appropriate performance is lower than 150 kW.

➢ Delivering Systems

To make the wood pellets arrive automatically from the stockroom or the storage vessel into the firing, a delivering system is needed. Basically there are three different versions of automatic delivering systems: the direct auger, the soulless auger and air intake systems. The direct auger is a laterally open, covered auger system, which has a back fire protection. To operate this auger system, heating and stockroom must be situated directly next to each other. Additionally, their use requires the installation of a slope into the stockroom, which leads to a high consumption of space. To avoid this problem two augers can be combined. The first runs on the soil of the stockroom and transports the wood pellets to a second auger which is situated outside the stockroom. The latter supplies the wood pellets to the furnace. The latter is often called soulless auger. The danger of a fire in the storage place can be prevented by the combination of two augers. An alternative for further distances is an air intake system, which sucks the pellets out of the stockroom into the storage vessel. The emptying of the stockroom is optimised by laying several pipes in the stockroom, into which the suction lance can be shifted alternating.

3 Market Analysis and System Selection

As a first step of the feasibility study for an ecolabel for wood pellet firings up to 50 kW a market analysis was executed. This yields an overview of manufacturers, sales, and installation figures of wood pellet firings as well as a systematisation of the installation types. The market analysis generates the basis for the selection of pellet firings, whereby apart from quality criteria their market relevance represents an important selective criterion.

3.1 Procedure

The market analysis within the area of the wood pellet firings includes available data of different institutions such as CARMEN e.V. (Central Agrarian Raw Material Marketing and Development Network, Centrales Agrar- Rohstoff- Marketing- und Entwicklungsnetzwerk) and bmvit (Federal Ministry for Traffic, Innovation and Technology, Austria) as well as available information on manufacturers from the internet. Those were completed by numerous standardised interviews with manufacturers, providers and federations, whereby an extensive picture of the recent and rapidly changing market for pellet firing was developed. The field research was necessary, since despite the studies of CARMEN and bmvit no current and comprehensive data on the market for wood pellet firings up to 50 kW exist. Furthermore, the market for wood pellet firings strongly depends on political and other external conditions (support programmes, oil price, ecological tax etc.). As since 1999 the purchase of biomass firings is nationally supported by the programme for market development for the use of renewable energies (Marktanreizprogramm zur Nutzung erneuerbarer Energien). Additionally, the oil price rose strongly in the year 2000. Therefore, the market for pellet firings expands since 1999.[1] This trend is supported also by an expansion of the infrastructure for pellets and pellet firings. This is indicated also in an increasing number of providers. Moreover, in the meantime some important conventional heating manufacturers included wood pellet firings to their product range. At the same time, the systems have been improved during the last years.

The questioning includes “suppliers” from wood pellet firings, i.e. both manufacturers and salesmen. The providers were asked for figures of wood pellet firings in Germany, sales trend, inventory numbers, the number of providers, the customer, the distribution channels, the selling price and for details about the construction types. This questioning cannot claim to be complete, since the market is very dynamic at present.

Additionally, federations and organisations were asked for their estimation of the market, sales trends, important basic conditions and technical advancements.

On the basis of some fundamental criteria, which should be fulfilled for the awarding of an ecolabel, a definition of the scope is made in the following (cf. Hoffmann/Hirschl 2001).

[1] In June 2001 the conditions of the support programme were worsened, and slightly improved in March 2001 (see paragraph 3.2.5.1)

The criteria refer to the market relevance of the different wood pellet firing types:

- Sales figures: Significance of the wood pellet firing types based on the sales figures
- Trend: stable to positive sales development
- Number of Providers: Competitive situation, i.e. several providers are available

These criteria describe aspects, which ideally should be fulfilled. Therefore the following reasons are to be stated : With the criterion of the sales figures it is to be guaranteed that the product is produced in large scale and is not a pilot or a research model. Exceptions of this condition receive products which appear as particularly promising. The attention to sales trend comprehends such tendencies and completes the first request. With the third argument, the provider number of product, specific supply monopolies are excluded. In the course of this aspect it is also made sure that at least one manufacturer originates from Germany, in order to increase the probability of a certification according to the ecolabel.

3.2 The Market for Pellet Firings in Germany

3.2.1 Market Data from the Literature

Only few data is available about the German market situation of wood pellet firing. Only since the establishment of the German Energy Pellet Federation (Deutscher Energie-Pellet-Verband) and the Pellet Federation Germany (Pelletverband Deutschland) in spring 2001, there has been an organised lobbying for the providers concerns. CARMEN e.V. undertook regularly written questionings of providers and manufacturers of wood pellets and pellet firings from 1994 to 2000. In the last questioning in July 2000, 82 manufacturers and suppliers were included, from which 29 answered, thereof 16 manufacturers and 13 suppliers.

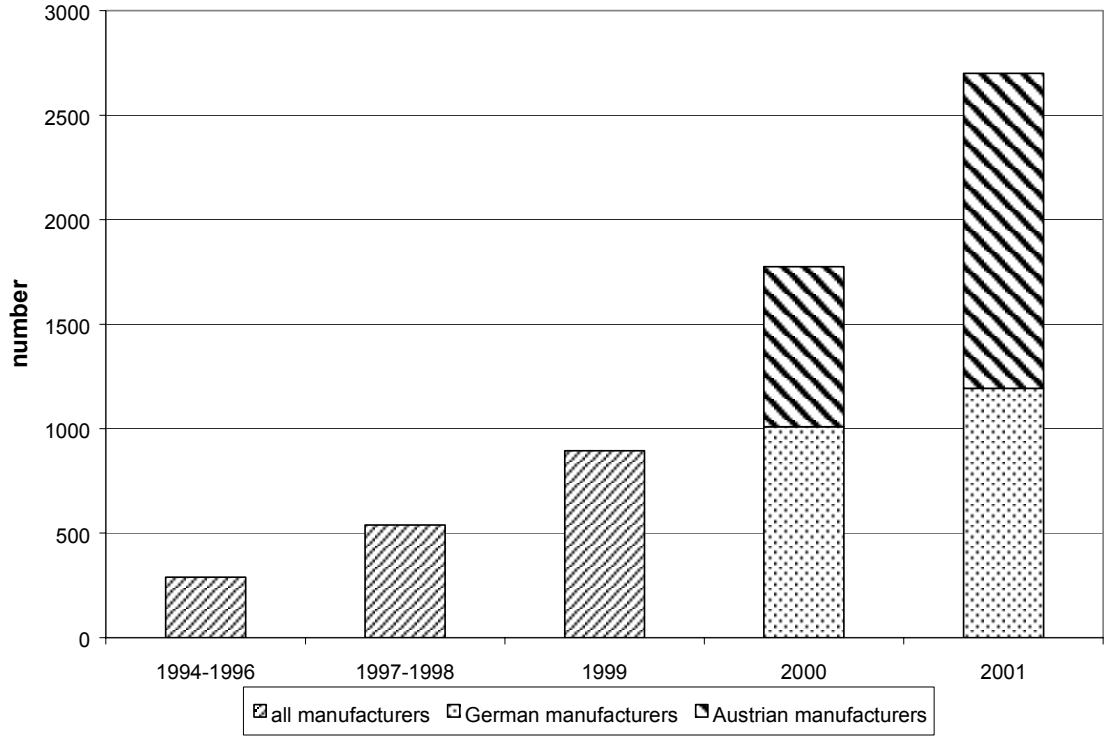
Table 1: Number of Manufacturers of Pellet Firings which Participated in the Written Questioning of CARMEN e.V.

Year	1994	1995	1996	1997	1998	1999	2000
German manufacturer	1	1	1	2	3	3	4
Austrian manufacturer	1	1	3	7	8	9	11
Swiss/Liechtenstein manufacturer	0	0	0	0	0	1	1

Source: CARMEN 2000

CARMEN asked the manufacturers to areas of distribution and sales figures. From the eleven Austrian manufacturers seven indicated to export systems to Germany. Also the manufacturer from Switzerland/Liechtenstein exports to Germany. Within the analysis of the sales figures only 20 companies were considered, in order to avoid overlapping between selling and manufacturers. In the period of 1994 to 1999, these manufacturers sold altogether 6,475 systems, of it 1,724 in Germany. Over the last years, a strong rise is to be observed (s. figure 4).

Figure 4: Sales Figures of Pellet Firings in Germany[2]



Source: CARMEN 2000

From the systems sold in Germany, 94% had a nominal load of less than 16 kW and only 4 systems a performance of more than 50 kW. The systems sold on the German market are to approximately 70% of German manufacturers, 20% are directly from Austria and the remaining systems are imported from other countries. 70% of the systems sold in Germany were at that time pellet furnaces, to a large extent non-water-based systems. The questioning by CARMEN offers a quite comprehensive picture of German and Austrian manufacturers. Krapf (1999) assumed a total number of 27 Austrian and four German manufacturers in the year 1998. In the questioning however the import from the Scandinavian area is completely missing, for which Krapf indicates a number of 14 Swedish and 23 Danish manufacturers (1998).[3]

In 2000, bmvit published a study "Wood Pellets in Europe". This study examines the barriers of a market expansion with wood pellet firings. Bmvit sees the lack of information as a main obstacle for an expansion of the pellet market, both with consumer and with dealer and installer. Beside communication problems between different handicraft sections, infrastructural lack with the supply of the pellet heaters is also an obstacle. Problems might occur in the case of the conversion of other heating systems, both due to changes in habits and due to missing installations in the house. A further obstacle can be the economic situation depending upon the prices. Apart from the fuel costs, the high capital outlays of pellet firings must also be considered. These con be lowered by the existing German support programme. The bmvit states that these non-technical barriers have the largest influence on the

2 Figures for 2000 and 2001 are estimations of the manufacturers.

3 This can be an actual insignificance of these providers on the German market or it is that CARMEN concentrates its work on Southern Germany where the import from the Scandinavian countries is less important than in north Germany.

pellet market. However, it also indicates technical obstacles for a further market spreading: the quality of the pellets is partly bad, due to non-professional delivery to the customers, pellets are damaged; with false storage by the customers it can develop high dust loads. The delivering and firing systems as well as the service on the part of the manufacturers need improvements.

3.2.2 Pellet Firings with Performance over 50 kW

In Germany, the market concentrates on pellet heaters for single and multi-family houses (2000 bmvit). In Sweden however, wood pellets are inserted also into medium sized boiler plants (500 kW to 4 MW) and in large district heating plants. The district heating plants are usually dust burners, so that the pellets are used only for storage and filling. The boiler plants are usually retort or “Stokerfirings” which are not particularly developed for the combustion of pellets. In its questioning CARMEN determined not more than four systems sold with a performance of more than 50 kW (1994 to 1999) in Germany. In Austria nevertheless, 62 systems were sold. The lack of system manufacturers cannot be the reason for small sales figures, since bmvit designates ten manufacturers in the capacity range of over 50 kW on the German market. Of those seven offer systems with a nominal load from 50 to 200 kW, two with up to 500 kW and one even up to 800 kW. CARMEN (2000) assumes that in the capacity range over 50 kW so far particularly systems are used which can burn pellets beside wood chips. Larger pellet systems thus far are not competitive in Germany (and also in Austria) due to the high pellet prices compared to Sweden. In this capacity range wood chips compete in particular with pellets, which are (so far) more easily available and less expensive (2000 bmvit). At the moment, Krapf (1999) does not consider larger wood pellet heating plants in Germany (over 100 kW), since there are cheaper solid biomass fuels on the one hand. On the other hand within this performance range the smaller storage volume of the pellets cannot offset the disadvantages due to the energy consumption of the pressing. Haas and Hackstock (1998) see a meaningful possibility in the use of biomass pellets in large-scale installations in areas without regional biogenous fuels. The bmvit study acknowledges good chances for pellet systems in micro networks, i.e. small long-distance heat supply networks in closely settled areas. In these cases the advantages of the simpler storage and filling, and thus smaller capital outlays as well as a more comfortable operation are important.

3.2.3 Questioning of Manufacturers

3.2.3.1 Sales Figures and Market Structure

In the context of the market analysis carried out (after deduction of the doublings) data on wood pellet firings of 16 manufacturers from Austria and 9 manufacturers from Germany as well as one manufacturer from each Italy, Liechtenstein, Sweden, Finland, Denmark, and the Czech republic were raised. Also those firms are considered as manufacturers which commission the construction partly or totally to other firms and sell the firings under their own name. Altogether, 31 manufacturers were thus asked, from whom information was raised to 38 different construction types.[4]

All following specifications refer to figures of the year 2001. The market survey was executed in the early summer of 2001, and raised prognosis values for the sales figures in 2001. Since in the mean-

[4] Five manufacturers, under it three Germans, could not specify sales figures, since their systems only just came onto the market

time the support conditions for pellet firings worsened (cf. paragraph 3.2.5.1), at the beginning of 2002 another survey was executed, which resulted in partially clear deviations from the prognosis values.[5]

From the 16 Austrian manufacturers three did not give specifications of their sales figures to Germany. The remaining 13 manufacturers from Austria sell altogether well over 3,000 systems to Germany each year. The sales figures distribute as follows:

- one manufacturer with more than 500 systems sold
- eight manufacturers who sold between 100 and 500 systems
- four manufacturers with less than one hundred systems

The predominant proportion of the Austrian manufacturers produces pellet boilers, only two produce exclusively pellet furnaces. Out of the nine German manufacturers five said to have sold altogether scarcely 2,000 firings each year. Two German manufacturers sold exclusively pellet furnaces.

The manufacturers from the remaining countries sell altogether 200 systems annually to Germany. The Swedish and the Finnish manufacturers produce thereby the pellet burner, typical to the Scandinavian area. The Italian manufacturer sells pellet furnaces, the manufacturers from Liechtenstein, the Czech Republic and Denmark sell pellet boilers.

In total, the questioning resulted in a total sales figure of over 5,000 pellet systems in the year 2001 in Germany. About half of them are pellet furnaces. This number is situated clearly over the value determined by CARMEN e.V. for 2001 (s. page 13), which was based on data of only 20 manufacturers. Within the total number of the heating systems sold annually in Germany, pellet firings have still a very small proportion. The manufacturers sell their firings to a large extent through heating engineers, partly through retailer. Only four manufacturers sell their systems directly and six sell their systems through the wholesale trade. Two manufacturers did not give specification about their distribution channels. The customers of wood pellet systems up to 50 kW are predominantly (clearly over 90%) private people, in particular owners of single and two-family houses. Commercial customers and owners of dwelling houses play however an increasing role starting with a performance of 30 kW.

3.2.3.2 Types of Systems

Most of the manufacturers produce one or two different construction types in the examined performance class up to 50 kW. The following differentiation refers to the 38 different construction types (of 31 manufacturers), to which data was collected.

➢ **Fuels**

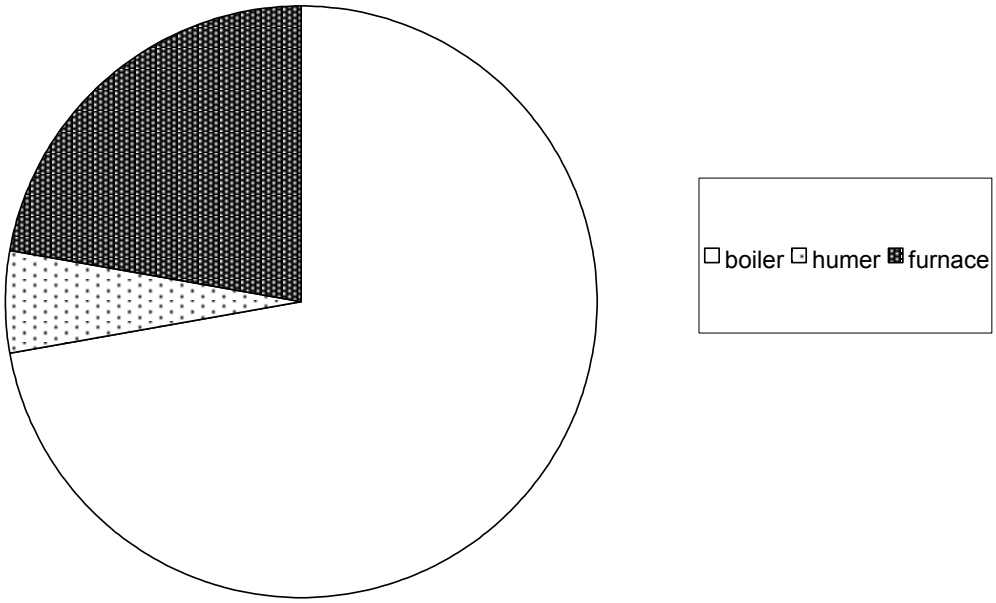
18 types can be operated with further fuels, six of them however only in the emergency operation with log wood. The genuine combination systems can work with log wood (11), wood chips (3), and with grain (1) Two further manufacturers indicated that their pellet boilers were tested for the operation with grain. All combination systems are pellet boilers.

[5] While the first questioning resulted in a total number of approximately 7,000 sold systems in 2001, the questioning in 2002 comes on scarcely 5,000 sold systems.

➢ **Types of System**

Eight of the construction types (of six different manufacturers) are pellet furnaces. Five of the pellet furnaces are water-based systems and can be used also as central heating (smaller houses or passive houses). These five systems have a max. heat output of 6 to 12.8 kW. Two of the construction types (of two manufacturers) belong to the burners.

Figure 5: Proportion of the Different Heating Types within the Questioning



The performance of the 26 examined cellar pellet boilers (of 23 different manufacturers) begins with 10 kW and goes up to 215 kW. They are often offered in several performance classes. The performance classes up to 15 and 25 kW are particularly frequent. The 15 kW-class is usually just below 15 kW, since wood combustion plants with a nominal load fewer than 15 kW are not in the scope of the exhaust measurements according to the German 1. BImSchV.

➢ **Firing System**

Concerning the firing system, the throw firing is most common: 22 of the construction types operate with this system. 13 construction types operate with an underfeed stoker. Related to the indicated sales figures the gap is not that clear: approx. 1,800 systems with underfeed stoker and 3,400 with throw firing are installed annually. Here, neither with the German, nor with the Austrian manufacturers a concentration can be observed on a certain firing system. It is remarkable however, that all eight pellet furnaces operate with a throw firing. Beside these common firing procedures one manufacturer produces a system with grate, one uses a jet burner process and one produces a system with flame tube.

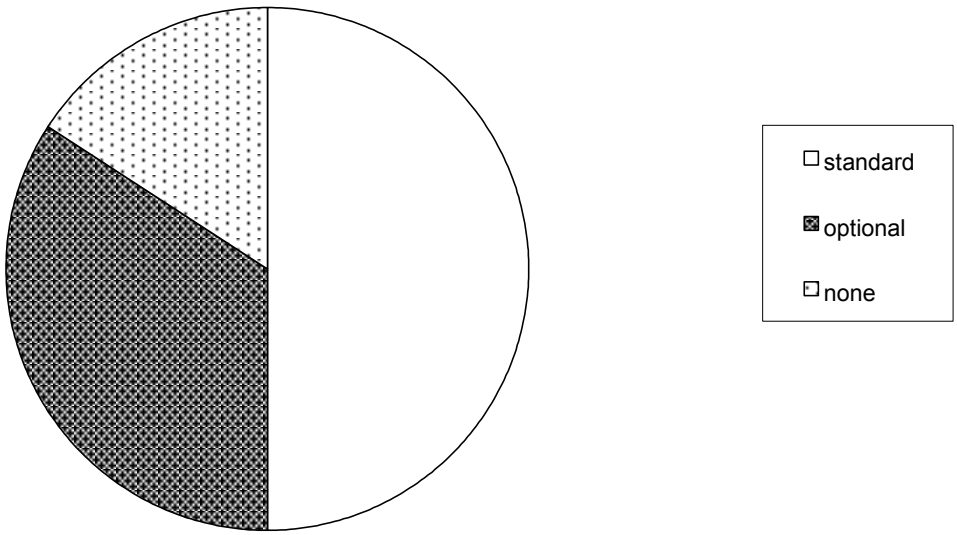
The filling of the systems takes place mostly from above. Only eight are fed from below and six from the side.

- **Level of Automation**

The frequent cleaning of the heat exchangers is a prerequisite for a permanently efficient operation. An automatic heat exchange cleaner is available in eleven systems, and optional in five. Seven have a semiautomatic (with a lever from the outside) and 15 do not have an automatic heat exchange cleaner. The examined systems without automatic heat exchange cleaner are pellet furnaces and pellet burners as well as additionally five pellet boilers.

Only with six construction types, all of them pellet furnaces, no automatic delivering from an underground storage or external weekly/monthly container is possible. With 19 types an automatic delivering is standard, with 13 it is optional (s. figure 6). 20 manufacturers enable the delivering over an auger, 20 providers over an air intake system and twelve over a soulless auger, whereby most offer several delivering systems which can be combined.

Figure 6: Construction Types with Optional or Automatic Delivering System



14 systems allow for automatically emptying the ash whereby for three systems this is optional. Further six systems have a semiautomatic ash disposal by manual operation. 17 systems do not have an automatic ash disposal, among them all pellet furnaces. In the case of manual cleaning the ash must be taken away regularly with a vacuum cleaner or a brush (cf. BIZ 2002).

3.2.4 Market Development

In addition to the manufacturers, different experts from federations and information centres were asked. They see a rise on the market for pellet firings both for the demand and for the supply. As factors, which favour this rise, the experts designate the support programmes, rising primary energy prices, media reports which increased the known facts, the better availability of the wood pellets. Also the trend to low-energy buildings and thermal insulation favours heating systems with small thermal output. Obstacles for the market expansion are however prejudices against solid biomass in the popu-

lation, the small degree of recognition of the pellets, the partly insufficient pellet quality, uncertainties during the pellet procurement and the high costs of the pellet heaters.

Also the providers were asked about the developments on the market for wood pellet firings. The estimates are far apart and contradict each other. Concerning the firing system a manufacturer regards in each case the throw firing and the underfeed stoker firing as a promising system, one the retort and one the bowl burner. Chances on the future market were given by six asked to the pellet furnaces, by five to the central heating boilers within the area up to 25 kW and by three to the medium sized pellet boilers with 50 to 200 kW for public facilities. Concerning the fuels, four manufacturers see the future in the pure pellet boiler, two in combined systems with log wood, two in a combination of pellet heaters with regenerative energies (in particular solar plants) and two in new biogenous fuels such as straw, hemp and grain.

As necessary improvements are mentioned: more flexible delivery systems, a unit of boiler and magazine, a decrease of the cleaning intervals (in particular with furnaces), high temperature combustion, the increase of the efficiencies to the calorific value technique and the separation of the primary and secondary air supply.

3.2.5 Costs of Wood Pellet Firings

Pellet boilers with automatic delivering cost depending upon performance size between 7,670 and 15,340 € (s. table 2). This data is given by manufacturers, and contains apart from the boiler price and the costs of the delivering system to different extent the further matters of expense (heat network, exhaust gas system, stockroom, etc.) and value added tax. The large differences in prices are due to the different delivering systems. Not considered are the costs of installation and assembly.

Table 2: Sales Prices of Pellet Boilers (incl. Delivering System)

	Boiler 15 kW	Boiler 25 kW	Boiler 30/35 kW	Boiler 40/50 kW
Average price [€]	9360	10020	11250	12020
Lowest price [€]	7670	8690	9720	10230
Highest price [€]	11760	11760	15340	15340
Spot tests	14	9	6	4

Some manufacturers gave only the price of the pellet boiler (without delivering system). These cost, depending on the performance class, between 6.140 and 8.180 €. The prices for pellet furnaces depend above all on whether it concerns water-based, or non-water-based systems (s. table 3).

Table 3: Selling prices for pellet boilers or furnaces without delivering

	Boiler 15 kW	Boiler 25/30 kW	Furnace air	Furnace water
Average price [€]	7010	7540	3480	5370
Lowest price [€]	6140	7160	2560	4090
Highest price [€]	7670	8180	4350	7160
Spot tests	7	4	8	5

3.2.5.1 Support Programmes

Federal support can be granted for systems for the firing of solid biomass in the context of programme for market development for the use of renewable energies (according the "Guideline for the Support of Measures to the Use of Renewable Energies from 23 March 2002"). The grant authority for this subsidy is the Federal Office for Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle).

In June 2001, the support conditions for pellet systems were clearly worsened and have improved again with the modification in March 2002.[6] The establishment of automatically fed systems for heating of biomass is supported starting from a nominal heat output of 3 kW. Systems under 50 kW are however only concerned, if they are central heating systems. Wood pellet firings are supported by this programme with 55 € per kW of nominal load, at least however with 1,500 € for each single investment.[7]

The Federal State of Hesse is the only federal state which has a special support programme for pellet firings and supports the establishment of „smaller systems for the firing of solid biomass in the form of wood pellets (Pellet boiler)". Entitled are above all public facilities, not however private owners of houses. For marketable pellet firings for central heat supply, which burn wood pellets according to DIN 51731 or ÖNORM M 7135, a subsidy of up to 30% of the capital cost, max. however 10,230 €, is granted.

3.2.5.2 Comparison of Cost

The costs of wood pellet firings combine from the capital cost and the operating cost. In the following table these costs are classified and are confronted with different heating systems for new buildings. The assumption to the annually developing costs and the capital cost were taken over from BIZ (2001). Since in the meantime the support conditions for the pellet firings changed, these data were updated and the capital related costs were calculated. The remaining data were taken over unchanged from BIZ (2001).

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[6] Until June 2001, also manually fed systems were supported (with 41 €/kW) and automatically fed biomass firings were supported with 61 €/kW, at least however with 2,045 €. In the period June 2001 to 2002 the promotion amounted to only 51 €/kW, with at the most ,2045 € for each single investment.

[7] A prerequisite for the minimum amount is an efficiency factor of at least 90%.

Table 4: Annually Resulting Total Costs of Different Central Heating Systems in a Single Family House (New Building)[8]

		Pellets	Log wood	Natural gas	Fuel oil
Investment cost					
Heater	€	8692	4090	3170	3579
Heat accumulator	€	1278	1278	869	869
Storage / tank / gas port	€	3016	767	1917	2045
Smokestack / exhaust gas conduction	€	1790	1790	1023	1790
Gas / electric installation	€	511	511	256	256
Interior distributing	€	3323	3323	3323	3323
Sum	€	18610	11759	10558	11862
Support	€	-1500	-	-	-
Sum investment cost	**€**	**17110**	**11759**	**10558**	**11862**
Capital-related cost[9]	**€/a**	**1240**	**852**	**765**	**860**
Annual heat demand					
Heating+hot water	MWh	16	16	16	16
Efficiency factor	%	92	87	100	92
Annual fuel requirement	**MWh**	**17.4**	**18.4**	**16**	**17.4**
Consumption-related cost					
Base price	€/a	0	0	124	0
Fuel price[10]	Cent/kWh	3.5	3.2	4.6	4.1
Sum consumption-related cost	**€/a**	**605**	**578**	**950**	**711**
Operation-related cost					
Maintenance/cleaning/repair	€/a	230	230	153	179
Chimney-sweeper /service cost	€/a	102	102	51	51
Insurance	€/a	0	0	0	61
Electrical consumption[11]	€/a	49	26	26	31
Sum operation-related cost	**€/a**	**381**	**358**	**230**	**322**
Average annually total cost (netto)	**€/a**	**2226**	**1788**	**1945**	**1893**

Source: following BIZ (2001)

This calculation shows that wood pellet heating is the most expensive of the compared heating systems. Krapf (2001) also gets this result. He assesses the cost of different heating systems for a single family house (annually heat requirement 20 MWh) to 2,194 € with pellets, 1,326 € with log wood, 1,524 € with natural gas and 1,703 € with fuel oil. The higher capital outlays are not counterbalanced in the process of 15 years by the lower fuel costs.

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8 Nominal load 10 KW, or with log wood 15 KW

9 The capital related costs were calculated by means of the annuity method following the VDI-Guideline 2067 (Economic Efficiency of building installations – Fundamentals and economic Calculation; the service life was considered to 15 years, the interest factor to 6%.

10 Assumption: pellets 174 €/t, log wood 42 €/Rm, natural gas 4.6 ct/kWh, fuel oil 0.4 €/l (BIZ 2001).

11 In comparison to the statements of the manufacturers (cf. 4.2.2.2) of our quotation this value seems to be too high. According to the questioning results the costs are about 18 € per year. Since we do not have appropriate values for the other heating systems, the data is directly taken over from BIZ (2001).

In order to improve the economic efficiency of pellet firings, substantial decreases of the system costs would be necessary. Due to the low sales figures, they are to be expected in middle to long terms. Also by a further rise of the fuel costs for fossil fuels or a decrease of the pellet costs by increasing production capacities and learning curve effects economic efficiency might improve. The clear cost differences compared with central heating for log wood are due to the fact that with the central heating for log wood no monetarisation of the self-work for wood chopping and the operation of the system is made.

3.3 The Wood Pellet Market in Germany

Literature data

Since wood pellet market in Germany is very dynamic regarding the number of manufacturers and the production capacity, reliable and coherent data so far hardly exist. While at the beginning of 2000 bmvit came to a number of six manufacturers specialized in wood pellets in Germany as well as further planned systems, Krapf assesses for the year 2000 with a total number of 10 pellet manufacturers. Rhoen Forstconsulting (2002) made an estimation of 100,000 t of pellet production per year after termination of the current system establishments. CARMEN (2000) led a survey in 2000 with pellet manufacturers and suppliers. The eight German pellet producers involved stated a production capacity of 40,000 t altogether per year. In the next two to three years according to Seeger engineering (2002) Germany, Austria, France and Belgium will build approx. 400,000 to 500,000 t/a new production capacities.

The selling of the pellets is arranged directly by the manufacturers, via fuel dealers and by dealers and manufacturers of firing plants (CARMEN 2000). As common for the marketing of pellets bags, BigBags and the loose delivery were determined. There are bags with 15 or 25 kg. BigBags, which are especially sold by German suppliers, have usually 1 to 1.5 m³ contents and are used preferentially for the sale of the pellets at retailers. For the transport to the final consumer they are suitable only conditionally, since they must be moved with a batch loader or the like. The transport of loose commodity is made with tank cars by a pneumatic filling of the stockrooms. Here it is to be noted (bmvit 2000) that the filling of the customers stockrooms should be clean and without damage of the pellets.

Both bmvit and CARMEN e.V. examined the prices for wood pellets in Germany. According to specification of the bmvit (2000) they move around 130 €/t with large units and 200 €/t with small packings and small quantities. As prices for 15 kg bags they designate 180 €/t, for BigBags 160 €/t and for loose pellets with purchased quantities over 3 t about 150 €/t. On the basis of a middle fuel price of 160 €/t pellets, bmvit calculates thereby fuel costs from 3.55 ct/kWh for the heat supply. CARMEN (2000) estimates 150 €/t as average price for loose pellets delivered free house, whereby the selling prices are situated between 120 and 180 €/t, and for bag commodity in 25 kg bags with single purchase 260 €/t.

Questioning Results

Through the literature, CARMEN and the German Energy Pellet Federation the addresses of 23 German wood pellet manufacturers were obtained.[12] These were contacted by telephone.[13]

The following data is based on the specification of twelve wood pellet producers in Germany. From these producers four are working in green food drying process, two produce saw dust for animals, one fibrous material products, one animal food, one is a central heating mechanic, one is active in the area of prefabricated house construction, one manufacturer exclusively produces bio fuels and one is specialised in the production of wood pellets, and sells additionally pellet firings since June 2001. One manufacturer already produces wood pellets since 1993, three since 1998, four since 1999, two since 2000 and two others since 2001. Two manufacturers use their own wood residues for pellet production, the other manufacturers receive their raw material from woodworking operations, usually from several. The produced pellets have predominantly a diameter of 6 mm and a length of under 30 mm or under 40 mm, some manufacturers produce pellets with a diameter from 8 to 10 mm.

Only some of the manufactures gave specification about the production capacities and the annual sales figures. With that seven manufacturers have an annual production capacity of approximately 100,000 t, whereby one manufacturer produces in Sweden and imports only one part of his production into Germany. The capacities rose by new production plants only lately, that is why the sale numbers can be hardly compared with the production capacities. Together with the planned 35,000 t the manufacturers have altogether a production capacity of approximately 135,000 t by the end of the year 2001. Seven of them stated their annual sales figures. They issue together approximately 25,000 t in Germany, which corresponds to a firing amount of heat of 122,500 MWh with an average caloric value of 4.9 kWh/kg.

The sale of the pellets of ten manufacturers takes place as direct sales, with six of them it is the only distribution channel. Three manufacturers sell to wholesale dealers, one sells through fuel dealers and two through boiler dealers. One manufacturer is self-selling. Five operations sell their pellets country wide, one additionally in the Benelux countries, two only in Southern Germany, one in Northern Germany and Scandinavia and four at close range (approx. 100 km).

The pellets of ten of the twelve manufacturers are sold in bags of 15, 20, 25 or 40 kg depending on the manufacturer. Eight manufacturers sell BigBags with 500 to 1.100 kg of pellets. With eleven manufacturers the pellets can be purchased loosely, whereby the operations use partial forwarding businesses, since not all of them have their own tank car.

An exact assessment of pellet prices is difficult, since the price is often dependent on the purchased quantity, the delivery distance and the raw material. The following table tries nevertheless to represent the price margin with the help of the quotations of four manufacturers.

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[12] Lists of providers e.g. under www.carmen-ev.de or www.pelletverband.de

[13] It turned out that under it six are dealing only with woodpellets, of which one dealer is planning to build up a production and three will begin the production in autumn 2001 with a production capacity of alltogether 35,000 t per year. One manufacturer meanwhile went bankrupt, three others had no current contact any more. Of the 13 interviewed wood pellet manufacturers one had no interest to participate in a questioning..

Table 5: Prices for Pellets Dependent on the Packing (Results of Own Quotation)

	Bags	BigBags	Loose goods
Price without delivery	160-210 €/t	120-140 €/t	120-150 €/t
Price delivery included	up to 250 €/t	up to 220 €/t	up to 190 €/t

Seven of the manufacturers estimate the market tendency with wood pellets as positive, only one as negative. As problems, the manufacturers name the partial insufficient quality of pellets on the market, thus worsening the image. Additionally, logistic problems occur in the distribution of the loose commodity by tank cars. As obstacles also the high prices of the pellet heaters are called as well as the excessive raw material costs of the splinters in some sections of Germany.

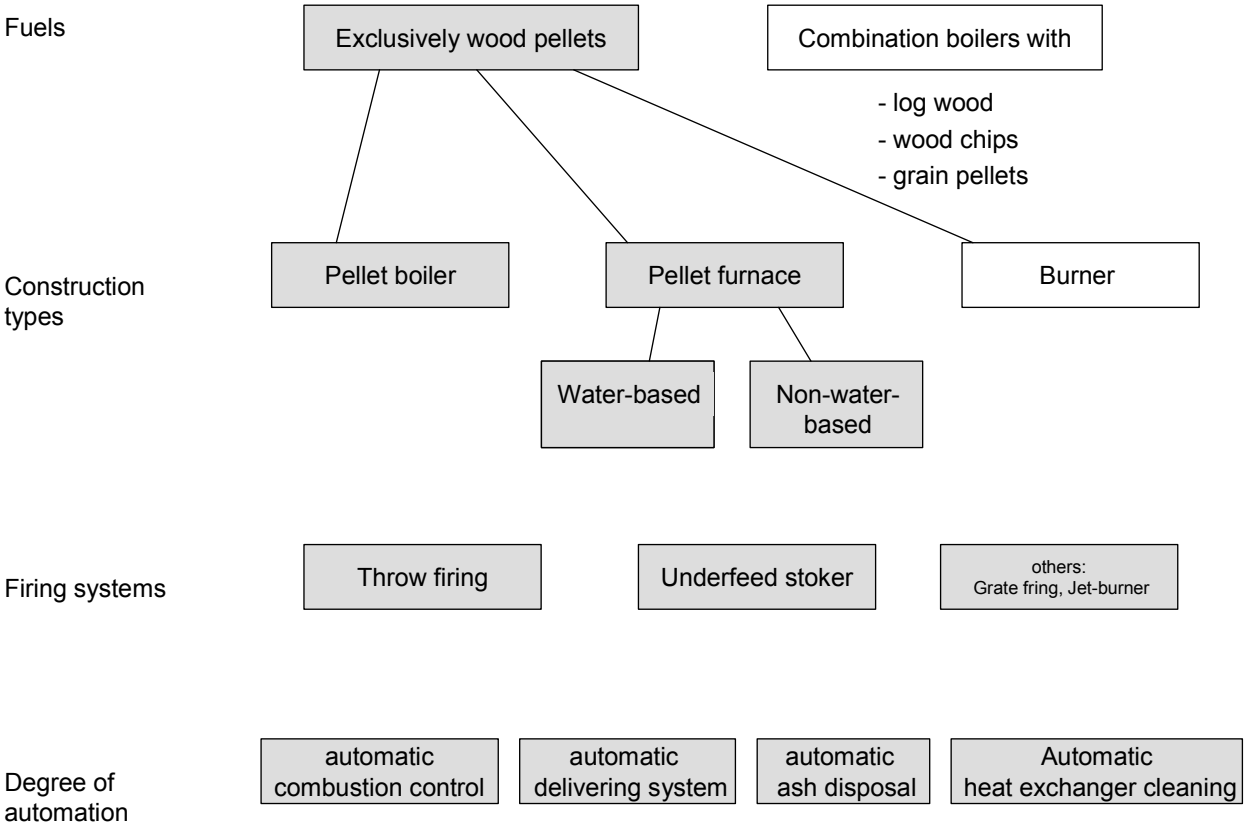
3.4 Definition of Scope

On the basis of the raised data a definition of scope of the ecolabel can be made. On the one hand quality requirements are considered, on the other hand the market-referred request described in paragraph 3.1 is considered. Wood pellet systems enable an efficient and low emission use of regenerative fuels by the automatic control and the use of fuels with uniform quality. A central request of a device distinguished with an ecolabel is that it operates efficiently and with low emission during its whole service life. Thus, only such devices are to be included into the development of the ecolabel,

- which are exclusively operated with pellets, in order to exclude degradations of the efficiency and worsening of emission by the application of qualitatively worse fuels (exclusion of combination boilers),
- which are regulated automatically, in order to avoid errors via inappropriate operation (exclusion of systems with manual control),
- which represent one complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners).

Therefore, both pellet boilers, and pellet furnaces are regarded, as both represent sensible systems. In particular an increasing meaning comes to the pellet furnaces on the one hand through increasingly better insulation standards, on the other hand by the combination with other regenerative energy sources (solar energy). All examined firing systems as well as the different additional automation functions should be regarded first, in order to determine possible differences in the course of the investigation of the environmental relevance. The capacity range is limited further on 50 kW, since this corresponds to the regular system sizes in Germany.

Figure 7: Structure of the Examined Pellet Firings



Source: IÖW (2002)

For the evaluation of the environmental relevance of pellet firings it should be differentiated primarily between pellet boilers and pellet furnaces. For these two groups the following picture results due to the executed market survey and literature data:

Table 6: Market relevance of the selected installation types

Construction types	Rated sale in Germany- for 2001	Trend of sale	German offerer
Pellet boiler	1800	↗	around 20
Pellet stove	2200	↗	around 5

Due to our market survey (total number of sold systems about 5,000) as well as the literature data it can be measured that by this pre-selection about 75% of the German pellet firing market in the capacity range up to 50 kW are covered. The pellet burners have a small market share with fewer than 200 sold devices. Combination boilers constitute a larger market share with a sales figure of approximately 1,000.

4 Analysis of the Ecological Relevance of Pellet Boilers and Pellet Furnaces

An analysis of the impact on the environment of the selected pellet firings is executed in the main part of the feasibility study for wood pellet firings. Additionally, quality requirements and relevant regulations are discussed. Suggestions and criteria for an ecolabel are developed upon this basis. Below the methodology is described, followed by the results of a manufacturers' questioning (paragraph 4.2), the analysis of regulations, standards and quality marks (4.3) and a system comparison with other heaters (4.4).

4.1 Procedure and Methodology

To evaluate the ecological relevance of wood pellet firings:

- the technical literature was analysed
- interviews with test and research institutes were conducted
- altogether 23 manufacturers were asked by telephone or in written form
- a system comparison with other heaters was executed

There were those manufacturers included into the questioning, who manufacture pellet firings of the selected types. By asking 23 manufacturers the regarded scope is almost completely covered. For the investigation a questionnaire was developed, containing the following aspects[14]:

- efficiencies with nominal load and minimal load
- supplementary electrical consumption of the systems
- emissions of CO, total carbon, dust and NO_x
- noise reduction measures and sound pressure level
- service life and maintenance
- construction appropriate for recycling
- disposal of the systems

The manufacturers gave predominantly specification for several systems, whereby they selected systems if necessary after their sales figures. Thus, data is available for:

- 32 pellet boilers[15] of 18 manufacturers in the performance range from 10 to 45.9 kW and
- 14 pellet furnaces of 6 manufacturers in the performance range from 6 to 13 kW.

[14] The questioning was executed by telephone, whereby the questionnaire was dispatched when desired for written answer. A part of the manufacturers completed the specification by test reports of testing institutes.

[15] For the boiler of one manufacturer values from a questioning of the ÖkoTest Magazin were taken over, since the manufacturer did not want to take part in the questioning.

4.2 Ecological Relevance of Pellet Boilers and Pellet Furnaces

In the following the results of the manufacturer questioning are represented and compared with literature values.

4.2.1 Performance Range of the Pellet Firings

The nominal load of the examined pellet firings covers the range from 6 to 45.9 kW. Pellet furnaces cover the smaller performance spectrum from 6 to 13 kW. The smallest pellet boilers have an output of 10 kW; the predominant number of the examined pellet boilers are situated in the performance range of 15 and 25 kW.

Both the boilers and the pellet furnaces can be operated and enabled in a relatively large capacity range allowing a flexible adaptation to changing load requirements. They permit a reduction of the performance up to approximately 25 to 30% of the nominal load. Table 7 shows – separated according to pellet boilers and furnaces – the average nominal load, the average minimal load and the minimal load in relation to the nominal load.

In accordance with the valid DIN regulations (cf. paragraph 4.3.1) usually the testing of the wood combustion plants takes place during nominal load and with minimal adjustable performance.

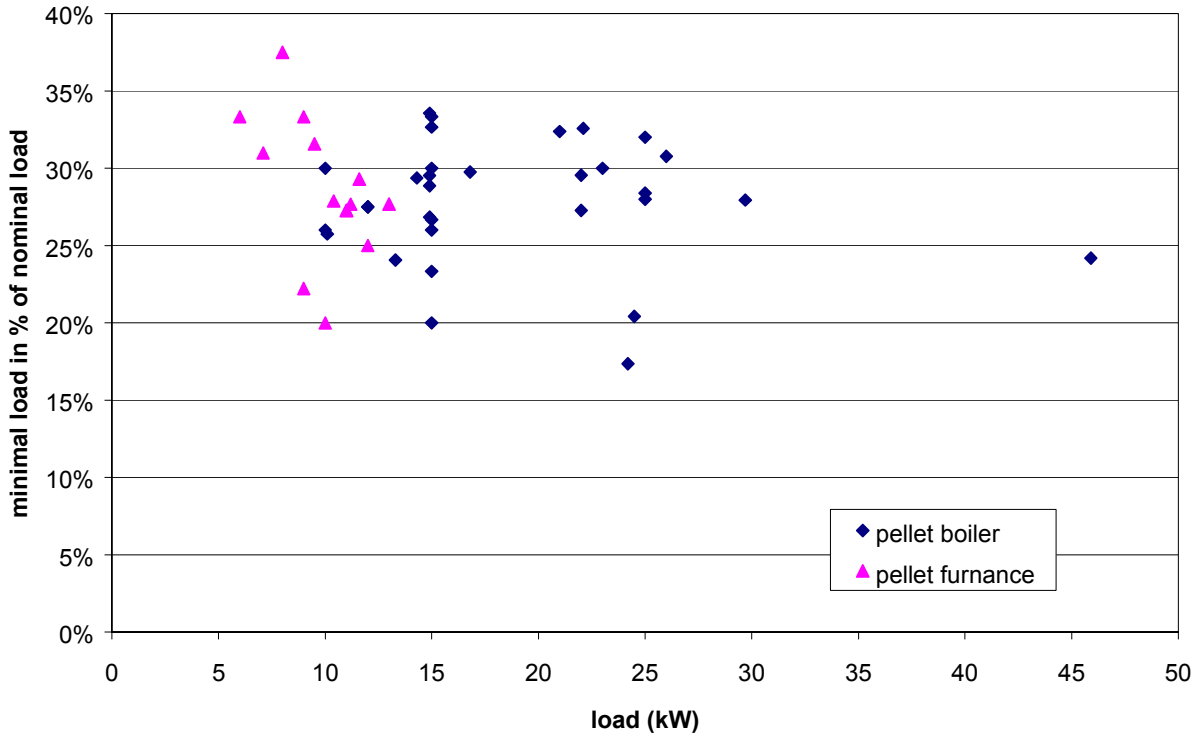
Table 7: Performance Characteristics of the Examined Pellet Firings

	Pellet Boiler (N=32)			Pellet Furnace (N=14)		
	Average	Median	Range	Average	Median	Range
Nominal load	18.7 kW	15 kW	10-45.9 kW	9.9 kW	10.2 kW	6-13 kW
Minimal load	5.2 kW	4.7 kW	2.6-11.1 kW	2.8 kW	3 kW	2-3.6 kW
Minimal load (% of nominal load)	28.0%	28.0%	17.4-33.6%	28.6%	27.8%	20-37.5%

Source: IÖW 2002, data source: questioning of manufacturers

The smaller the nominal load is, the more difficult is the partial load operation. This applies in particular to firings with a nominal load smaller than 8 kW, since no complete burning process is possible, if the thermal output falls below approximately 2 kW. Figure 8 shows the minimal load of the systems in relation to the nominal load.

Figure 8: Minimal Load of the Examined Pellet Firings in Relation to Nominal Load



4.2.2 Energy Efficiency

Relevant for the energy efficiency of the systems are on the one hand the efficiencies with full and partial load and on the other hand the electrical consumption of the systems.

4.2.2.1 Efficiency Factors

The efficiency of the systems describes the energetic efficiency or the degree of utilisation of fuel; it is defined as the relation of the amount of heat delivered during a certain period to the assigned fuel energy (specific thermal value H_u). Here is to be differentiated between the firing efficiency and the boiler efficiency. For boilers, the boiler efficiency is consulted, whereby the radiant heat is rated as loss. The firing efficiency contains the radiation losses and is consulted for pellet furnaces, since with these also the radiant heat is used for room heating. The questioning included the efficiency factors at nominal load and minimal load. The following table shows the determined average efficiencies of the different pellet firing types.

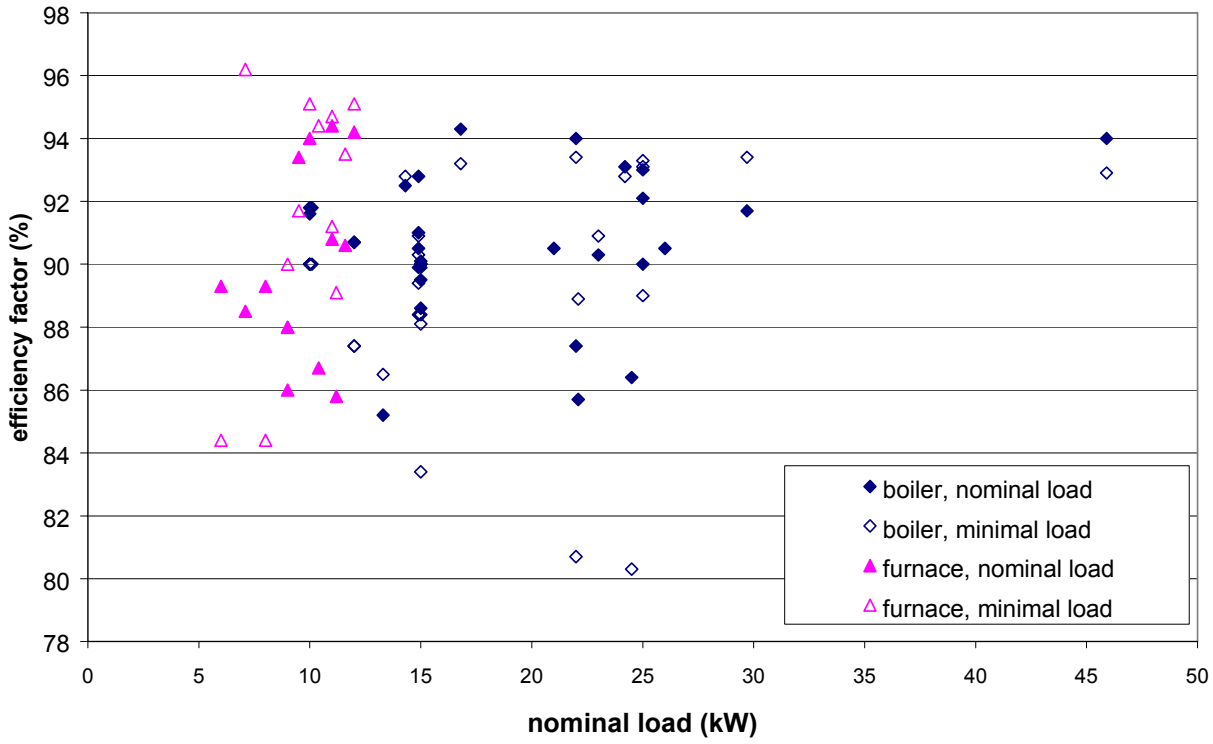
Table 8: Efficiency Factors of the Examined Pellet Firings

	Pellet Boiler (N=32)[16] Boiler Efficiency (%)			Pellet Furnace (N=13) Firing Efficiency (%)		
	Average	Median	Range	Average	Median	Range
At nominal load	90.6%	90.5%	85.2-94.3%	90.1%	89.3%	85.8-94.4%
At minimal load	89.4%	90.0%	80.3-93.4%	91.4%	91.7%	84.4-96.2%
Efficiency factor at minimal load (% of efficiency factor at nominal load)	99.0%	99.0%	92.3-103.7%	101.5%	101.2%	94.5-108.9%

Source: IÖW 2002, data source: questioning of manufacturers

The questioning results are represented additionally in the following figure.

Figure 9: Efficiencies of the Examined Pellet Firings (Pellet Boilers: Boiler Efficiency, Pellet Furnaces: Firing Efficiency)



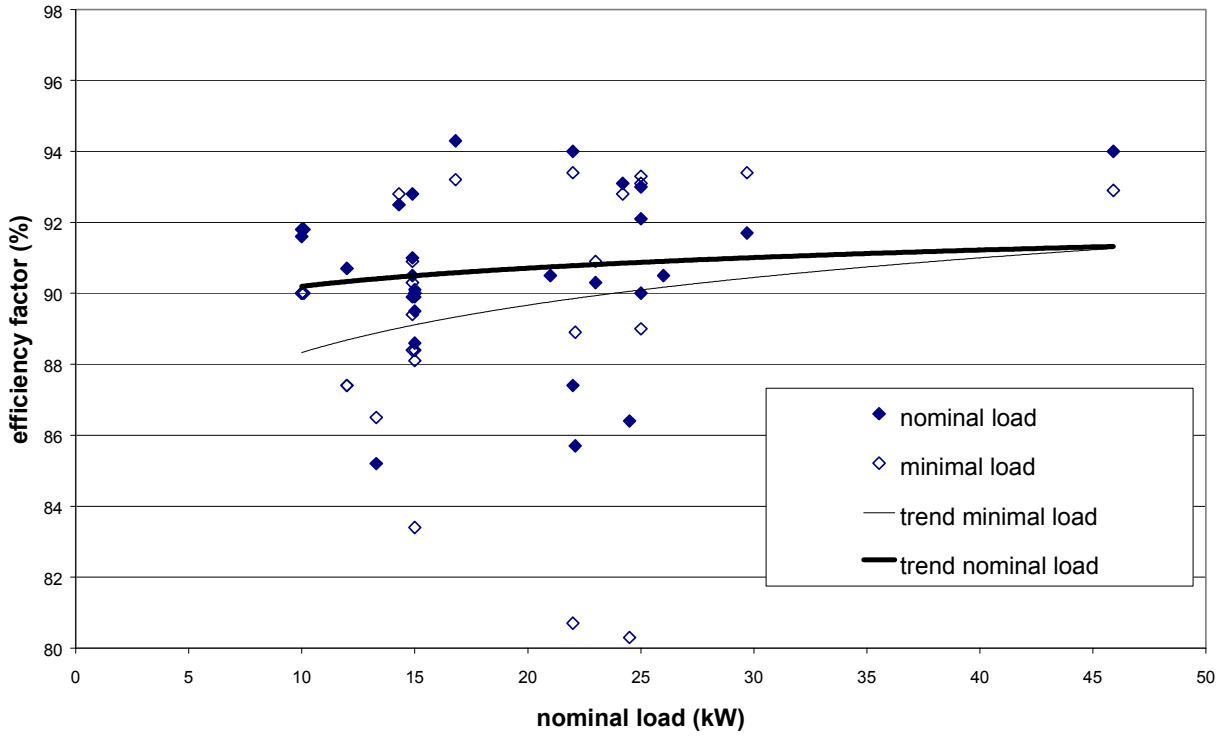
Source: IÖW 2002, data source: questioning of manufacturers

Both with the pellet furnaces and with the boilers a relatively broad dispersion of the values can be detected. This applies both to the values with the two different performance adjustments, and to the difference between the values. The average efficiency factors of pellet furnaces and boilers are approximately on the same level, although the pellet furnaces can achieve higher efficiencies in principle, since with them the firing efficiency is determined. Clearly, a part of the pellet furnaces achieves higher efficiencies than the pellet boilers.

[16] Concerning pellet boilers, only 26 values are available at minimal load.

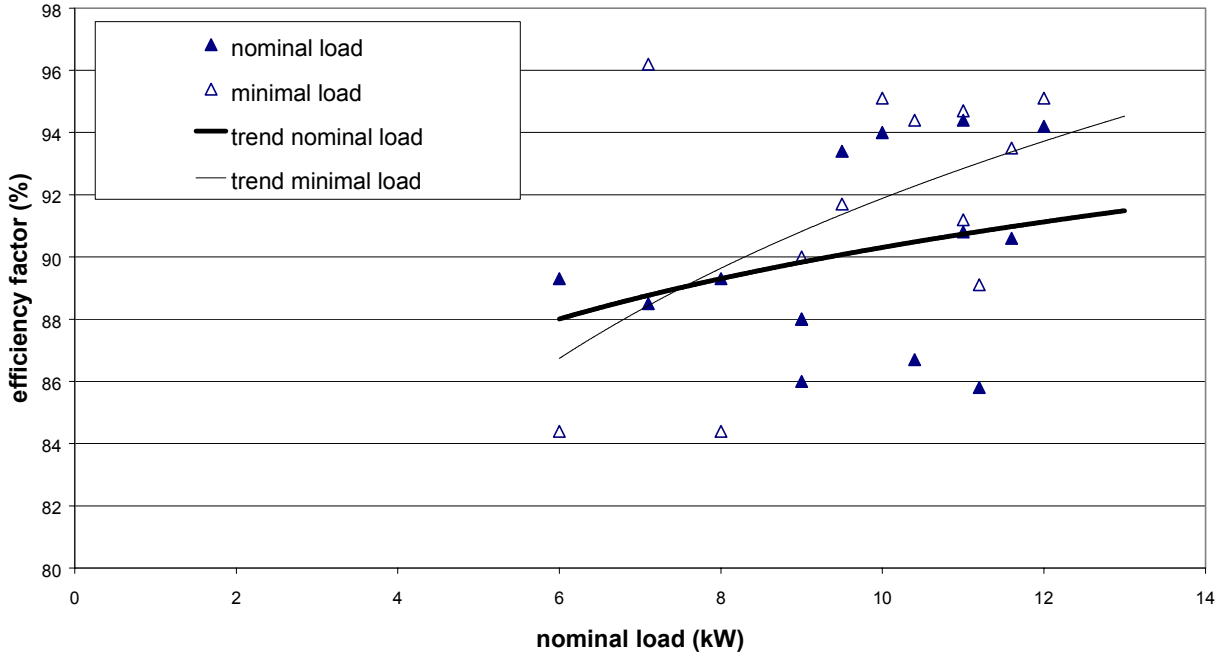
To get the picture more accurately the values for pellet boilers and furnaces are represented separately in the following. Since the exhaust gas temperatures and thus also the exhaust gas losses are smaller, the pellet furnaces tend to a better efficiency with minimal load than during nominal load (cf. figure 11). With pellet boilers the modification is different, depending on the relation between heat exchanger surface and the firing room volume. In the majority of the cases the efficiency however is declining (cf. figure 10).

Figure 10: Boiler Efficiencies of the Examined Pellet Boilers



Source: IÖW 2002, data source: questioning of manufacturers

Figure 11: Firing Efficiencies of the Examined Pellet Furnaces



Source: IÖW 2002, data source: questioning of manufacturers

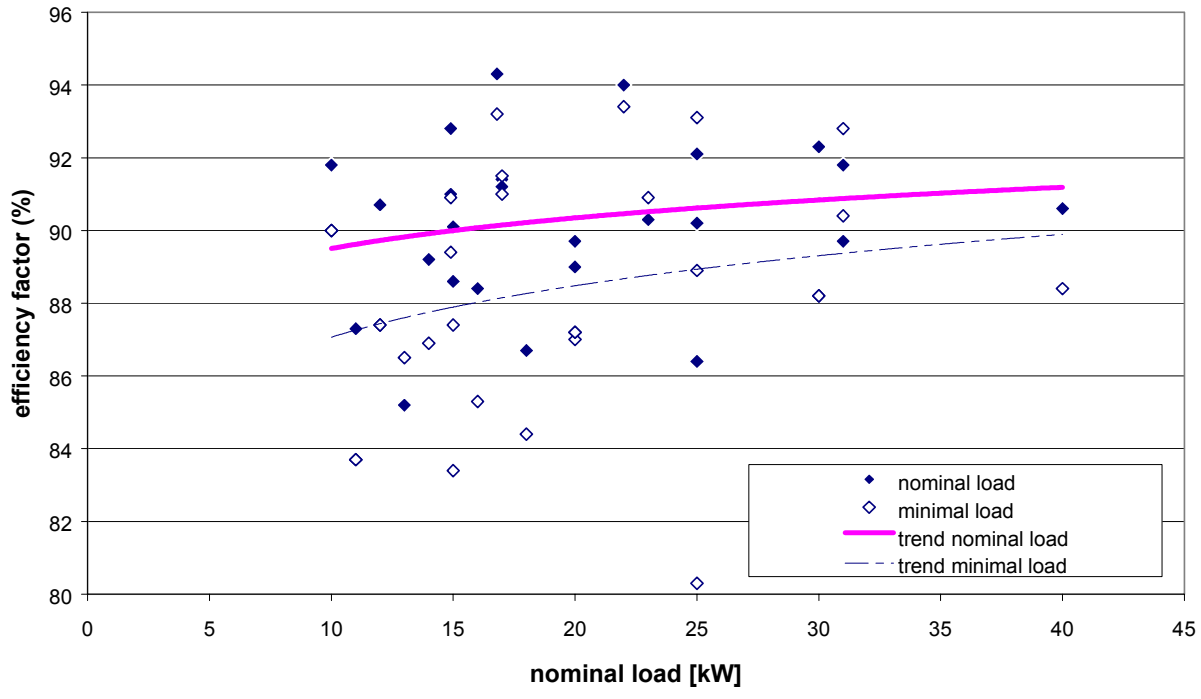
As reference values the published testing results of the BLT (Federal Institution for Agricultural Engineering - Bundesanstalt für Landtechnik) in Wieselburg, Austria can be consulted. In Jungmeier et al. (1999) the testing results of the BLT Wieselburg of the years 1996 to 1998 are combined into efficiencies and emission values of 40 pellet firings with nominal load and minimal load. They determine an average efficiency of 87% (median) with the wood pellet firings (Jungmeier et al. 1999). An evaluation of the results of 35 boiler tests which were conducted since 1999 by the BLT and published on the Internet points out that 30 pellet boilers show a median of the efficiency factor of 90.5% with nominal load and a median of 88.2% with minimal load (cf. figure 12).

Table 9 summarises the values of the BLT testings. This clarifies that in the course of time the efficiency factors rose. The values raised in this assessment are corresponding well both with the range and the average of the newer BLT values.

Table 9: Efficiency Factors of Pellet Boilers within BLT Wieselburg Testing

	BLT Testing, 1996 - 1998 (Jungmeier et al. 1999) (N=40)		BLT testing, since 1999 (www.blt.bmlf.gv.at) (N=30)	
	Median	**Range**	**Median**	**Range**
Nominal load	87%	55-94	90.5%	85.2-94.3
Minimal load	88%	78-93	88.2%	80.3-93.4

Figure 12: Boiler Efficiencies of Tested Pellet Boilers (BLT Wieselburg, since 1999)



Source: IÖW 2002, data source: BLT Wieselburg (www.blt.bmlf.gv.at)

There are only five pellet furnaces among the BLT measurements. The exhaust gas loss of these five pellet furnaces was measured, instead of the efficiency factor. The median here is at 13% during nominal load and at 6.5% at minimal load. From the exhaust gas loss the firing efficiency factor can be calculated as

Firing efficiency (%) = 100% - exhaust gas loss (%).[17]

Thus, an average firing efficiency factor of 87% can be emphasised for the pellet furnaces in the case of nominal load and of 93.5% in the case of minimal load. This supports the view that the efficiency factors tend to be higher with minimal load.

4.2.2.2 Auxiliary Electrical Consumption

The wood pellet firings need electricity for the control and regulation as well as for the drive of pumps, blower, augers and for the ignition. In this connection the electricity consumption to operate the central water circulation pump is system-specific and is determined by the concrete installation conditions in practice. In contrast to this, test stand values can be indicated for other auxiliary electricity consumption.

The following table shows the power input with nominal load. The values show a large range. Probably, no common understanding of power input exists. It is to be assumed that different devices are included into the valuation of the power input. The BLT Wieselburg executes for example separate measurements for the power input to the auger, the blower and the electrical ignition.

Pellet boilers indicate a higher power consumption than pellet furnaces. This is to be attributed particularly to the larger performance. If the current consumption is set in reference for the thermal performance, the values of the pellet furnaces are only slightly below those of the boilers.

Table 10: Power Input and Auxiliary Electrical Consumption of the Examined Pellet Firings

	Pellet boilers (N=29)[18]			Pellet furnaces (N=10)		
	Average	**Median**	**Range**	**Average**	**Median**	**Range**
Power input at nominal load (W)	115.5 W	95 W	50-500 W	54.8 W	35.0 W	25-100 W
Specified supplementary electrical consumption at (% of thermal output)	0.7%	0.5%	0-2.3%	0.6%	0.4%	0.3-1.1%

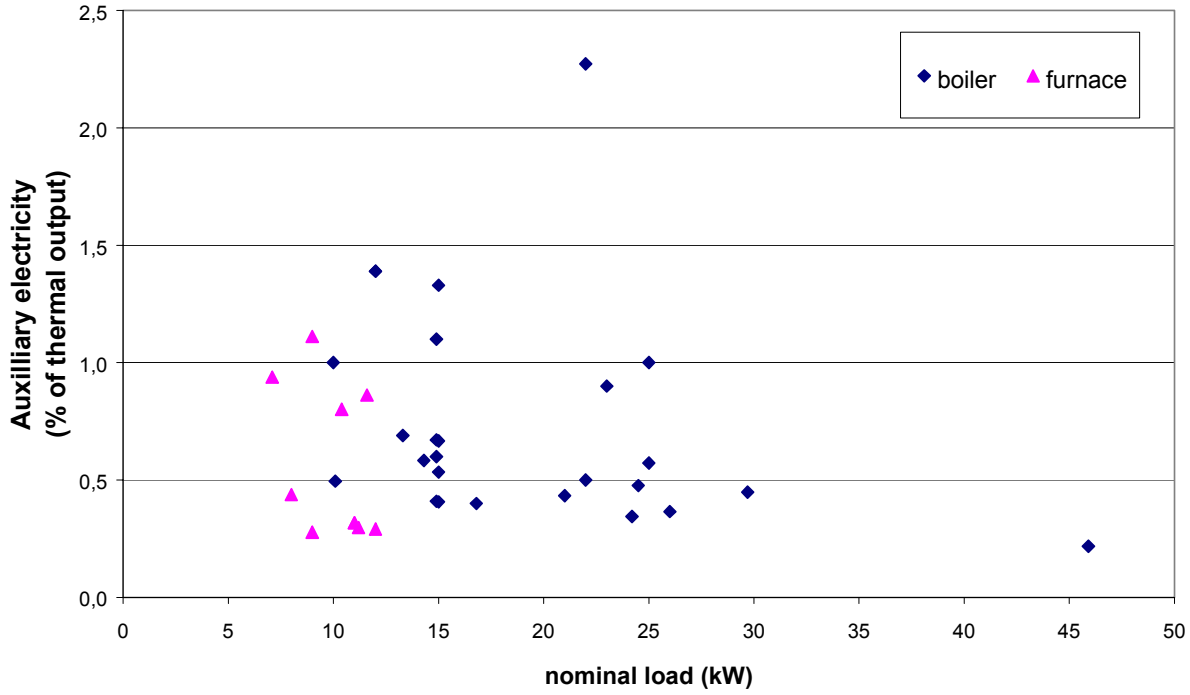
Source: IÖW 2002, data source: questioning of manufacturers

As the following figure shows, the specific auxiliary electricity consumption tends to decrease with increasing performance, laying in most cases at fewer than 1% of the nominal load.

[17] The efficiency factor results according to DIN 18891 as n = 100 - (q_a + q_b + q_r), with q_r as loss of free warmth in exhaust gases; q_b loss of bound warmth in the exhaust gases and q_r as calorific loss in the inflammable constituents in the rust and tying failure. The latter can be neglected for the determination.

[18] For Power Input data was only available for 21 pellet boilers.

Figure 13: Auxiliary Electrical Consumption in Relation to the Thermal Output



Source: IÖW 2002, data source: questioning of manufacturers

The power input with minimal load and in a state of rest („stand-by“) was likewise included in the questioning. There is no data on the state of rest. To the minimal load one pellet furnace manufacturer and one boiler manufacturer made specification. In the case of the pellet furnace the power input with minimal load (approx. 30% of the nominal load) corresponds to about 42% of nominal load and in the case of the boiler about 60% of the power input with nominal load.

Additionally the water-side flow resistance was determined. Only two manufacturers of pellet furnaces gave statements for this specification. The values are represented in table 11.

Table 11: Water-side Flow Resistance of the Examined Pellet Firings

	Pellet boiler (N=16)			Pellet furnaces (N=3)		
	Average	Median	Range	Average	Median	Range
Water-side flow resistance (mbar)	11.7	3.4	0.2-64.2			30.6-110

Source: IÖW 2002, data source: questioning of manufacturers

The values indicate a substantial range, whereby with the boilers only four values are over 10 mbar.

4.2.3 Emissions

Wood firrings, in particular small systems, had for many decades a negative image due to neighbourhood annoyance by smoke and smell. A cause for this were above all bad burnings due to insufficient technique as well as due to inappropriate operation by the operator.

Since the emission control regulations have become more strict (TA air 1986, 1. BImSchV 1988) the technique of wood combustion plants was clearly developed further. An improved burning can be essentially attained by optimised operating conditions and a suitable control engineering. On the market today many systems point to low emission values.

According to § 4 of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz - BImSchG) wood combustion plants up to 1 MW firing thermal output require no approval, nevertheless for those the 1. BImSchV (1. Federal Immission Control Ordinance, Regulation on Small-scale Combustion Plants) applies. It sets limit values for carbon monoxide (CO) and dust for plants with a performance of more than 15 kW. Small plants with fewer than 15 kW are subject only to the general request of the 1. BImSchV; to them no appropriate emission limit values apply. Hydrocarbons (total carbon) and nitrogen oxides (NO_x) are, beside those which are regulated in the 1. BImSchV, further relevant pollutants.

It is discussed among experts in what respect the emission values and efficiency factors under test conditions are comparable to the values in practice. A comparative investigation of emission values at different locations on automatically fed wood chips firing comes to the result, that the differences between the emission values under test conditions and in practice for dust and NO_x are small. In practice conditions clearly higher emissions were measured for CO and in particular for hydrocarbons (Bayrisches Staatsministerium für Ernährung, Landwirtschaft und Forsten 1999). For pellet firings it is argued that in practice a „test stand condition “ can be achieved, because

- the plants are fed automatically and thus stay in continuous operation
- faulty operations due to the automatic regulation are practically impossible and
- the fuel is standardised (cf. Astfalk 1999b).

Prerequisites are however regular maintenance and adjustment of the system.

A comparison of a practical test stand measurement of a run pellet heating (cf. Hartmann et al. 2001) with test stand measurements at the initial testing (manufacturer data in our collection) showed clear differences, in particular with the efficiency rates. The boiler efficiency amounts at the practical measurement during nominal load only 85%, whereas the test stand value is rated with 90%.

4.2.3.1 Measurements for Emission Reduction

In the capacity range up to 50 kW, generally, primary measures for emission reduction are used exclusively (e.g. construction of heating room, burn regulation, air staggering). Secondary measures such as dust collectors are only used in the larger range of performance. An optimal relation between amount of fuel and combustion air is important for low-pollution burning. With to little surplus of air, the amount of pollutant is increasing by occurring local oxygen deficiency, with to big surplus of air the pollutant emissions might rise due to reduced burn temperatures (cf. Kaltschmitt/Neubarth 1998). The burning can be optimised e.g. by a Lambda regulation (regulation of the excess air and regulation of the supplied amount of fuel).

In the executed questioning it was raised, which measures the manufacturers use for emission reduction. For this, different measures were described:

- One pellet furnace and three boiler manufacturers control the exhaust gas temperature.
- Four pellet furnace manufacturers use lambda probe.

- One pellet furnace manufacturer and two boiler manufacturers indicated as emission-reducing measure a separate air circulation for primary and secondary air.
- Two pellet furnace manufacturers use air sensors.
- Two boiler manufacturers describe specific technical procedures.
- Two pellet furnace and four boiler manufacturers did not give specification
- The remaining specification is partly very vague, two pellet furnace- and six boiler manufacturers indicated to keep the emissions low by means of the burn technique.

From the raised measures no general trend to certain measures can be determined. The manufacturers develop partially their own solutions for optimising their systems. For the development of an ecolabel, the actually achieved emission values are more meaningful than the measures, with whose assistance they are achieved. Therefore in the following emissions of different pollutants are represented.

4.2.3.2 Carbon monoxide

Carbon monoxide and hydrocarbons are always developing when burning wood or other fuels; the amount of emissions differs depending upon the quality of the burning. The limit value for carbon monoxide, according to the 1. BimSchV, is indicated as of 4 g/m^3 for firings between 15 and 50 kW, operating with untreated wood.[19]

Since carbon monoxide has a retention time of several months in the atmosphere, co which has been emitted near the surface can spread in the entire lower atmosphere. Carbon monoxide contributes with photo-chemical reactions to the increase of tropospheric ozone and CO_2-concentration. The contribution to the atmospheric CO_2-concentration is of subordinated importance in relation to the directly emitted CO_2-amounts. Nevertheless, CO has a substantial contribution to the tropospheric ozone formation. Ozone contributes both to the anthropogenic greenhouse effect and to the photo-chemical smog. (cf. UBA/Schael 1995.)

Additionally carbon monoxide is toxic for humans. Inhaled carbon monoxide blocks the oxygen accommodation into the blood and leads depending upon taken up quantity to headache, feelings of dizziness and nausea; larger quantities lead to death (cf. e.g. WHO 2000). Due to the poisoning to humans the max. workstation concentration (MAK) is about 33 mg/m³. TA air (1986) contains an immission short time value of 30 mg/m³ for CO and a long-term value of 10 mg/m³. Due to the low chimney heights of residential buildings carbon monoxide emissions from household firings can lead to substantial annoyance of the neighbourhood. From the manufacturer questioning the CO emission value results are represented in the following table.

[19] Related to a volume content of oxygen in the exhaust gas of 13%.

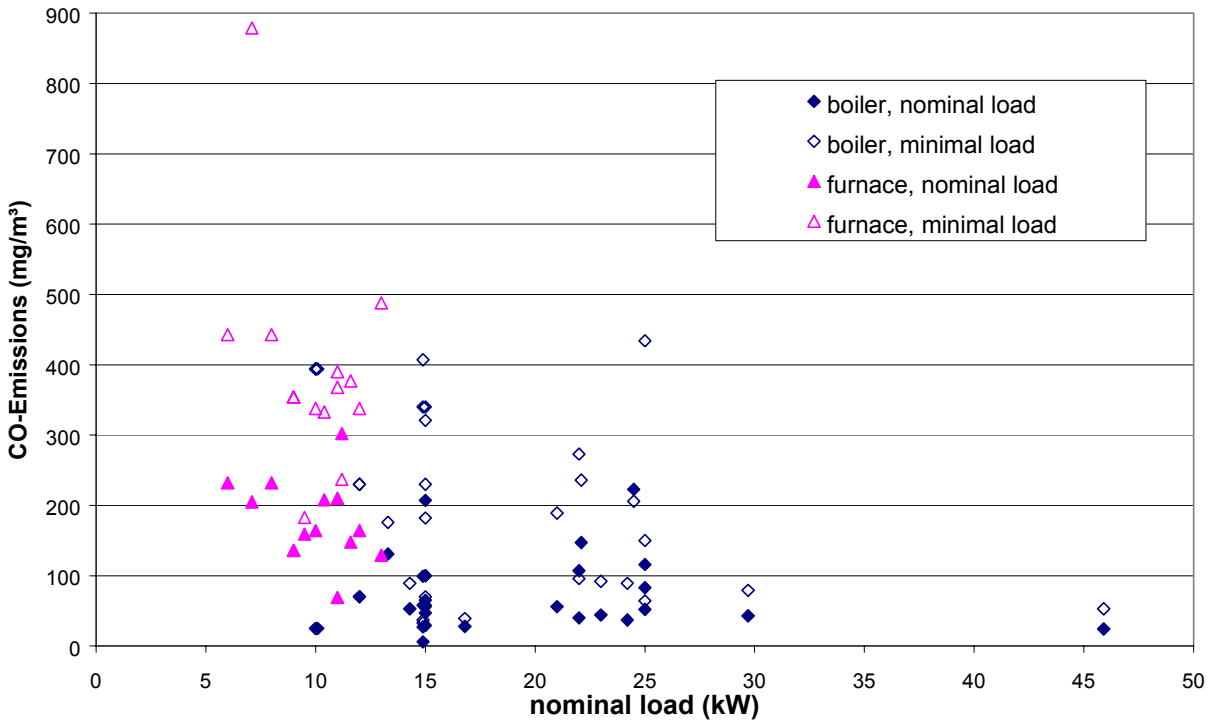
Table 12: CO Emissions of the Examined Pellet Firings

CO-Emissionen	Pellet boiler (N=30)			Pellet furnace (N=14)		
	Average	Median	Range	Average	Median	Range
Nominal load	69.4 mg/m^3	56.0 mg/m^3	6.0-223.0 mg/m^3	178.1 mg/m^3	164.0 mg/m^3	69.0-302.0 mg/m^3
Minimal load	198.9 mg/m^3	185.5 mg/m^3	33.0-434.0 mg/m^3	394.6 mg/m^3	361.0 mg/m^3	183.0-879.0 mg/m^3
Minimal load CO-emissions in % of nominal load emissions	413.0%	248.0%	92.4-1576.0%	247.9%	206.1%	78.5-565.2%

Source: IÖW 2002, data source: questioning of manufacturers

All values are situated clearly underneath the limit values of the 1. BImSchV (4 g/m³, related to 13% O_2) in the relevant performance range and clearly under the request of the strictest class of the DIN EN 303-5 (3000 mg/m³, related to 10% O_2) (cf. 4.3.1). Pellet furnaces indicate basically higher CO emissions than boilers. The CO emission value is at both firing types during minimum load clearly higher than during nominal load. For each firing type, there is one exception, in which the emission value with minimal load is less. The differences between boilers and pellet furnaces as well as between nominal load and minimal load become clear in the following figure.

Figure 14: Carbon Monoxide Emissions of the Examined Pellet Firings

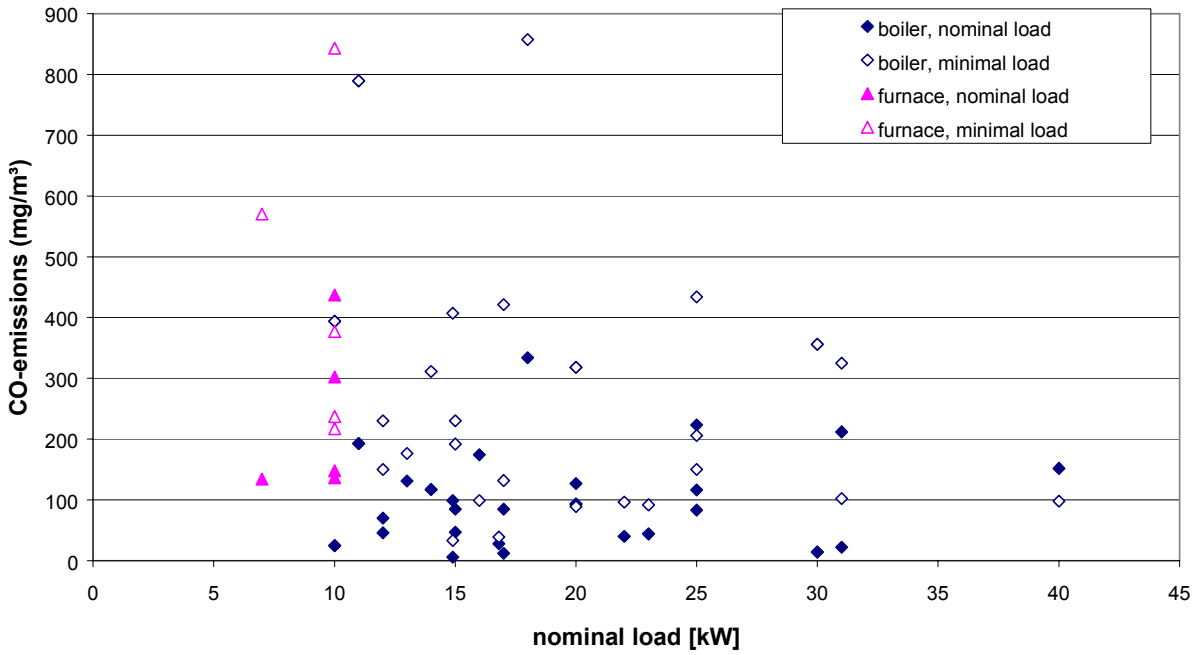


Source: IÖW 2002, data source: questioning of manufacturers

To compare the results the data of the BLT testings can also be used. Jungmeier et al. (1999) measured average CO emission values of 88 mg/MJ (minimum 15, maximum 272) for nominal load, corresponding to approximately 135 mg/m³.

The carbon monoxide emissions were analysed also with the Internet data of the BLT. The medians are situated here during nominal load at 85 mg/m³ for pellet boilers, and 148 mg/m³ for pellet furnaces. With 230 mg/m³ or 377 mg/m³ CO (cf. figure 15) during minimal load the exhaust gases contain substantially higher pollutant concentrations. Also for CO the data of this study and the BLT values are corresponding well.

Figure 15: Carbon Monoxide Emissions of the Tested Pellet Firings (BLT since 1999)



4.2.3.3 Hydrocarbons

Under the comprehensive term total carbon a multiplicity of organic compounds are hidden. The dominating hydrocarbons are C_1 -, C_2 -, and C_6-compounds. They develop within oxygen-poor areas of the flame. Hydrocarbon emissions are responsible for smell and toxicity of the exhaust gases. A good combustion with a low percentage of burnable materials in residues can lead to low emissions. Among the hydrocarbons small amounts of dioxins and polycyclic aromatic hydrocarbons (PAH) might occur. PAH can emerge particularly with incomplete combustion. A substantial factor of influence for the dioxin formation is the chlorine content of the fuel, which is small in untreated wood, nevertheless possible is the dioxin formation. Dioxin is built preferentially at ash particles and dust deposits.

The results of the manufacturer questioning concerning the emission values for organic carbon are represented in the following table.

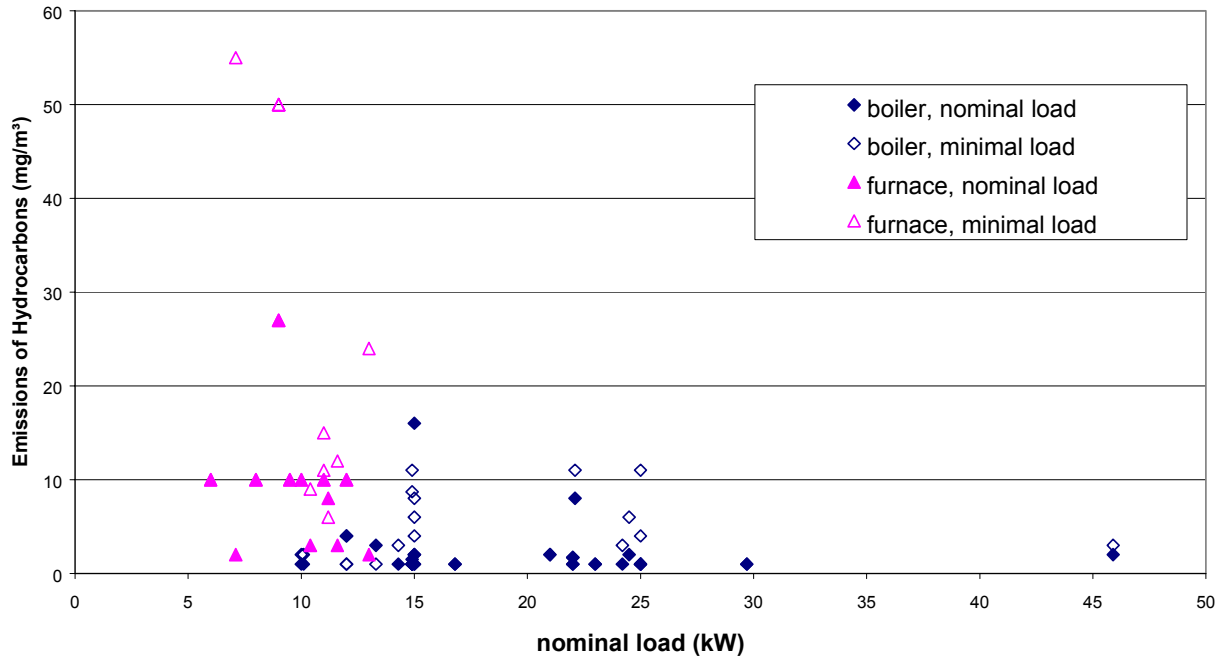
Table 13: Emissions of Hydrocarbons of the Examined Pellet Firings

Carbon emission (C_{total})	Pellet boiler (N=27)			Pellet furnaces (N=14)		
	Average	Median	Range	Average	Median	Range
During nominal load	2.3 mg/m³	1.0 mg/m³	1.0-16.0 mg/m³	10.1 mg/m³	10.0 mg/m³	2.0-27.0 mg/m³
During minimal load	3.6 mg/m³	2.0 mg/m³	1.0-11.0 mg/m³	20.1 mg/m³	10.5 mg/m³	6.0-55.0 mg/m³
C_{total}-Emission at minimal load in % of the emission at nominal load	246.0%	100.0%	25.0-1.100.0%	418.2%	130.0%	75.0-2.750.0%

Source: IÖW 2002, data source: questioning of manufacturers

The indicated values show a large dispersion (cf. also figure 16). Clearly The pellet boilers indicate a smaller emissions than the pellet furnaces. In the majority of the cases the C_{ges} emissions are larger with minimal load than during nominal load. The boilers show four reverse cases and the pellet furnaces one case, where the C_{ges} emissions at minimal load is smaller (the same as with CO) and five cases which the emission are alike. It becomes clear, that some pellet furnaces show clearly increased values during minimal load. Nevertheless the values in the entire capacity range are clearly below 100 mg/m³, which is the standard for the strictest emission class according to DIN EN 303-5 (cf. 4.3.1).

Figure 16: Emissions of Hydrocarbons (C_{total})

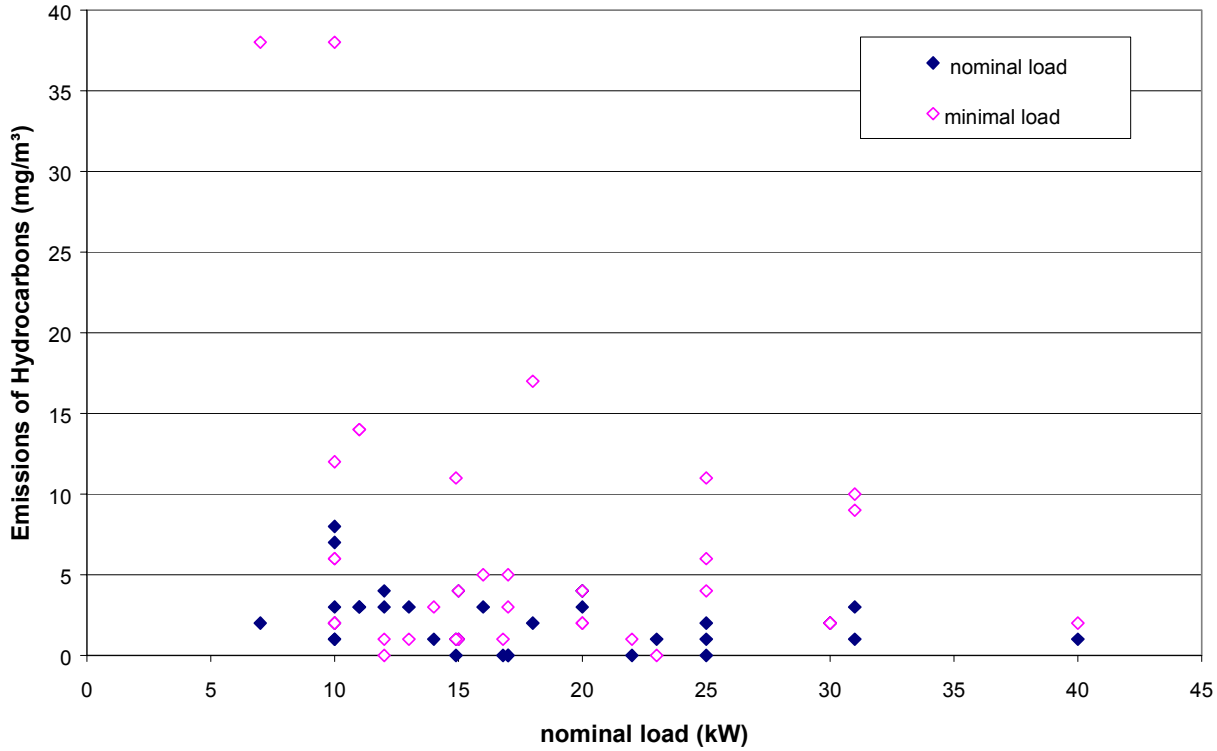


Source: IÖW 2002, data source: questioning of manufacturers

The concentrations of hydrocarbons were likewise measured by the BLT Wieselburg and can be consulted as reference values. They amount in the newer systems to the median of 2 mg/m³ during nomi-

nal load in the exhaust gas of the boilers and 3 mg/m³ during minimal load. Pellet furnaces show a median of 3 and 13 mg/m³.

Figure 17: Emission of Hydrocarbons of the Tested Pellet Firings (BLT since 1999)



Source: IÖW 2002, data source: BLT Wieselburg (www.blt.bmlf.gv.at)

The values of the BLT Wieselburg for pellet boilers correspond well with the values raised in this study. The BLT values of the pellet furnaces show particularly lower values during nominal load. Since the values of the BLT study are based on only five pellet furnaces of two different manufacturers, the data of this assessment, as a result of the larger quantity, shows a broader dispersion.

4.2.3.4 Nitrogen Oxides

Nitrogen oxides (NO_x) are acid forming air pollutants and contribute to the acidification of soil and water. Further they contribute to the nutrification of soil and waters. Besides, NO_x are precursory substances for near-surface ozone and contribute thus to the photo-chemical smog.

Nitrogen oxide emissions can be formed by the oxidation of atmospheric nitrogen at high temperatures (thermal NO_x) or by oxidation of nitrogen from fuel (fuel NO_x). With wood combustion NO_x emissions develop particularly from the nitrogen contained in the fuel, since the combustion temperatures are not sufficient for producing thermal NO_x (cf. Jungmeier et al. 1999). The NO_x emissions are thus determined above all by the fuel. Since pellets are to a large extent standardised fuels, only small fluctuations between individual systems are to be expected; According to Marutzky and Seeger (1999) the nitrogen oxide emissions of untreated wood range between 100 and 200 mg/m^3. Since the NO_x emissions are above all dependent on the fuel, they are not measured by all manufacturers. The NO_x emission values from the manufacturer questioning are represented in the following table.

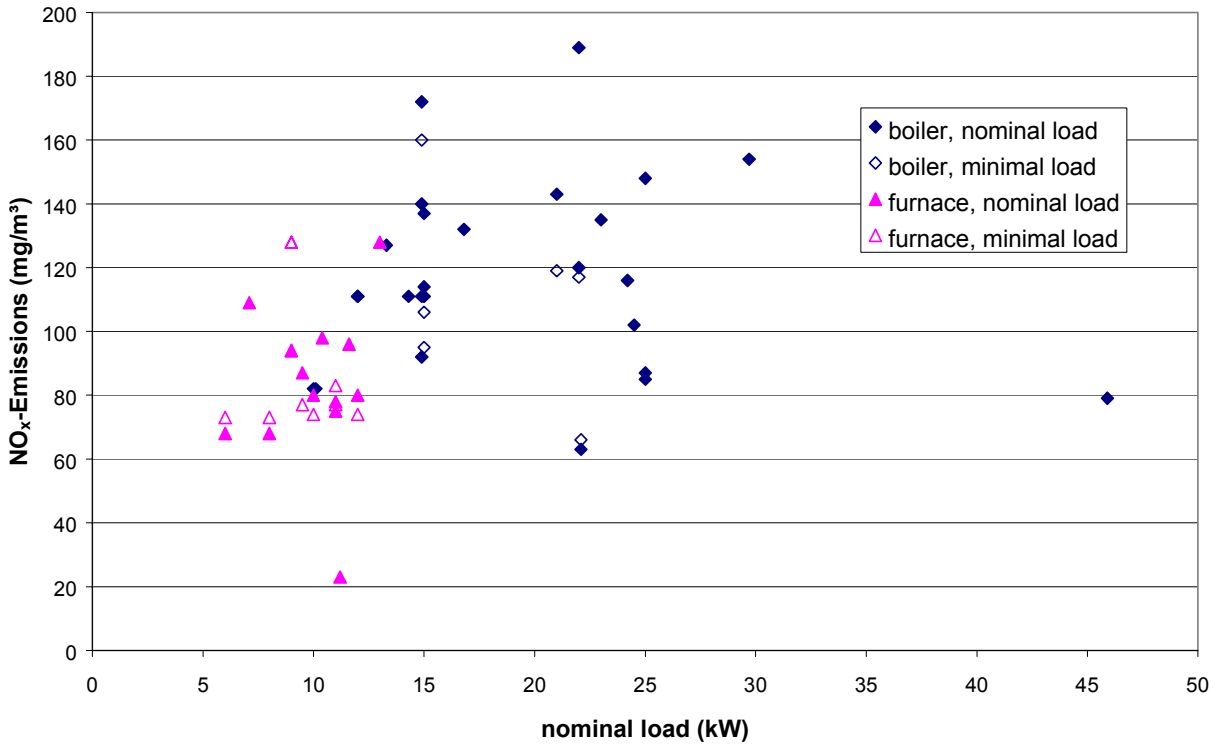
Table 14: NO_x Emissions of the Examined Pellet Firings

NO_x-Emission	Pellet boilers (N=27)[20]			Pellet furnaces (N=14)[21]		
	Average	Median	Range	Average	Median	Range
At nominal load	117.2 mg/m³	111.0 mg/m³	63.0-189.0 mg/m³	84.1 mg/m³	83.5 mg/m³	23.0-128.0 mg/m³
At minimal load	110.5 mg/m³	111.5 mg/m³	66.0-160.0 mg/m³	87.4 mg/m³	77.0 mg/m³	73.0-128.0 mg/m³
NO_x-Emission at minimal load in % of the emission at nominal load	87.0%	89.0%	61.9-104.8%	107.7%	106.4%	88.5-136.2%

Source: IÖW 2002, data source: questioning of manufacturers

Pellet furnaces indicate smaller NO_x emissions than pellet boilers. The deviations between the individual systems are clearly smaller than with the pollutants discussed so far. Additionally, the differences between nominal load and minimal load are smaller.

Figure 18: NO_x Emissions of the Examined Pellet Firings



Source: IÖW 2002, data source: questioning of manufacturers

Since to NO_x values during minimal load only a few values are indicated, additionally the emission values (nominal load) of these systems are mentioned for direct comparison: At nominal load, the boilers cause 132 mg/m³ NO_x emission, and the pellet furnaces 80 mg/m³, i.e. that the boilers indicate

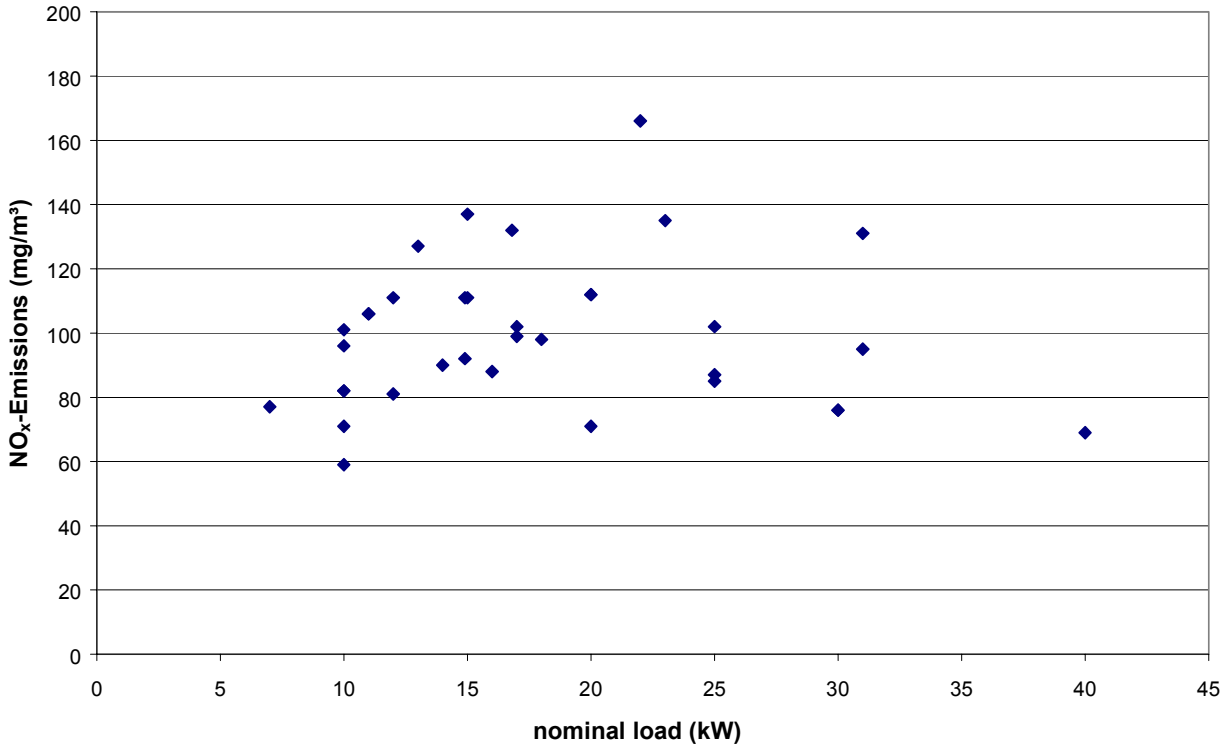
[20] For minimal load, data was only available for six pellet boilers.

[21] For minimal load, data was only available for nine pellet furnaces.

on the average smaller values during partial load, while the values of the pellet furnaces rise slightly during partial load.

In Jungmeier et al. (1999) NO_x emissions were measured only with nominal load, they were on the average about 83 mg/MJ (minimum 49, maximum 128), which corresponds to a value of 128 mg/m³. The values are clearly below the Austrian limit value of 150 mg/MJ (Jungmeier et al. 1999). The NO_x emissions were measured by the BLT in Wieselburg also in the measurements since 1999 during nominal load. Here the medians are about 100 mg/m³ for the boilers and 77 mg/m³ for the pellet furnaces.

Figure 19: Nitrogen Oxide Emissions of the Tested Pellet Firings (BLT since 1999)



Source: IÖW 2002, data source: BLT Wieselburg (www.blt.bmlf.gv.at)

4.2.3.5 Dust

Dust emissions are essentially caused by ash particles, which are included in the incineration gases as fly ash. With incomplete combustion (e.g. partial load operation) the dust emissions consist also of soot particles and condensable hydrocarbons. The mass concentration, particle size and mineral composition of the dust types depend on the type of fuel, the thermal conditions and the flow conditions in the firing (cf. Jungmeier et al. 1999). The dust emissions are determined also by blower fan (dust-whirling up effect) and by the size of the reheating surface (dust-separating effect) (cf. Launhardt et al. 1998). The regulation 1. BImSchV sets a limit of 0.15 g/m^3 for systems with a performance of more than 15 kW and operating with untreated wood.[22]

[22] Related to a volume content of oxygen in exhaust gas of 13%.

In recent time above all fine types of dust (particles with an aerodynamic diameter £ 10 mm, PM_{10}) are in suspicion of causing a high human toxic potential. Fine types of dust, in particular $PM_{2,5}$, can cause acute health-endangering effects, particularly on the respiratory system. Beyond that, newer studies show also a high mortality risk in long-term effects of fine particles (WHO 2000). Fine dust has a retention time up to ten days in the atmosphere, consequently long-distance transport is possible (HLUG 2002).

The dust emissions of wood combustions consist to the predominant section of fine dust. Baumbach et al. (1999) examined the composition of the dust emissions of a pellet furnace and came to the result, that with 95% the by far largest part of the emission has an aerodynamic particle diameter of less than 2,1 µm. Thus the particle sizes are situated in the range of fine dust and have a high mortality risk. The emission values from the manufacturer questioning for dust are represented in the following table.

Table 15: Dust emissions of the examined pellet firings

Dust emission	Pellet boilers (N=31)[23]			Pellet furnaces (N=14)[24]		
	Average	Median	Range	Average	Median	Range
At nominal load	19.6 mg/m^3	17 mg/m^3	6.0-50.0 mg/m^3	26.9 mg/m^3	24.0 mg/m^3	13.0-59.0 mg/m^3
At minimal load	44.2 mg/m^3	49.0 mg/m^3	28.0-60.0 mg/m^3	28.0 mg/m^3	28.0 mg/m^3	13.0-43.0 mg/m^3
Dust-Emission at minimal load in % of the emission at nominal load	333.3%	144.0%	100.0-1000.0%	144.4%	127.3%	481-238.9%

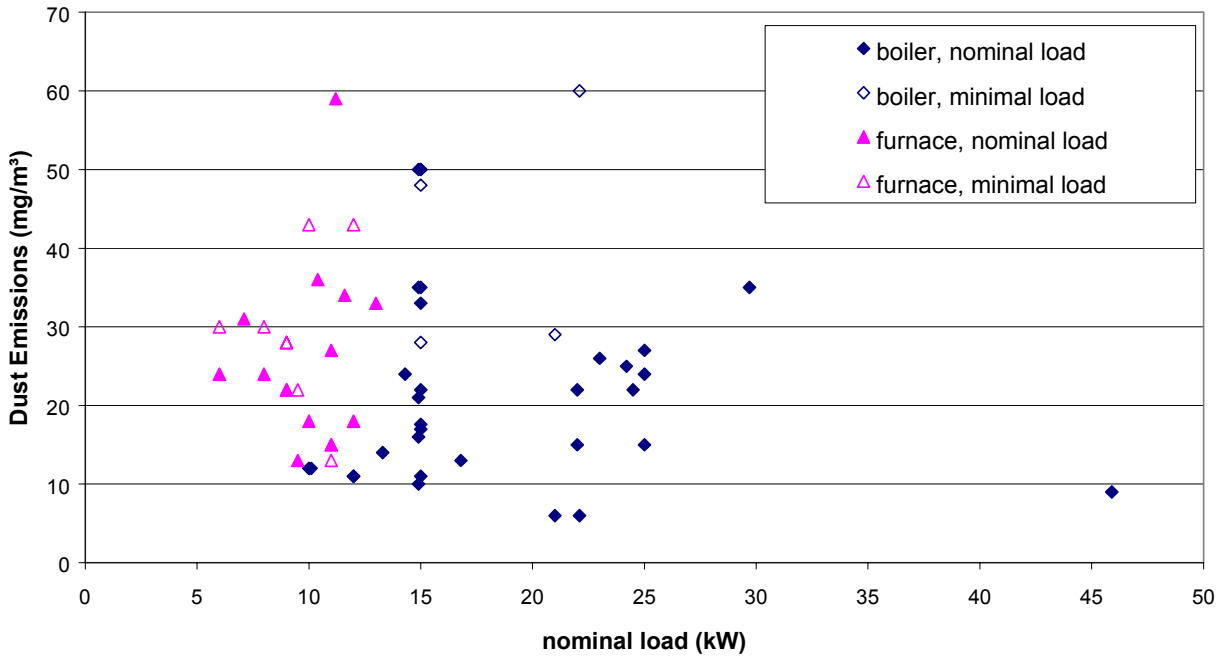
Source: IÖW 2002, data source: questioning of manufacturers

All the values are clearly below the values of the 1. BImSchV, they are even less than half of the limit. The emission values point to a relatively broad dispersion. During nominal load the values of the pellet furnaces are higher than those of the pellet boilers, with minimal load it is the other way around. Data at minimal load is available only for parts of the firings. The values of these systems are during nominal load of the boilers at 25 mg/m³, of the pellet furnaces at 20 mg/m³. The values during minimal load are situated on the average and are thus over the emission values of nominal load. In the partial load operation the burning becomes incomplete, resulting in an intensified soot formation and the formation of condensable hydrocarbons.

[23] For minimal load, data was only available for six pellet boilers.

[24] For minimal load, data was only available for nine pellet furnaces.

Figure 20: Dust Emissions of the Examined Pellet Firings

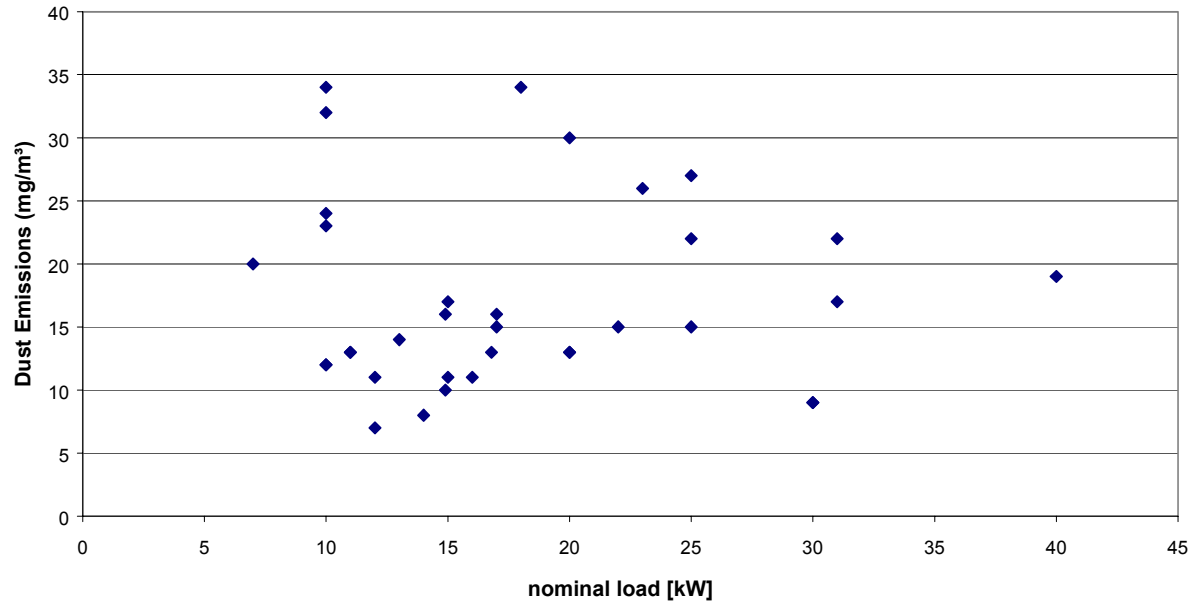


Source: IÖW 2002, data source: questioning of manufacturers

The testings of Jungmeier et al. (1999) shows average dust emission values of 18 mg/MJ (minimum 5, maximum 49) during nominal load, which corresponds to 28 mg/m³.

In the newer investigations of the BLT the dust emissions were measured only during nominal load. The median of the measurements since 1999 is about 13,5 mg/m³ for the boilers and 24 mg/m³ for the pellet furnaces.

Figure 21: Dust Emissions of the Tested Pellet Firings (BLT since 1999)



Source: IÖW 2002, data source: BLT Wieselburg (www.blt.bmlf.gv.at)

4.2.4 Sound Emissions

Pellet firings are used in houses; they are mostly set up as boilers in the cellar, while pellet furnaces are set up directly in the dwellings. Requirements, concerning the noise emissions, should be oriented therefore to the immission values of the TA noise (Technical Regulation for Sound Emissions, TA Lärm), which apply to populated areas. During day-time an immission value of 50 dB(A) should not be exceeded and at night of 35 dB (A). Particularly blowers, pumps and augers cause sound immissions of pellet firings. Both in the literature and in our manufacturer questioning hardly any values for sound emissions could be determined. The determination of the sound emissions does not belong to the typical testing program of the testing institutes. In the manufacturer questioning three pellet furnace and one boiler manufacturer gave specification to the sound emissions. The indicated sound emissions of pellet furnaces are between 37 and 42 dB(A), of the boiler (15 kW) at 40 dB(A). Here is to be considered that the emission values should not be related directly to immission values. Additionally, it was asked, by which measures the manufacturers lower theirs sound imissions. Four boiler manufacturers and one pellet furnace manufacturer indicated that they do not use any noise reduction measures, two further manufacturers gave no specification. The remaining manufacturers named a multiplicity of different measures, e.g.:

- De-coupled auger (3 times mentioned)
- system on rubber plates (3 times mentioned)
- low noise blower (3 times mentioned)
- blocking-time for suction system (2 times mentioned)
- system case (2 times mentioned)

The sound emissions are influenced not only by the device, but also by the concrete setting up conditions. The emissions on the test stand can therefore differ substantially from the practice values. This applies in particular to the exhaust sound. Since an ecolabel cannot take into consideration the concrete setting up conditions locally, we recommend, due to the deviation between test stand and practice, to dispense with noise emission at the definition of requirements for an ecolabel.

4.2.5 Operation, Service Life, and Maintenance

An optimal combustion and thus the efficiency of the system depend apart from technical adjustments crucially on the used pellets and the operation. The correct operation can be facilitated by automatic control. The performance and combustion regulation is completely automatic for all examined boilers. The power adjustment of pellet furnaces can take place completely automatically, if a room thermostat is available. Without a room thermostat the performance must be regulated manually. The combustion regulation of almost all devices is fully automatic.

The efficiency of the systems can be improved by the combination with a accumulator tank. Using a accumulator tank the system is exclusively operating with nominal load and achieves thereby improved efficiencies and emissions. Besides, it reduces the number of starting processes, which contribute by the ignition process substantially to the electrical consumption of the system. The energetic and also the economic efficiency depend apart from the effectiveness and the efficiency of the system strongly on its service life. This results in requirements to quality, durability and maintenance. The latter concerns also the following aspect of the construction appropriate for recycling (cf. paragraph

4.2.7), whereby repair and maintenance usually can be facilitated likewise. This contributes thus to the service life extension.

According to the manufacturers, 1 to 2 hours per year are needed for maintenance of the systems. This applies both to the boilers and to the pellet furnaces. The maintenance is conducted usually once a year.

The range of the services, offered by the manufacturers, is very differentiated. Some manufacturers offer a complete supply of services from consultation and planning, over installation up to maintenance and repair, others leave these services completely to the fitters. Of the 24 interviewed manufacturers 16 offer the maintenance, 15 offer a repair service, 12 install the firings themselves or are present during the installation, which only a fitter is allowed to do. Five manufacturers offer consultation and planning and three execute training courses for the fitters in contract.

The service life of the systems is indicated by the majority of the manufacturers as 15 to 20 years. A boiler manufacturer pointed out that by modular building method the exchange of components is facilitated and thus the service life is extended. The specification of the service life are estimated values, since no system has been on the market that long to actually achieve the values in practice. 19 years, as one manufacturer indicated, is the longest run time achieved so far. This probably concerns a demonstration unit. Four further manufacturers indicate values between eight and ten years. on the average the longest run time achieved so far is 6 years both for boilers and for pellet furnaces.

With the installation of a pellet system the exhaust system has to be coordinated with the chimney. The manufacturers indicated as a general request to the chimney of a wood pellet firing that it must be insensitive to humidity, it should have a diameter from 120 to 180 mm and it should be insulated. These request are usually fulfilled by modern chimneys. A modernisation may be necessary for older chimneys. However the responsible chimney sweeper sets the exact request of the chimney before its appliance. Therefore operators should first contact the manufacturer or fitter and the responsible chimney sweeper.

4.2.6 Ash Disposal

During combustion, the predominant mass of the wood is transformed into gaseous constituents. Only one small proportion, between 0.5 and 1%, are ash forming materials (Marutzky/Seeger 1999). The amount of ash depends both on the used wood and on the quality of the combustion.

A single family house comes up with about 20 kg of ash per year (BIZ 2002). Ash is a waste that has to be deposed off correctly. Ash from firing plants within the domestic area is mostly disposed over the domestic rubbish and partly used as fertiliser. In the firing plant, ash can cause problems by contamination of the components. For good combustion conditions, a regular ash-removal and cleaning is necessary.

18 of the examined wood pellet boilers have an automatic or a semiautomatic ash-removal system. From nine devices the ash has to be removed manually. For five devices no specification was made. One under 14 pellet furnaces is offered optionally with automatic ash-removal, from the others the ash must be removed manually.

22 of the 32 examined pellet boilers have an automatic heat exchanger cleaner, with two it is optional, with two further it is semi-automatic. The cleaning of the heat exchanger is manual in five boilers and in all pellet furnaces.

4.2.7 Appropriate Construction for Recycling, Hazardous Substances and Disposal

Particularly with the criteria of long service life and maintenance the recycability of systems and their individual components is an important factor for the environmental relevance. Substantial requests for a appropriate construction for recycling are a small variety in materials, separable connections, no laminated materials and labelling of materials. Wood pellet firings consist predominantly of metallic materials. Further materials, e.g. plastics, are among other things in the electronic components.

In the manufacturer questioning the measures for appropriate construction were raised. Two boiler and a pellet furnace manufacturer did not give specification, two boiler manufacturers indicated that recycling was no a relevant topic. The remaining manufacturers pay attention particularly to small material variety (11 times mentioned) and suitability for disassembly (6 times mentioned). Only one manufacturer named the labelling of materials. Guidelines for appropriate construction for recycling e.g. the VDI 2243 are however hardly explicitly included into the construction. The guideline is not specified on certain product groups and is in its general form rather an orientation, than an examinable regulation. The manufacturers have not made any experiences with the disposal of pellet systems yet, since the systems are on the market only a relatively short time

A majority of the manufacturers indicates that the disposal is the customer's responsibility. One boiler manufacturer takes back the used systems and uses components again, two manufacturers take back the devices when desired and dismantle them. Five manufacturers indicate that the fitter takes back the old plants. A part of the manufacturers indicates that it is a usual practice that the fitters take back old systems with new purchase.

Asked for occurring problems with the disposal likewise only one part of the manufacturers made specifications. 16 manufacturers do not see problems, five name electronics, one the coating of the metals and one regards fibre glass as a problem. The responses show that the majority of the manufacturers did not yet consider thoroughly the topic of disposal.

In order to guarantee a correct disposal, it could be considered to oblige the manufacturers to take back their devices. Since however in practice a majority of the systems is installed by local craftsman and the manufacturers have decentralised sales network, a decentralised take back would be more practical. This seems to be usual in practice already.

Because of the reasons outlined above and since pellet firings are long-life devices, which consist to the predominant part of metallic materials and with relatively small material varieties, the ecolabel does not necessarily have to consider appropriate construction for recycling.

4.3 National and International Regulations and Agreements

4.3.1 Testing and Standardisation

In Germany there are no specific test standards for pellet furnaces (so far); their test is performed according to standards for fire places for solid fuels. The European standard EN 303-5 applies to pellet boilers: „Boilers for solid fuels, manually and automatically fed firings, nominal load up to 300 kW – Terms, request, testing and labelling". This standard is published in Germany as DIN EN 303-5 „Boilers" since 1999. With respect to the DIN EN 303-5 three quality classes are differentiated which are defined by different requirements to efficiency factors and emission values (s. table 16). For classifica-

tion all requirements of a class must be fulfilled. The quality class is recorded in the test report and indicated on the boiler label.

Table 16: Request in Accordance with DIN EN 303-5 to Different Quality Classes for Boilers with Biogenous Fuels, Automatic Filling and a Nominal Load QN < 50 kW[25]

	Class 1	Class 2	Class 3
Boiler efficiency factor[26] [%]	47 + 6 log Q_N	57 + 6 log Q_N	67 + 6 log Q_N
Carbon monoxide[27] [mg/m³]	15,000	5,000	3,000
Hydrocarbons [mg/m³]	1,750	200	100
Dust[28] [mg/m³]	200	180	150

The values of class 2 for carbon monoxide and dust correspond to the values of the 1. BImschV for wood combustion plants with a nominal load of less than 50 kW. Due to the emission limit values of the 1. BimSchV, in Germany only the classes 2 and 3 of this table are authorised. The 1. BImSchV sets limit values of 150 mg/m³ for dust and up to a nominal load of 50 kW a limit value of 4,000 mg/m³ for carbon monoxide (with a reference oxygen content of 13%) for boilers, which are heated with untreated wood and have a nominal load of more than 15 kW.

The DIN EN 303-5 regulates the testing conditions as well as the determination and calculation of the emission values. The standard requires the margins of error for the efficiency to be + 3/-3 per cent points and for the emission values +5/-5 per cent of the emission limit value. The test fuel „compressed woods“ must fulfil the following request: the water content may amount to max. 12% and the ash content to max. 0.5%, the calorific value (water-free) must be at 18 MJ/kg (+ 5%/-5%). Apart from the demands on heating technique (e.g. minimum efficiency rates, combustion duration, supply pressure, exhaust gas emissions) the DIN EN 303-5 also contains demands on safety engineering.

The testing of pellet furnaces takes place following DIN 18891 „Furnace for solid fuels“. An adjustment of the test conditions on pellet systems is compiled at present and will presumably pass next year (design DIN 18894: Fire places for solid fuels – pellet furnaces – request, check and indication). apart from test conditions, it will also contain demands on efficiencies and CO emissions as well as the safety engineering.

The at present still valid DIN 18891 requires an efficiency of at least 70% or 60% with a glass window larger than 0.2 m². There are no standards concerning the emission values. In a modification draft (DIN 18891/A2) an uniform efficiency of at least 70% as well as a max. carbon monoxide emission are required of 0.4 Vol% for wood combustion.

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25 With a reference oxygen content of 10 Vol%

26 At nominal load, the efficiency rates must not be below this value.

27 These emission values may not be exceeded both at nominal and at minimal load.

28 These emission values may not be exceeded at nominal load.

Apart from the national standardisation, the European standardisation wins increasingly in meaning. At present, different European standardisation procedures for single room fire places are running, e.g. for conventional furnaces for log wood or coal (prEN 13240) and open fire-places (prEN 13229) (Astfalk 1999a). They contain some environmental request, however only for minimum efficiency factors and limit values for CO emissions. Demands for dust, nitrogen oxide and hydrocarbon emissions are not intended. For pellet furnaces a European standard is planned.

To place pellet firings into circulation requires the fulfilment of the general protection targets of the EEC-directive on construction-products (among other things fire protection, hygiene, health, environmental protection, safety/function use, mechanical firmness and stability). Pellet firings have to be CE labelled regarding the EEC-directives low voltages (73/23/EWG), electromagnetic compatibility (EMC) (89/336/EWG), machines (89/392/EWG) and construction-products (89/106/EWG) which have to be considered with the firings or their components (Astfalk 1999a).

4.3.2 Quality Marks for Wood Combustion Plants

In Germany both the DIN CERTO and Zentralverband Sanitär-Heizung-Klima (ZVSHK) assign the DIN plus label as a certification sign for low-pollution combustions of wood. It includes demands on the emissions (CO and dust) and on the customer service and product information. These certificate does not yet apply to pellet firings. The standardisation committee Heiz-, Koch- und Wärmgerät is preparing a DIN standard for wood pellet furnaces.

The Bavarian Institute for Agricultural Engineering (Bayrische Landesanstalt für Landtechnik) is developing in co-operation with the TÜV Bavaria a quality sign for wood boilers. This applies both to pellet boilers and to wood chips and log wood boilers. It includes automatic and manually fed systems. Details on the request are not yet known.

The Pellet Federation of Austria assigns a quality mark to manufacturers of pellet firings which fulfil the following request: Experience for many years with wood heatings, emissions below defined maximum values, own development and manufacturing, at least 80% of the value added in Austria and service within 24 h during the heating season. Five Austrian manufacturers are allowed to use the quality mark of the Pellet Federation Austria.

In the USA a standard exists for „Standard Specification for Room Heaters, Pellet Fuel Burning Type“ (ASTM E 1509, of 1995) for automatically fed pellet furnaces for the use of wood pellets or other suitable solid fuels. It contains performance requirements, testing methods and indication requests (ASTM 2002).

Also in Sweden, there is a quality sign for wood pellet firings, the „P-Märke“. This is assigned by the Swedish Testing and Research Institute (Sveriges Provnings och Forskningsinstitut, SP). The criteria are effectiveness, security and reliability. The certification guideline for pellet burners and pellet boiler (Certifieringsregler P-maerkning av Pelletsbraennere och Pelletspannor, SPCR 028) is for pellet burners with a nominal load of up to 25 kW and pellet boilers (with it burners and boilers are to be seen as units) with up to 100 kW (SP 1999). Likewise there is a certification guideline for pellet furnaces (Certifieringsregler P-maerkning av Pelletskaminer SPCR 093) (SP 1998). The fuel transport systems for the automatic filling are part of certifying.

4.3.3 Summary of Different Standards and Quality Marks

Table 17 summarises the requests of valid standards and quality signs in Germany, which are relevant for pellet firings.

Table 17: Requirements for Pellet Firings within Valid Standards and Quality Marks in Germany

Requirements	DIN EN 303-5[29]	DIN 18891/A2[30]	DIN CERTCO[30]
Scope	boiler for solid fuels	furnace for solid fuels	furnace for solid fuels
Efficiency factor[%]	67 + 6 log Q_N	70	75
CO-emissions [mg/m³]	3,000	0.4 Vol%	1.500
C_{total}-emissions [mg/m³]	100	no requirements	120
Dust-emissions [mg/m³]	150	no requirements	75
NO_X-emissions [mg/m³]	no requirements	no requirements	200
Other requirements	technical safety requirements	technical safety requirements	installation service, information

So far, neither special standards nor quality marks for pellet firings were developed. Since the scope of the standards and quality marks extends generally to boilers or furnaces with solid fuels, the environmental requirements do not offer incentives for improvements for wood pellet firings. Additionally, all standards do not consider environmental aspects in comprehensive manner. Thus, an ecolabel for wood pellet firings can close on the one hand gaps in the past requirements and bundle environmental referred requirements, on the other hand it offers the possibility of making stricter demands because of the narrower scope.

4.3.4 Ecolabels of Other Countries

In Austria an ecolabel for wood boilers already exists. This applies to different wood fuels (log wood, wood chips, wood pellets), for manually fed systems up to a nominal load of 49 kW, for automatically fed systems up to 70 kW. It contains requirements on efficient energy utilisation, on pollutant emissions as well as on raw materials and packing materials, services of the manufacturer (Verein für Konsumenteninformation 2001). One manufacturer (Compact) is allowed to use the ecolabel on a wood pellet boiler in three performance classes.

The rational energy use is checked on the basis of the boiler efficiency (see table) and the electrical consumption, which must not exceed 1.5% of the nominal load for automatically fed firings.

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[29] With a reference oxygen content of 10% O_2.

[30] With a reference oxygen content of 13% O_2.

Table 18: Minimum Values for the Boiler Efficiency for Automatically Fed Wood Boilers according to the Guideline of the Austrian Ecolabel (UZ 37)

	Nominal load Q_N < 10 kW	Nominal load Q_N > 10 kW
Boiler efficiency	79%	71.3 + 7.7 log Q_N

Source: Verein für Konsumenteninformation 2001

The ecolabel contains emission values for carbon monoxide, hydrocarbons, nitrogen oxides, and dust (see table 19). The testing for the ecolabel must meet the request of the EN 303-5.

Table 19: Maximum Values for Emissions for Automatically Fed Wood Boilers according to the Guideline of the Austrian Ecolabel (UZ 37)

	CO		C_{total}[31]		NO_x[32]		dust	
	mg/MJ	mg/m³	mg/MJ	mg/m³	mg/MJ	mg/m³	mg/MJ	mg/m³
Nominal load	250	379	30	45	150	227	50	76
Minimal load (< 30 % of nominal load)	500	758	30	45	-	-	-	-

Source: Verein für Konsumenteninformation 2001

A Nordic ecolabel for automatically fed wood boilers and manually fed wood boilers with accumulator tank up to an output of 300 kW which are suitable as dominating heating source exist since December 2001. So far, two Danish boiler manufacturers (CN Maskinfabrik A/S and LIN-KA Maskinfabrik A/S) are allowed to use the label. The specification of the Nordic ecolabel includes requirements on efficiency, emissions (CO, dust, hydrocarbons), material requirements, packaging, installation manual, information and operating instruction (Nordic Ecolabelling 2001). The requirements for automatically fed firings to the efficiency and the emission values are shown in table 20.

Table 20: Requirements at Nominal Load of the Nordic Ecolabel (Emissions Related to 10 vol% O_2)

	Efficiency factor [%]	C_{total} [mg/m³]	CO [mg/m³]	Dust [mg/m³]
Automatically fed firing up to 100 kW	69+6 log Q_N	70	1000	70

Source: Nordic Ecolabelling 2001

The ecolabels in Austria and the Nordic countries apply not particularly to pellet firings, but generally to wood firings. Therefore, they include less strict requirements compared to the planned German ecolabel.

[31] Sum of hydrocarbon emissions, cited as elementary carbon

[32] Sum of emissions of NO und NO_2, cited as NO_2

4.3.5 Standards and Quality Marks for Wood Pellets

Also for wood pellets there are different standards and quality marks. There the quality mark of the Pellet Federation Austria (PVA) includes the strictest demands. The German Pellet Federation (PVD) is at present trying to develop its own quality label following the criteria of the PVA. For wood pellets, both in Austria (ÖNORM M 7135 „Requests on compressed woods from untreated wood and untreated crust, pellets and briquettes“) and in Germany (DIN 51731 „Requests on compressed woods from untreated wood“) standards are on hand.[33] The ÖNORM M 7135 contains thereby partly stricter quality requirements to the pellets than the DIN 51731, e.g. content of nitrogen or chlorine. The RAL quality community “Used Wood” develops another sign for pellets. This has however clearly lower request to the pellets and is suitable rather for pellets in the industrial application than in small pellet firings.

In Austria an ecolabel for fuels (wood pellets, wood briquettes) from biomass (UZ 38) exists. The appropriate guideline requires untreated products from the wood processing and wood working as raw material. The compressed woods must be manufactured without bonding agents. For the content of sulphur, nitrogen, chlorine, chrome, copper and extractable organically bound halogens maximum values are given. These bundle the request of the ÖNORM M 7135 (for sulphur, nitrogen, chlorine and halogens) and the DIN 51731 (heavy metals). Further aspects of the guideline concern the packaging, the dimension of the pellets and fuel-technical request as well as request on storage and feed logistics. The wood pellets of two Austrian producers are allowed to use the ecolabel (Öko-Wärme Schörkhuber & Hörmann, St. Nikola: „POWER PELLETS“ and Umdasch AG: Holzbrikks and Pellis).

4.3.6 Support Programmes

Support programs contain partly likewise ecological request on wood pellet firings. Their consideration is therefore interesting with the development of criteria. The federal programme for market development for the use of renewable energies supports only central heating systems which do not operate on natural draught conditions and which do not exceed the following emission limit values : Carbon monoxide: 250 mg/m³ with nominal load and 500 mg/m³ in the partial load operation (during smallest thermal output), dust: 50 mg/m³. The boiler efficiency must amount to at least 85%, the minimum subsidy of 1,500 € is only granted to firings with a boiler efficiency of at least 90%.

4.4 System Comparison between Wood Pellet Firings and other Heating Systems

With a system comparison between wood pellet firings and other heating systems it is to be determined whether the use of wood pellet firings is ecologically meaningful for heating and warm-water supply in the small capacity range (< 50 kW). As reference values the data of the heating system stock is consulted. A comparison is made between boilers with the fuels oil, gas, log wood, wood chips and wood pellets. Apart from this comparison with current average systems, in paragraph 4.4.4 wood pellet boilers are compared to modern boilers.

For pellet furnaces no system comparison can be executed, since no function equivalents with other fuels exist. Therefore, in paragraph 4.4.5 their emission data and efficiency are confronted with the values of log wood furnaces and coal furnaces.

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[33] The request of the two standards is dealt with in paragraph 2.

The different heating systems are compared regarding the use of non-renewable primary energy and their emissions of carbon dioxide, carbon monoxide, nitrogen oxide, dust and hydrocarbons. In the following, first the assumptions of the system comparison are described, afterwards the results are represented and a conclusion from the comparison is given.

4.4.1 Assumptions for the System Comparison

The system comparison takes place by the example of a fictitious supplied single family house with a surface of 140 m². As heating system the average values of the examined wood pellet boilers with nominal load of 15 kW are compared to the references systems: manually fed wood boiler (log wood) automatically fed wood boiler (wood chips), gas boilers and oil-fired boilers. With that the following assumptions are made for the fictitious single family house:

Table 21: Parameters of the Fictitious Object of Supply (Single Family House)

Housing surface (m^2)	140
Persons/one family house	4
Specific annual demand for heating (kWh/m²a)[34]	100
Annual demand for heating of the whole surface (kWh/a)	14,000
Demand for warm water (kWh/a)[35]	1,750
Annual demand for warm water (kWh/a)	15,750

Source: IÖW 2002

In the following table the average values of the emissions and efficiencies of the pellet boilers from the questioning are represented. Additionally, the emission factors and efficiency rates of the compared systems are shown. In order to make the emission values of the wood pellet boiler comparable with the yearly emission factors, i.e. the average over all operating conditions, it is assumed that half of the annual heat requirement is generated in nominal load and half in minimal load conditions.

[34] This value corresponds to the maximum limit permitted by the German statuary regulation on heat insulation enacted in 1995 and can be interpreted as a representative value for the actual stock of family houses.

[35] The annual demand for warm water was calculated according to the value of 12,5 kWh/m²·a (Regulation on Energy Saving).

Table 22: Parameters of the Compared Heaters (Heater Stock)

	Pellet boiler[36]		Wood chips[37]	Log wood[38]	Oil[39]	Natural gas[39]
	Nominal load	*Minimal load*				
Efficiency factor	90%	89%	83%	80%	84%	84%
CO [mg/MJ]	44	127	934	3,228	25	14
Dust [mg/MJ]	13	28	28	51	2	0,03
NO_x [mg/MJ]	75	71	85	77	46	38
C_{total} [mg/MJ]	2	2	53	191	3	2

Source: own combination

The electrical consumption of the boilers causes an additional use of non-renewable primary energy and contributes to the CO_2-output. Nevertheless, it is not considered within the system comparison, since for this no comparable data of the different boilers exist. For the pellet boilers electrical consumption could only be raised with nominal load within the questioning of the manufacturers[40], whereas with the oil and gas heatings annual average values are known, and no values are available for the wood heatings. Here it can be assumed that the electrical consumption of oil and gas heating systems within the heating stock is at least as high as that of the pellet systems. Wood chips firings are supposed to have a similar electric consumption and log wood firings might have a smaller electricity consumption.

4.4.2 Results

4.4.2.1 Use of Primary Energy

The cumulated use of primary energy (Kumulierter Energieaufwand - KEA) is a measure for the energy efficiency of processes. The KEA of non-renewable primary energy supplies a picture of consumption of fossil fuels. The cumulated use of non-renewable primary energy was calculated for the fuel supply (production and transport) by means of the data from the GEMIS 4.0 data base. With the fuel requirement the efficiencies of the heaters were considered. The transport of wood pellets, wood chips, log wood and oil is considered with one delivery per year and a middle transportation distance of 50 km. The emissions and the energy expenditure of the trucks were taken over from the GEMIS

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36 The values are average values of the examined pellet firings nominal and minimal load.

37 The emission values are average values of test stand measurements with wood chip firings (1980 to 1998). CO und total Carbon were measured with nominal, partial, and minimal load, NO_x and dust with nominal load (Jungmeier et al. 1999). The value for dust is an average value from Jungmeier et al. (1999) and the emission value of modern wood chips firings (Pfeiffer et al. 2000).

38 The values are averaged values from average emission factors of wood boilers (4-25 kW) within the stock of heaters (Pfeiffer et al. 2000) and average values from test stand measurements of log wood boilers (1980 to 1998). CO und total Carbon were measured with nominal, partial, and minimal load, NO_x and dust with nominal load (Jungmeier et al. 1999).

39 The values are average values of emission factors of gas- and oil-boilers from the stock of heaters (emissions: Pfeiffer et al. 2000, efficiency factor: Specification from Environmental protection agency).

40 The average electrical consumption of the examined pellet firings amounts to less than one per cent of the produced thermal performance, which would mean auxiliary electricity requirements of approximately 150 kWh/a for the regarded example and thus a use of primary energy of approximately 450 kWh/a.

4.0 data base for an average truck. The results of the calculations of the use of non-renewable primary energy are represented in table 23.

Table 23: Cumulated Use of Non-renewable Primary Energy for the Fuel Supply

	Wood pellets	Wood chips	Log wood	Oil	Natural gas
KEA non-renewable [MJ/a]	5,342	3,511	382	9,455	8,265

Source: own combination. Data source: GEMIS 4.0

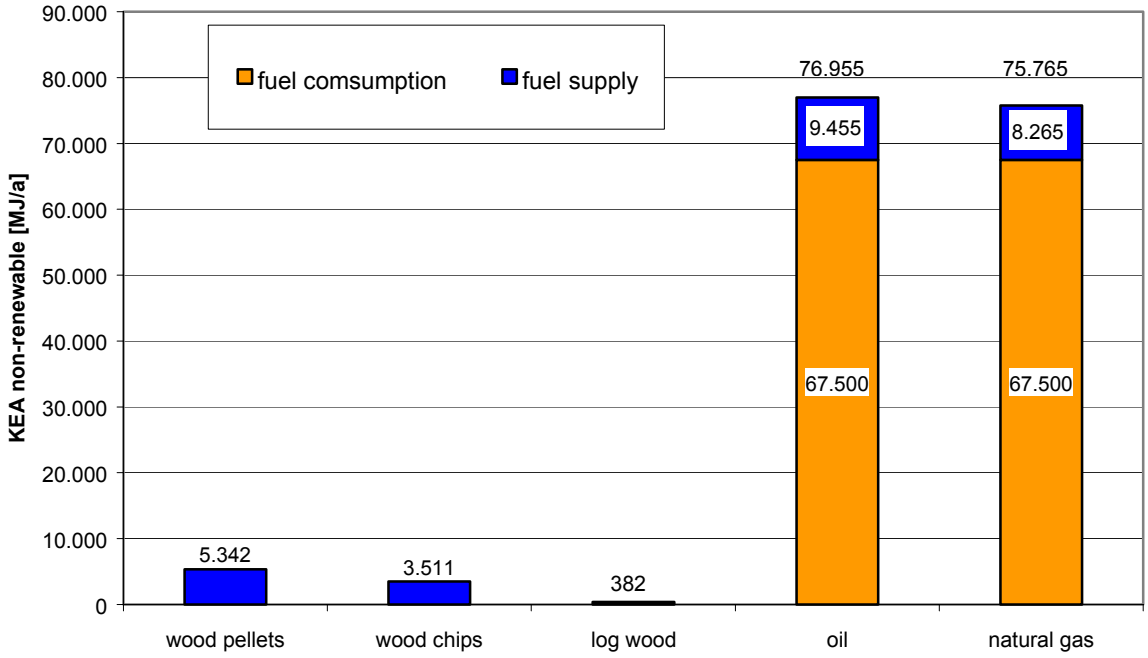
Already the supply of the fossil fuels (natural gas and fuel oil) requires the highest use of non-renewable primary energy according to table 23. The higher energy consumption for the supply of the wood pellets, compared with log wood and wood chips, results from the electricity necessary for pellet production, which according to specification of Kaltschmitt and Neubarth (2000) amounts to 90 kWh/t wood pellets. This corresponds to a proportion of fewer than 2% of the energy content of the pellets. Other sources go by an energy expenditure of pellet production of 3% of the energy content(Krapf 1999). The data base GEMIS 4.0 calculates a cumulated use of non-renewable primary energy of 79 TJ per 1000 TJ energy content of the pellets, thus 7.9% of the energy content. Here the necessary energy is considered for production by wood chips and to their further processing to wood pellets. Since wood pellets are made usually however directly of the residual substance of saw dust, the first processing step can be neglected. Thus with GEMIS 4.0 data a cumulated use of non-renewable primary energy at a value of 3.4% of the energy content results.

For log wood the energy expenditure only results from the transport, since in the GEMIS data it is assumed that it concerns forest remainder wood, for which no (industrial) editing takes place.[41]

If additionally the energy content of the fuels is considered, the use of non-renewable primary energy of the oil and gas heatings rises (see figure 22). This is essentially because of the fact that with the fossil fuels natural gas and fuel oil and the energy contained in the fuel flow into the cumulated use of primary energy. For a complete comparison the energy expenditure for the auxiliary electricity would have to be considered, which is not possible due to the missing data. The inclusion of the auxiliary electricity with all systems would contribute to an almost equal rise of the primary energy use (except for the log wood heating systems). Thus, the relation of the different heating systems does not change.

[41] The work of the user chopping the wood is not considered.

Figure 22: Cumulated Use of Non-Renewable Primary Energy



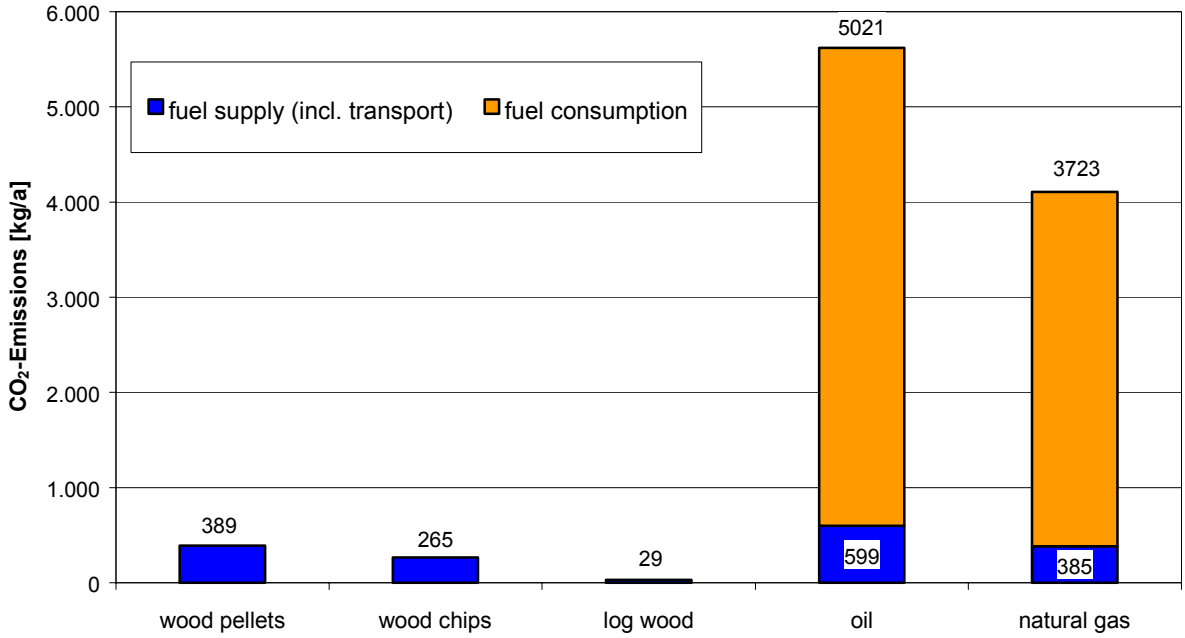
Source: IÖW 2002

4.4.2.2 Carbon Dioxide Emissions

Carbon dioxide emissions are considered as one of the central triggers of the anthropogenicly caused greenhouse effect. A substantial source for carbon dioxide emissions is the consumption of fossil fuels. The increase of the proportion of renewable energies is regarded as a measure for the decrease of the CO_2-emissions. With the combustion of biomass CO_2 is set free, the emitted quantity corresponds however to that, which was bound beforehand in the form of carbon. The energetic use of biomass can therefore be regarded as rather neutral to climate change.

The carbon dioxide emissions was regarded for the fuel supply (inclusive fuel feed) and the direct emissions of the heaters (fuel consumption). These emissions are summed, whereby the carbon dioxide emissions of the regenerative wood do not find consideration. The carbon dioxide emissions with climate impact are for all three wood heating systems clearly below those of the heaters with fossil fuels (see figure 23). Similar to the energy use the pellet heating is somewhat more unfavourably compared with the other wood heatings because of the additional processing step. The annually needed quantity of fuel is however smaller with the pellet firings due to the higher efficiency and the high heat value of the wood pellets compared with log wood and wood chips; therefore, the CO_2-emissions are smaller in the case of transportation.

Figure 23: Carbon Dioxide Emissions with Climate Impact

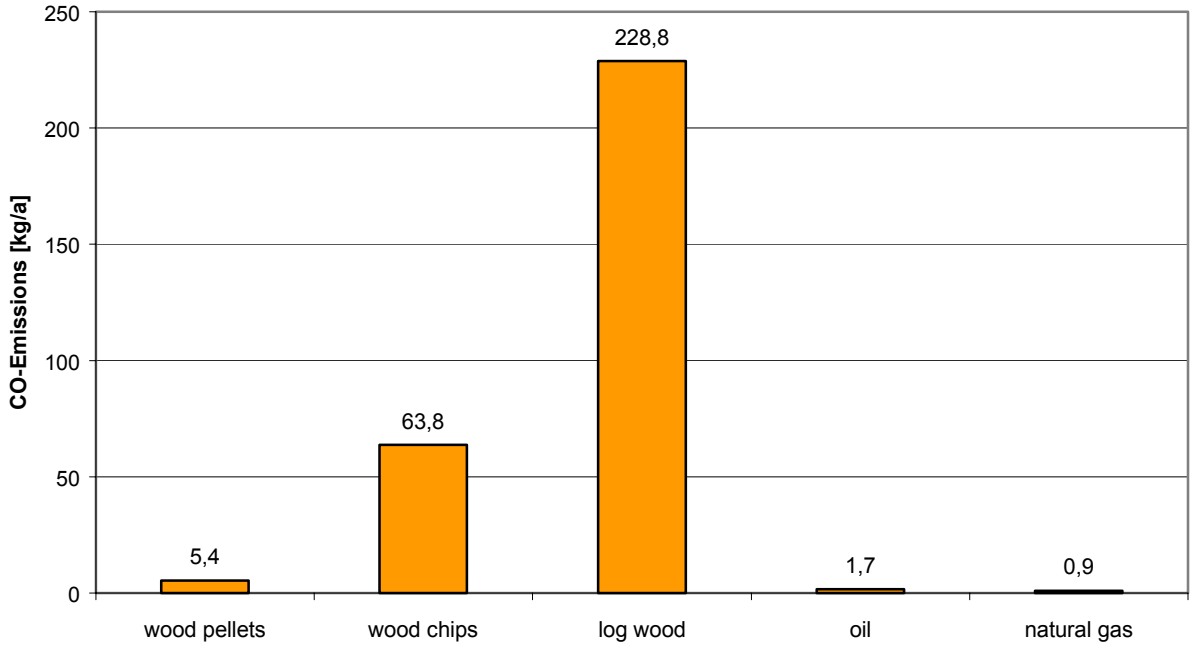


Source: IÖW 2002

4.4.2.3 Carbon Monoxide Emissions

In figure 24 the annual carbon monoxide emissions of the different heating systems are represented. The emissions of the wood heatings are situated over those of the natural gas and oil heatings, whereby the log wood heating systems is clearly the worst. The wood pellet boiler has the lowest emission values among the wood heatings and achieves almost the level of oil and gas-fuelled heaters.

Figure 24: Carbon monoxide emissions

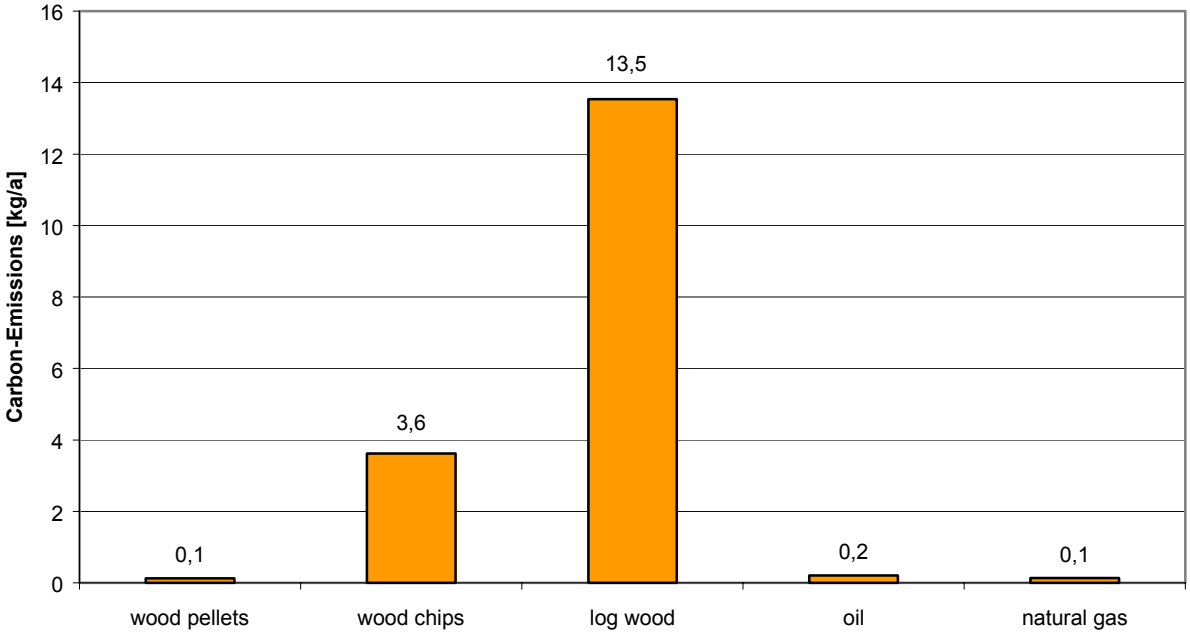


Source: IÖW 2002

4.4.2.4 Hydrocarbons

The heating system with the pellet boiler achieves with the lowest hydrocarbon emission. The oil and gas heatings have almost similar annual emissions. The other wood heatings, in particular the log wood heating system, emits a multiplicity of hydrocarbons. With newer heaters the emission values of log wood and wood chips heating systems sank likewise clearly (cf. table 29).

Figure 25: Emissions of Hydrocarbons

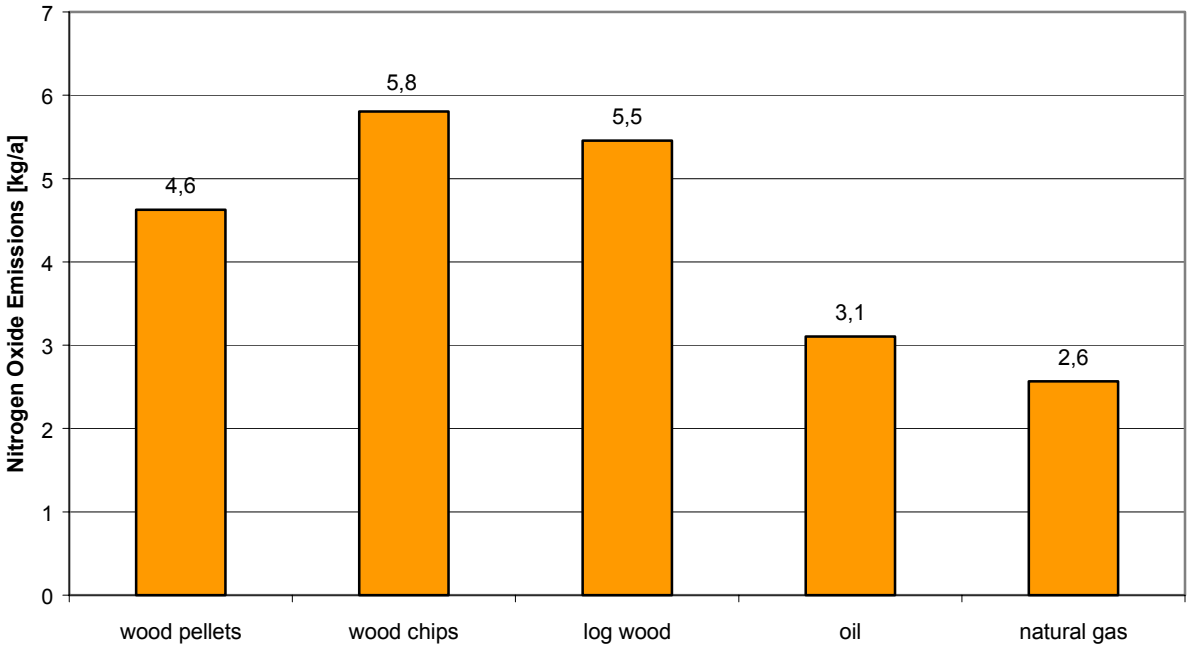


Source: IÖW 2002

4.4.2.5 Nitrogen Oxide Emissions

The annual emissions of the wood heatings are higher with the nitrogen oxides than those of the natural gas and oil heatings (see figure 26). In addition to thermal nitrogen oxides, during the combustion especially fuel bound nitrogen is emitted as NO_X. Wood has thereby a higher nitrogen content than oil and gas. The wood pellet heating has slightly lower emissions compared to the other wood firings. Apart from the advantages of a standardised fuel (wood pellets according to DIN 51731) this can also be explained with the combustion regulation. The high emission values of the wood chips heating system are remarkable. Here it is to be noted that for this system only nominal load values could be considered and the NO_x emissions are usually higher with nominal load than with partial load.

Figure 26: Nitrogen Oxide Emissions

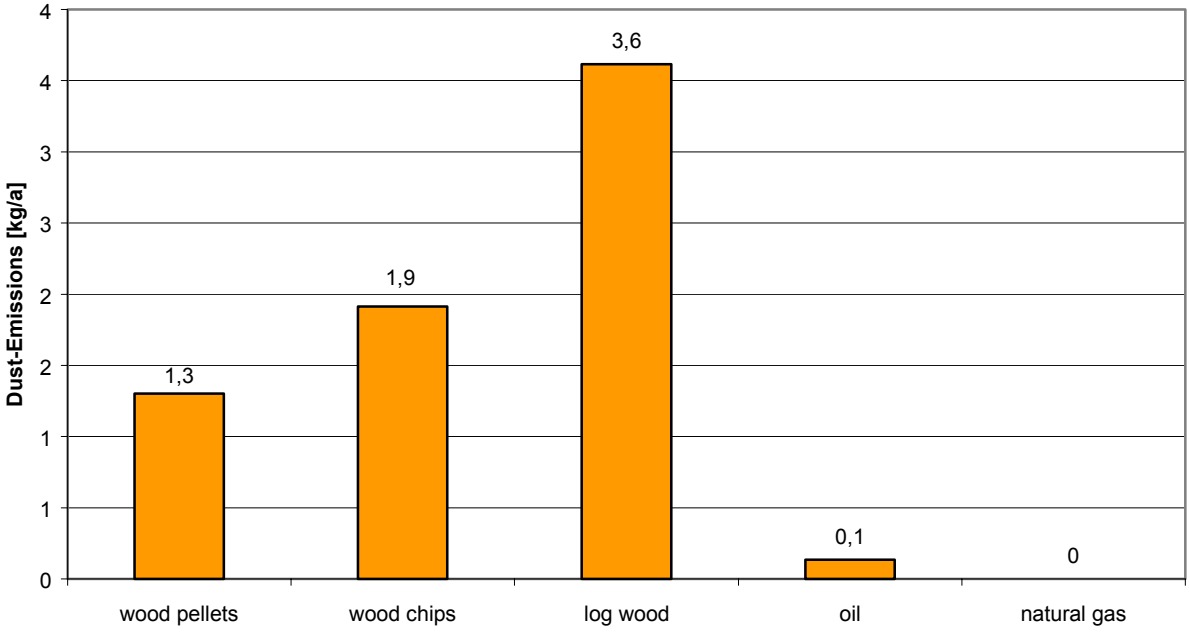


Source: IÖW 2002

4.4.2.6 Dust Emissions

The annual dust emissions of the wood heatings are significantly higher than the emissions of the oil and natural gas heaters (see the following figure). In comparison to the other wood heatings the pellet heating causes significantly lower dust emissions.

Figure 27: Dust Emissions



Source: IÖW 2002

4.4.3 Results of the System Comparison

The following table combines the results of the system comparison. The grey cells indicate in each case those heating systems, which are best.

Table 24: Results of the System Comparison for the Regarded Single Family House

	Pellet boiler	Wood chips	Log wood	Oil	Natural gas
Fuel consumption EFH [MJ/a]	63.354	68.313	70.875	67.500	67.500
KEA nonrenewable [MJ/a]	5.342	3.511	382	76.955	75.765
CO_2 [kg/a]	389	265	29	5.620	4.108
CO [g/a]	5.431	63.805	228.785	1.688	945
Dust [g/a]	1.301	1.913	3.615	135	0
NO_x [g/a]	4.624	5.807	5.457	3.105	2.565
Cges [g/a]	127	3.621	13.537	203	135

Source: IÖW 2002

The system comparison clarifies that wood heatings have some important ecological advantages in relation to heaters with fossil fuels. These advantages show up particularly clearly with the comparison of the cumulated use of non-renewable primary energy and the CO_2-emissions with climate impact. All examined wood heatings obtain substantial savings at non-renewable resources and lead to a clear decrease of the output at CO_2, which contributes considerably to the anthropogenicly caused greenhouse effect.

However, regarding the pollutant emissions Wood heatings show clear disadvantages in comparison to fuel oil or natural gas boilers. This disadvantage is particularly important with handfed log wood firings. Pollutants such as dust, hydrocarbons and nitrogen oxides contribute to different environmental impacts such as summer smog, acidification and nutrification of soil and water (NO_x) as well as increased mortality (PM_{10}). Beyond that, wood combustion plants show in relation to oil or gas firing systems a higher pollutant formation potential for carcinogenic and highly toxic substances e.g. polycyclic aromatic hydrocarbons (among other things Benzo(a)pyren), benzene and dioxins. This happens in particular with incomplete combustion processes and outdated, simple fuel engineering. With pellet firings is to be assumed that no increased emissions of these substances occur due to the high combustion quality and the constant high fuel quality. They show by far the lowest emissions from all regarded wood heatings. With the pollutants carbon monoxide and hydrocarbons the wood pellet heaters achieve almost the emission level of the stock of gas and oil heatings, while the wood chips and log wood heating systems cause significantly higher emissions. Due to their high efficiencies, pellet boilers can operate extremely energy-efficiently. The system comparison showed that pellet firings have some significant advantages in comparison to other wood firings.

4.4.4 Comparison of Pellet Boilers to Modern Heaters

Apart from the system comparison with the stock of heaters the emissions and efficiency factors of pellet boilers are compared to those of other modern wood heatings and with special gas-boilers and oil-burner-boiler with ecolabels (see table 25).

Table 25: Comparison of the Examined Pellet Boilers to Other Modern Boilers

fuel	Oil[42]	Natural gas[43]	Wood pellets[44]	Wood chips[45]	Log wood[46]
Efficiency factor	95%[47]	93%[47]	90%	87-89%	80-87%
CO [mg/m³]	6	5	69	121-203	239-561
Dust [mg/m³]	3	0	20	32-48	29-35
NO_x [mg/m³]	43	21	117	129-138	124-162
C_{ges} [mg/m³]	2	2-3	2	2-6	9-27

Source: own combination

The emission values of the examined pellet boilers are clearly higher than those of the gas and oil heatings, the efficiency factor is lower than the nominal utilisation ratio of the fossil heaters. To the comparison with modern wood heatings, the range of the average values from several sources is represented. It usually concerns test stand data. In appendix 4, the literature data are specified in detail. Compared with log wood and wood chips heating systems the pellet heaters still show better results. The advantages of the wood pellet boiler with the CO -, total carbon and dust emissions are still clear, but no longer as largely as with the comparison with the stock of wood heaters (see table 22).

4.4.5 Comparison of the Pellet Furnaces to Other Small Firings

The pellet furnaces were compared to log wood furnaces and coal furnaces. The emission values of the heater stock was consulted, as well as the requirements of a certified log wood furnaces according to DIN plus and the emission data of coal furnaces from an Austrian study.

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42 Average values of oil-burner-boiler with ecolabel RAL-UZ 46

43 Average values of special gas boiler with ecolabel RAL-UZ 39

44 These values are average values of the examined pellet boilers at nominal load.

45 Values from Jungmeier et al 1999, Hartmann et al. 1997, Pfeiffer et al. 2000 and Hartmann et al. 2001

46 Values from Jungmeier et al 1999, Hartmann et al. 1997, Launhardt et al. 1998, Pfeiffer et al. 2000 and Hartmann et al. 2001

47 Nominal utilisation ratio

Table 26: Characteristic Values of Pellet Furnaces, Log Wood Furnaces and Coal Furnaces

	Pellet furnace[48]	Log wood furnace		Coal furnace	
		Present firing stock [49]	Requirements according to DIN plus[50]	Furnace[51]	Present stock of tile stoves[52]
Efficiency factor	90%	-	75%	77%	-
CO [mg/m³]	114	5,077	1,500	5,449	4,982
Dust [mg/m³]	17	126	75	225	409
NO_x [mg/m³]	55	59	200	194	75
C_{total} [mg/m³]	7	548	120	501	85[53]

Source: own combination

The conventional wood or coal fired single room fire places within the stock of heaters show the highest specific emissions of all regarded heating systems with distance. Even modern furnaces, which can achieve the emission values of DIN plus, still cause clearly higher emissions, which are obtained by modern wood boilers. The emission values of the pellet furnaces are significantly below the requirements of DIN plus. These requirements are clearly exceeded by the average values of the stock of the log wood furnace with exception of NO_x. Besides, the efficiency factors of the wood pellet furnaces are by far above the requests. Due to their very low emissions and higher energy efficiency, pellet furnaces come off as best compared to the stock of log wood furnaces and coal tile stoves.

5 Participation of the Interest Groups

According to the principles laid down by ISO 14024, the development of an ecolabel involves the participation of those people and organised groups which are concerned and interested. In order to increase the transparency of the project, these people should become involved from an early stage onwards. This implies presentation of the selected product categories and of the developed criteria. Representatives from the interested groups are to have the opportunity to get informed about the process and bring in their opinion.

In the context of the project, the participation of the interested groups was carried out by interviews with manufacturers. Additionally, an expert discussion was conducted in co-operation with the Environmental Protection Agency where the results of the analysis of ecological relevance and a draft of the developed criteria were presented and discussed. In the discussion, representatives of manufacturers, testing institutes, and organisations participated, as well as the Environmental Protection

48 The values are average values of the examined pellet furnaces at nominal load.

49 The emission values are average values of the stock of log wood furnaces (Pfeiffer et al. 2000).

50 The values are the limit values of the certification criteria of DIN plus for furnaces with solid fuels with low emission combustion (DIN Plus 2000).

51 Source: Spitzer et al. 1998

52 Source: Pfeiffer et al. 2000

53 as volatile organic carbon (VOC)

Agency[54]. Here the participants had the opportunity to discuss results of the feasibility study and take position to the draft of criteria. As the active participation during the expert talk and further statements in the aftermath of the discussion round showed, the project was met with vivid interest.

In the following, the results of the discussion to the draft criteria are shown:

- **Ecolabel and Scope**

The manufacturers and organisations support the introduction of an ecolabel for wood pellet firings. The majority of the manufacturers endorses the exclusion of combination systems, systems with manual regulation and pellet burners.

A majority of the participants of the discussion supports the development of different criteria for boilers and pellet furnaces.

Since wood pellets according to ÖNORM M 7135 have an at least equivalent quality compared to DIN 51731, the manufacturers proposed that in the context of the ecolabel wood pellet according to ÖNORM M 7135 should be considered as equal DIN 51731.

- **Efficiency Factors**

The manufacturers regard the definition of minimum values for the efficiency factors with minimal and nominal load as meaningful. The definition of the pellet boilers partial load should be in accordance with DIN EN 303-5.

- **Auxiliary Electrical Consumption**

For the determination of the electrical consumption, the participants suggest a measurement with three operating conditions (ignition, continuous operation and stand-by without heat production). The circulation pump and mechanisms to the fuel transportation from the underground storage should be excluded. For the ecolabel, test criteria are to be developed for the measurement of the auxiliary electrical consumption.

- **Emissions**

The suggested requirements for nitrogen oxide and carbon monoxide emissions meet the agreement of the manufacturers and organisations. Concerning the dust emissions, the manufacturers suggest to take first only the nominal load value into consideration, since, so far, some testing institutes determine no values at partial load. The suggested requirements for the emissions of hydrocarbons are considered as too strict, since the suggested values con hardly be measured due to the measuring accuracy. As maximum value for the total carbon emission of the boilers 5 mg/m³ for minimal and nominal load are suggested, since smaller values are hardly above the detection limit.

- **Service and Operating Instructions**

The manufacturers suggest to integrate the possibility of passing the service obligation to service partners. Since the manufacturers export their firings to foreign countries, they criticize the requirement to indicate in the operating instructions that only wood pellets according to DIN 51731 may be used in the wood pellet firings. Therefore, the formulation is modified in such a way that also fuels of at least equivalent quality may be used.

[54] A list of the participants is included in the appendix.

➢ **Standards and Guideline Conformity**

Since the DIN 18894 might not be passed before the passing of the ecolabel criteria, the manufacturers suggest for the time being referring the criteria for pellet furnaces to the draft of the DIN 18894.

6 Suggestion of Criteria for Ecolabels for Wood Pellet Boilers and Furnaces

Wood pellet firings are a climate friendly form of energy conversion, since heat is produced with a renewable energy source. Thereby, they make an important contribution for the reduction of the fossil primary energy use and the reduction of carbon dioxide emissions.

The introduction of an ecolabel for wood pellet firings is recommended on the basis of the results of this study.

Wood pellet firings show a clearly smaller climate relevant CO_2-output compared to fossil-fuelled heating systems and help to reduce the consumption of fossil resources. Thus, they contribute to two substantial objectives of environmental politicy: the decrease of carbon dioxide emissions and the associated anthropogenic greenhouse effect, as well as the increase of the share of renewable energies.

Pellet firings cause higher dust, carbon monoxide and nitrogen oxide emissions (with pellet furnaces also higher emissions of organic carbon) than oil and gas firing systems. However, compared to conventional wood combustion plants (log wood and wood chips) they have lower pollutant emissions. In comparison to other wood heating systems wood pellet firings are more efficient. In addition, the use of wood pellets with continuously high fuel quality and with a high degree of automation of the system enables operation with low emission levels. The risk of errors caused by inappropriate operation is minimised by the high degree of automation.

The criteria for ecolabels for wood pellet firings are suggested in analogy to those developed for other boilers. The requirements for oil and gas-operating heating systems (RAL UZ 9, 39, 40, 41, 46, 61, 71, 80)[55] include the following criteria:

- evidence of the guideline conformity and authorisation for having a CE label
- nominal utilisation ratio or efficiency factor (RAL UZ 71)
- emissions of CO and NO_x and for oil-operated devices (RAL UZ 9 and 46) additionally soot, hydrocarbons (C_xH_y) and CO_2-concentration in the exhaust gas
- adjusting and operating instruction and
- electrical consumption and water-side flow resistance (cf. RAL 2000.)

Due to the advantages of pellet firings presented above the criteria put special emphasis on energy efficiency and the emissions of the systems. Thus, we suggest that ecolabels for wood pellet firings are granted with the argument „**low emission and energy efficient**“.

[55] RAL UZ 9: Low-Emission Atomising Oil Burners, RAL UZ 39: Special Gas Boiler, RAL UZ 40: Combination Boilers and Circulating Water Boilers for the Use of Gaseous Fuels, RAL UZ 41: Combined Burner- and Boiler Units Equipped with Gas Burner and Fan, RAL UZ 46: Combined Oil-Burner and Boiler Units, RAL UZ 61: Low-Emission and Energy-Saving Gas-Fired Calorific-Value Heating Devices, RAL UZ 71: Independent Gas Heaters and Gas Heating Elements, RAL UZ 80: Low-Emission Fan-Assisted Gas Burners.

A prerequisite for having an ecolabel is that all criteria are fulfilled. On the one hand the criteria should be strict enough, in order to create incentives for improvements, and on the other hand they should be formulated so that some wood pellet firing systems can fulfil all criteria. In addition a balance between different environmental requirements has to be found, since different pellet firings have different strengths and weaknesses.

In the following, the recommendations regarding the criteria for an ecolabel for pellet boilers and furnaces are developed. After the description of each criteria a concrete formulation is represented. The complete draft text is in the annex.

6.1 Scope

Since for pellet furnaces and pellet boilers different standards and testing procedures apply, and as the comparison showed, differences regarding the efficiencies and emissions are existing (cf. chapter 4), the assignment of two separated ecolabels is recommended.

As upper limit for the performance range 50 kW for boilers and 15 kW for pellet furnaces are recommended. The market analysis and also the evaluation of the environmental relevance showed that the majority of the systems is situated in this performance range. Additionally, systems that are not operating automatically to a large extent should be excluded as well as combination boilers and pellet burners can (cf. chapter 3.4).

For the definition of scope the following text is suggested:

Wood pellet boiler
This criteria applies to wood pellet boilers according to DIN EN 303-5 with a nominal load up to and including 50 kW which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. ÖNORM M 7135). A central request on a product distinguished with an ecolabel is that it operates efficiently and low on emission during service life. Thus, only such devices are to be included in the scope of the ecolabel: • which are exclusively operated with wood pellets, in order to exclude degradations of the efficiency and the emission behaviour by the application of qualitatively worse fuels (exclusion of combination boilers) • in which the ignition, performance and combustion regulation as well as the heat exchanger cleaning take place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers)) • which represent a complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners)

Wood pellet furnaces
This criteria applies to wood pellet furnaces according to the draft of DIN 18894 with a nominal load up to and including 15 kW, which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. OENORM M 7135) . *Continuation as with wood pellet boilers, the second point is suggested as follows for pellet furnaces:* • in which the ignition and the burn regulation takes place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers).

6.2 Guideline Conformity

With the fulfilment of the requirements of the DIN 303-5 or the draft of DIN 18884 it can be assumed that substantial safety-relevant demands of the relevant EEC guidelines are fulfilled, so that in the certification criteria one can disclaim on a reference to the corresponding EEC guidelines.

The following demand is recommended:

Wood pellet boiler
Beside the following requirements on energy efficiency and emissions the compliance with the demands of the DIN EN 303-5 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[56]

Wood pellet furnace
Beside the following requirements on energy efficiency and emissions the compliance with the demands of the draft of DIN 18894 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[57]

6.3 Criteria of Energy Efficiency

The most important indicators for the energy efficiency are requirements on the efficiency factors of the systems at nominal load and partial load. The request on the efficiency factor at nominal load can be defined equally for both installation types, since both types achieve equivalent values (cf. table 8). For the demands at partial load it has to be determined first, at which load one has to measure. Basically, the value for the smallest adjustable performance is to be indicated. During minimal load the

[56] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet boilers.

[57] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet furnaces.

prescribed efficiency factor has to be differentiated between pellet furnaces and pellet boilers. While pellet furnaces at partial load usually achieve even higher values, since the exhaust gas losses are smaller, the efficiency factors of boilers in most cases decrease with partial load conditions.

As minimum values are recommended:

	Efficiency factor at nominal load (%)	Efficiency factor at partial load (%)	Fulfilled by (number of systems)
Pellet furnaces	≥ 90	≥ 88	24[58] out of 32
Pellet boilers	≥ 90	≥ 90	6 out of 13

Additionally, important for the energy efficiency is the auxiliary electric consumption of the systems. Since only a few manufacturers made specifications to this aspect (cf. 4.2.2.2), moderate demands should be determined initially. It is recommended that supplementary electrical consumption may not amount to more than 1% of the produced thermal output at nominal load operation; i.e. that per kWh of produced heat no more than 10 Wh electricity may be used. 21 of 26 examined wood pellet boilers, which gave specification on this question, fulfil the demands and nine of ten pellet furnaces.

Additionally, the manufacturers should also specify the electric consumption at other operating conditions. These are hardly measured so far, so that from this an increased measuring effort results. So far, no sufficient empirical values are available from the questioning for the height of electric consumption at partial load, at stand-by or during the ignition process. The specification of the electric consumption of certain – not continuously operating – components would be meaningful (e.g. fuel delivering system, engines for heat exchanger cleaning), since these are central power consumers, whose requirements of electric current are averaged however in a measurement lasting several hours. For this specification so far not enough values are available to formulate requirements.

Due to the insufficient data conditions at present a two-step procedure is recommended - similar to the criteria development with oil and gas heatings: To the current version of the certification criteria, first the demand should be included that the electrical consumption of the systems at partial load, stand-by operation and ignition is to be indicated (without definition of maximum values). Likewise the electrical capacity of components which are integrated into the device should be indicated (blower engines, engines for ash removal and augers, etc..). Based on these specification a request could possibly be developed and integrated into the next revision of the certification criteria.

The measuring method for supplementary electrical consumption must be concretised, since it is not part of the measurement according to DIN EN 303-5. In particular the system boundaries of the pellet heating are to be defined, whereby the circulating heating pump and mechanisms for pellet delivering from the storage should be excluded. Besides, the specification of the water-side flow resistance is recommended.

[58] The data at minimal load are missing for six systems. However, these meet the demands at nominal load.

The following text on demands is suggested:

Wood pellet boiler
Energy Efficiency The efficiency factors are to be determined in accordance with DIN EN 303-5 at nominal load as well as at partial load (minimal adjustable performance). The efficiency factor in accordance with DIN EN 303-5 must not be lower than 90% at nominal load and 88% at partial load. **Supplementary Electrical Consumption** Supplementary electrical consumption of the systems are to be determined in accordance with specification in annex 1 to the certification criteria. It may not exceed 1% of the produced thermal output during nominal load. Supplementary electrical consumption at partial load operation (minimal adjustable performance), at stand-by (stand-by without heat production) and for the ignition process are to be determined and documented in the test report. The power input to the following integrated components (if available) is to be indicated separately in Watts: • blower engine(s) • engine(s) for heat exchanger cleaning • engine(s) for ash removal and fuel augers If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated. The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

Wood pellet furnace
The efficiency factors are to be determined in accordance with DIN 18894 (draft) at nominal load as well as at partial load (minimal adjustable performance). The efficiency factor in accordance with DIN 18894 (draft) must not be lower than 90% at nominal load and at partial load. **Supplementary Electrical Consumption** *Continuation as with wood pellet boilers, the last paragraph is suggested as follows for pellet furnaces:* For water-based pellet furnaces the water-side flow resistance is to be determined in accordance with DIN 18894 (draft) and documented in the test report. If the device includes a heating water circulation pump, the electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

6.4 Pollutant Emissions

From the questioning results, maximum values for emissions can be determined for carbon monoxide, hydrocarbons, nitrogen oxides and dust. These are the pollutants usually measured in the exhaust gases in testing procedures.

The definition of the emission values is based on conditions given in the 1. BImSchV (exhaust gas in the standard temperature and pressure (0°C, 1013 mbar) with a volume content of oxygen in the exhaust gas of 13%). For the testing conditions the specifications of the appropriate DIN regulations are to be consulted, for the boilers in accordance with DIN EN 303-5, for the pellet furnaces in accordance with the design DIN 18894 (draft). Since the draft of DIN 18894 does not consider the measurement of total carbon, dust and nitrogen oxides, testing methods in accordance with DIN 303-5 are recommended.

The demands on the **carbon monoxide emissions** should be as strict as possible, since this is the guidance parameter for the combustion quality. The criteria are derived on the basis of the analysed state of the art. Differences between pellet boilers and pellet furnaces have to be considered.

The following maximum values are recommended:

	CO-Emission at nominal load (mg/m³)	**CO-Emission at partial load (mg/m³)**	**Fulfilled by (number of systems)**
Pellet boilers	100	250	25 out of 31
Pellet furnaces	200	400	8 out of 14

The **hydrocarbon** emissions of boilers are already close to the detection limit. Between total carbon- and the carbon monoxide emissions exists a close correlation. Due to the carcinogenic potentials of certain hydrocarbons and the contribution of volatile hydrocarbons to summer smog, the certification criteria should nevertheless contain a limit value to the emission of total carbon.

The following maximum values are recommended:

	Total-Carbon-Emission at nominal load (mg/m³)	**Total-Carbon-Emission at partial load (mg/m³)**	**Fulfilled by (number of systems)**
Pellet boilers	5	5	20 out of 27
Pellet furnaces	10	15	10 out of 14

The emissions of **nitrogen oxides** are to a large extent determined by the fuel. Nevertheless, there are differences between the different systems. Since the measurement with partial load so far does not belong to the standard testing program and the part and nominal load values are situated close to each other, no specific requirement is made on the emission values at partial load.

The following maximum values are suggested:

	NO_x-Emission at nominal load (mg/m³)	**Fulfilled by (number of systems)**
Pellet boilers	150	24 out of 27
Pellet furnaces	150	14 out of 14

The **dust measurement** at partial load does so far likewise not belong to the standard testing program. Here, in order to create a database for a later revision of the ecolabel, the specification of the partial load values is suggested.

For the nominal load operation the following dust mission maximum values are recommended:

	Dust emission at nominal load (mg/m³)	**Fulfilled by (number of systems)**
Pellet boilers	30	26 out of 31
Pellet furnaces	35	12 out of 14

The Austrian ecolabel also defines emission limit values for automatically fed wood boilers for carbon monoxide and organically bound carbon at nominal and partial load as well as for nitrogen oxides and dust with nominal load. As partial load however 50% of the nominal load is assumed, thus these values cannot be compared directly. The emission limit values of the Austrian ecolabel at nominal load are for all pollutants higher than the emission values suggested here. The maximum values of the Nordic ecolabel are higher as well. The stricter limit values suggested for the German ecolabel are justified, since the scope of the other two ecolabels extends also to wood chips, which cause on average higher pollutant emissions (cf. 4.3.4). Additionally, the emission values of automatically fed wood boilers constantly sank in the last years, so that an newly established ecolabel should define stricter values.

For the emission request the following formulations are suggested:

Wood pellet boiler

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in paragraph 4.

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 100 mg/Nm^3 at nominal and 250 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 5 mg/Nm^3 at nominal and partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 30 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

Wood pellet furnace

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in para. 4

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 200 mg/Nm^3 at nominal and 400 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 10 mg/Nm^3 at nominal and 15 mg/Nm^3 at partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 35 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

6.5 Adjusting and Operating Instruction

Similar to other certification criteria of heating devices, certification criteria for an ecolabel for pellet firing should contain requirements on the adjusting and operating instruction. Hereby, it is to be guaranteed that experts can adjust pellet firings in such a way that they are operating as efficient as possible and low on emission. They should inform the users about how to properly operate the systems. This includes a note to the exclusive use of standardised wood pellets as fuel.

Following other ecolabel certification criteria, the following formulation is recommended:

Wood pellet boilers and wood pellet furnaces

The instruction manual must include precise and definite information on the proper adjustment of the wood pellet firing by an expert. Adjustment according to the instruction manual must enable the operator to meet the requirements under paras. “Energy Efficiency” and “Pollutant Emissions” during operation. The instruction manual must include detailed information on how to adapt the pellet firing to the exhaust gas system as well as the combination with an accumulator tank.

Additionally, one has to point out that in Germany only wood pellets according to DIN 51731 or wood pellets with an equal quality (e.g. according to ÖNORM M 7135) are to be used in combustion plants in the private households.

The documents have to correspond at least to the standards of EN 303 part 5 (*for pellet furnaces: DIN 18894 (draft)*).

6.6 Services

The behaviour of the user can influence the actual combustion quality and the emission under practical conditions. The producers should support the users by offering certain services (maintenance, consultation etc.) for an environmentally sound operation of the system. Because of the combination of the devices with an accumulator tank, increased emission at partial load operation is avoided and the efficiency of the system is increased. With an accumulator tank, the devices are almost exclusively operated at nominal load and thus starting processes are minimised. Hence, the producers should inform their customers about the possibilities of combining the devices with an accumulator tank and should offer accumulator tanks.

Following the Austrian ecolabel the following formulation is recommended:

Wood pellet boilers and wood pellet furnaces
The environmentally sound operation of a wood pellet heating is substantially influenced by the behaviour of the users. In order to positively influence this, the producer or service partners should offer specific services when selecting and installing a system as well as during operation: • technical training for fitters and salesmen • consultation and supply for the installation of an accumulator tank • consultation for the installation of the exhaust system • offering of the initial operation of the boiler and explanation of the parameters for an efficient, low emission combustion as well as the controlling of the firing (customer training) • offering of a maintenance service available at usual customer service times • offering of an annual examination of the heating • availability of equivalent spare parts for at least 10 years

6.7 Summary of the Suggested Criteria

In summary, the requirements are represented in the following table. A comparison of the demands with the data of the manufacturer questioning shows that the complete demands can be fulfilled by five of the 14 pellet furnaces (of three different manufacturers) and eleven of the 32 boilers (of six different manufacturers). About nine wood pellet boilers and three wood pellet furnaces miss the demands only scarcely, here is to be assumed the set criteria trigger an incentive for technical advancements.

A comparison of the demands with the data to 97 wood pellet boilers in BIZ (2000) shows that about 20% of the specified wood pellet boilers can fulfil the request.

Table 27: Summary of the Suggested Requirements

Product	Scope	Efficient energy utilisation			Emission[59]						Other requirements
		Efficiency		Auxiliary electrical consumption	NO_x (mg/Nm³)	CO (mg/Nm³)		Dust (mg/m³)	C_{total} (mg/Nm³)		
		Nominal load	Minimal load	Nominal load	Nominal load	Nominal load	Minimal load	Nominal load	Nominal load	Minimal load	
Pellet boiler	• Performance up to 50 kW • Automatic ignition, automatic heat exchanger cleaning, automatic regulation of performance and combustion • Only for wood pellets	≥ 90%	≥ 88%	≤ 1% of the generated thermal performance	150	100	250	30	5	5	• Specification of the concentration of dust in the exhaust gases at minimal load • Specification of electrical consumption with minimal load and stand-by operation • Specification of power input of important plant components, as well as the water-side flow resistance • requirements on adjustment and operating instructions • Offer of services
Pellet furnaces	• Capacity up to 15 kW • Automatic ignition automatic and regulation of combustion • Only for wood pellets	≥ 90%	≥ 90%	≤ 1% of the generated thermal performance	150	200	400	35	10	15	

[59] Related to the exhaust gases at normal condition (0°C, 1013 mbar) with an volume content of Oxygen of about 13%

7 Summary

The feasibility study deals with the question whether the ecolabel “Blue Angel” is suitable for wood pellet firings and which requirements should be fulfilled in the case of certification. The study was carried out by the Institute for Ecological Economy Research (IÖW) gGmbH on behalf of the Environmental Protection Agency in the context of the environmental research plan (project no. 200 95 308/01). It was financed with federal funds. The investigation was executed following the ISO 14024 (Environmental labels and declarations - Type I environmental labelling – Principles and Procedures).

The aim of the study was to check the suitability of wood pellet firings for the granting of an ecolabel as well as to create a transparent discussion basis for the interested groups. For this purpose a market analysis was executed, the state of the art was determined, environmental impacts and improvement potentials were identified, and a draft of criteria for an ecolabel was suggested. For the selection of suitable product categories an ecological system comparison between wood pellet firings and oil and gas-fuelled heating systems as well as conventional wood heatings (wood chips and log wood) was executed. The comparison analysed the pollutant emissions and the consumption of primary energy.

Wood pellet firing systems are particularly designed combustion systems, which use wood pellets as fuel. Wood pellets is cylindrical compressed wood from untreated wood, usually made of wood residues or sawdust from woodworking operations. Wood pellets are a standardised fuel, in Germany in accordance with DIN 51731 „Requests at compressed woods from untreated wood“. Due to its size and form the pellets may be poured and trickled and thus are suitable for an automatic filling of the firings and for the transportation by tank cars. Wood pellets can be used in central heating systems, single room furnaces (room heaters or pellet furnaces) and in long-distance heating systems. Both the standardised fuel with to a large extent uniform quality and the automatic combustion regulation contribute to the fact that wood pellet firing systems operate efficiently and with low emissions. Additionally, operating errors due to inappropriate operator behaviour can be minimised as far as possible.

Market Analysis

Within the market analysis a questioning of manufacturers and providers was carried out. It resulted in a sales figure of more than 5,000 pellet firings in the performance range up to 50 kilowatts in the year 2001 on the German market. About half of it were each pellet boilers and pellet furnaces. The sales figures strongly rose in the last years. However, compared to the German heating system market the share of pellet firings is still relatively small. This is among other things due to the comparatively high investment costs which are hardly counterbalanced by the lower fuel costs. During the last years, wood pellet firings became more attractive. A big advantage is the high comfort of the systems. Additional favourable conditions are the support from the programme for market development for the use of renewable energies and the rise of costs for the fuel oil.

The manufacturers of the pellet firings which are offered on the German market are to the predominant section German and Austrian firms. Additionally, there are further providers from the Scandinavian countries, from Italy, Liechtenstein and the Czech republic which have however altogether relatively small sales figures. For the product evaluation in the context of the ecolabel wood pellet boilers (performancerange up to 50 Kilowatts) and wood pellet furnaces (performance range up to 15 kilowatts) were selected. The predominant number of pellet firings ranks among this performance range.

Besides, this performance range is particularly relevant for private consumers who are the primary target group of the ecolabel.

Environmental Characteristics

Products labelled by an ecolabel should guarantee an environmentally sound operation during service life. In order to minimise sources of error by inappropriate operation, the scope was limited to such systems, which are operated exclusively with wood pellets and which have an automatic combustion regulation as well as an automatic ignition.

For the development of criteria an extensive questioning of manufacturers was executed. The questioning concentrated on environmental characteristics. The results of the data collection clarify that between the systems substantial differences exist regarding the ecological quality. This concerns in particular the efficiency factors and the pollutant emissions of the examined products. The efficiency factors of pellet boilers are on the average 91% with nominal load and 89% with partial load, for pellet furnaces they amount to an average of 90% with nominal load and 91% with partial load.

According to § 4 of the Federal Immission Control Act (Bundes-Immissionsschutzgesetz - BImSchG) wood combustion plants up to 1 MW firing thermal output require no approval, nevertheless for those the 1. BImSchV (1. Federal Immission Control Ordinance, Regulation on Small-scale Combustion Plants) applies. It sets limit values of 4 g/m³ for carbon monoxide (CO) and 0.15 g/m^3 for dust. Smallest plants with fewer than 15 kW are not subject to the emission request of the 1. BImSchV. All systems to which data were raised had emission values clearly below these limit values. Nevertheless, the different systems point to substantial dispersions. Further relevant pollutant emissions are hydrocarbons and nitrogen oxides, these were also examined.

System Comparison

A system comparison including pellet boilers, wood heatings with log wood and wood chips, as well as gas- and oil fired boilers from the heating system stock, clarifies that in comparison to fossil-fuelled boilers wood heatings show clear advantages with the climate relevant carbon dioxide emissions and thus make a smaller contribution to the climate change. In contrast to this, wood heatings cause higher emissions of the air pollutants carbon monoxide, nitrogen oxides and dust. These contribute to the environmental impacts of acidification, terrestrial nutrification, PM_{10} (mortality risk) and summer smog. Among the wood heatings pellet firings have ecological advantages, in particular due to the high degree of automation and the homogeneous fuel quality. This leads to low emissions on carbon monoxide, hydrocarbons and dust. Additionally, pellet firings have a smaller potential of forming hazardous and carcinogenic substances, e.g. polycyclic aromatic hydrocarbons, benzene and dioxins as conventional wood combustion plants. This advantages is especially important in relation to handfed systems.

Suggested Certification Criteria

On base of the assessment the introduction of an ecolabel for wood pellet firings is recommended. Compared to conventional wood heating systems they cause lower emissions and can be operated more efficiently. Additionally, they contribute to a reduced consumption of fossil resources and the reduction of CO_2-emissions with climate impact.

From the collected data and the system comparison requirements for an ecolabel were developed and discussed in an expert discussion with representatives of manufacturers, testing institutes, organisations and the Environmental Protection Agency.

As the active participation during the expert talk and further statements in the aftermath of the discussion round showed, the project was met with vivid interest.

The transcription of the ecolabel is proposed as "because of low emissions and energy-efficiency". The suggested certification criteria cover request on:

- guideline conformity
- efficient energy use (efficiency factors and supplementary electrical consumption)
- emission values for carbon monoxide, hydrocarbons, dust and nitrogen oxides
- adjusting and operating instruction and
- services of the manufacturer

As emphasis request the efficient energy use and the reduction of pollutant emissions were worked out.

The suggested criteria are fulfilled by every third case of the examined wood pellet boilers and pellet furnaces. Beyond that, there is a number of further systems which miss the suggested criteria only scarcely. Here is to be assumed that the requirements can serve as an incentive for technical improvements.

With the pursuit of the topic of wood pellet firings in the context of the ecolabel an important product group is taken up for environmentally sound and energy-efficient heat production. The voluntary labelling of wood pellet firings gives a signal for an environmentally sound heat production. It can make a contribution to the intensified use of renewable energy sources and thus for the reaching of the climatic protection targets of the Federal Government.

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INDEX OF THE APPENDICES

1. List of the provides interviewed in the market analysis

The following providers were interviewed in the context of the market analysis, partially through telephone interviews, partially in writing.

Germany		
AUGUST BRÖTJE GmbH		Mr. Rieke
BHSR Energie und Umwelttechnik	Extertal-Silixen	N.N.
Biomat Niederlassung D	Tholey	Mr. Schwarz
Buderus Heiztechnik GmbH	Wetzlar	Mr. Diebel
EconTech	Bobingen	N.N.
Energie & Umwelt Wolfram Bach	Forbach-Hundsbach	Mr. Bach
Fritz Grimm GmbH & Co. KG	Amberg	Mr. Grimm
HDG Bavaria		Mr. Ecker
Industrie Handelsvertretung Peters	Burgdorf	Mr. Peters
Innovative Haustechnik Heinz Keens	Bad Orb	Mr. Keens
Meier & Co. KG	Hüfingen	Mr. Meier
Nolting Feuerungstechnik		Mr. Wegner
Ofenfreund	Bad Kreuznach	N.N.
ÖkoFen Heiztechnik GmbH	Reichertshofen	Mr. Thomaschek
Paul Künzel	Prisdorf	Mr. Künzel
pro solar Energietechnik GmbH	Ravensburg	Mr. Döhr
Schulz Heizungs- und Sanitärmeisterbetrieb	Sontra-Wischmannshausen	Mr. Schulz
Solar Projekt Energiesysteme GmbH	Weingarten	Mr. Walser
Sonnenkraft GmbH	Neutraubling	Mr. Hartmannsgruber
Wagner & Co.	Cölbe/Marburg	Mr. Schabbach
Wamsler Haus- und Küchentechnik GmbH	Garching	Mr. Einhellig
Wodtke GmbH	Tübingen-Hirschau	Mr. Astfalk
Austria		
Biomassetechnik Ottowitz	Dornbirn	Mr. Ottowitz
Calimax	Rankweil	Mr. Kessler
Compact Heiz- und Energiesysteme	Gmunden	Mr. Schunn
Fröling	Grieskirchen	Mr. Mohnitzer
Guntamatic Heiztechnik	Peuerbach	Mr. Prokurist Hurimer
Hager		Mr. Hager
Hargassner GmbH		Mrs. Hargassner
Herz Feuerungstechnik Ges.mbH	Sebersdorf	Mr. Ganster
Kalkgruber	Aschach/Steyr	Mr. Kerbler
KWB - Kraft und Wärme aus Biomasse	St.Margarethen/Raab 235	Mr. Jauschnegg
Lohberger Heiz- und Kochgeräte	Mattinghofen	Mr. Magister Scheicher
RIKA		Mr. Hellinger
sht Heiztechnik aus Salzburg GmbH	Salzburg-Bergtheim	Mr. Schruffner
Sommerauer & Lindner GmbH	St.Pantaleon	Mr. Lindner
Lichtenstein		
Hoval Werk Vaduz	Vaduz	Mr. Hegele
Czech Republic		
Atmos		Mrs. Zebuckowa
Sweden		
EcoTec		Mrs. Anet

2. List of interviewed federations and organisations

With the following federations and organisations telephone interviews were led in the context of the market analysis.

Germany		
AUGUST BRÖTJE GmbH		Mr. Rieke
BHSR Energie und Umwelttechnik	Extertal-Silixen	N.N.
Biomat Niederlassung D	Tholey	Mr. Schwarz
Buderus Heiztechnik GmbH	Wetzlar	Mr. Diebel
EconTech	Bobingen	N.N.
Energie & Umwelt Wolfram Bach	Forbach-Hundsbach	Mr. Bach
Fritz Grimm GmbH & Co. KG	Amberg	Mr. Grimm
HDG Bavaria		Mr. Ecker
Industrie Handelsvertretung Peters	Burgdorf	Mr. Peters
Innovative Haustechnik Heinz Keens	Bad Orb	Mr. Keens
Meier & Co. KG	Hüfingen	Mr. Meier
Nolting Feuerungstechnik		Mr. Wegner
Ofenfreund	Bad Kreuznach	N.N.
ÖkoFen Heiztechnik GmbH	Reichertshofen	Mr. Thomaschek
Paul Künzel	Prisdorf	Mr. Künzel
pro solar Energietechnik GmbH	Ravensburg	Mr. Döhr
Schulz Heizungs- und Sanitärmeisterbetrieb	Sontra-Wischmannshausen	Mr. Schulz
Solar Projekt Energiesysteme GmbH	Weingarten	Mr. Walser
Sonnenkraft GmbH	Neutraubling	Mr. Hartmannsgruber
Wagner & Co.	Cölbe/Marburg	Mr. Schabbach
Wamsler Haus- und Küchentechnik GmbH	Garching	Mr. Einhellig
Wodtke GmbH	Tübingen-Hirschau	Mr. Astfalk
Austria		
Biomassetechnik Ottowitz	Dornbirn	Mr. Ottowitz
Calimax	Rankweil	Mr. Kessler
Compact Heiz- und Energiesysteme	Gmunden	Mr. Schunn
Fröling	Grieskirchen	Mr. Mohnitzer
Guntamatic Heiztechnik	Peuerbach	Mr. Prokurist Hurimer
Hager		Mr. Hager
Hargassner GmbH		Mrs. Hargassner
Herz Feuerungstechnik Ges.mbH	Sebersdorf	Mr. Ganster
Kalkgruber	Aschach/Steyr	Mr. Kerbler
KWB - Kraft und Wärme aus Biomasse	St.Margarethen/Raab 235	Mr. Jauschnegg
Lohberger Heiz- und Kochgeräte	Mattinghofen	Mr. Magister Scheicher
RIKA		Mr. Hellinger
sht Heiztechnik aus Salzburg GmbH	Salzburg-Bergtheim	Mr. Schruffner
Sommerauer & Lindner GmbH	St.Pantaleon	Mr. Lindner
Lichtenstein		
Hoval Werk Vaduz	Vaduz	Mr. Hegele
Czech Republic		
Atmos		Mrs. Zebuckowa
Sweden		
EcoTec		Mrs. Anet

3. List of the providers interviewed in the environmental analysis

The following providers were interviewed in the context of the market analysis, partially through telephone interviews, partially in writing.

Germany		
AUGUST BRÖTJE GmbH		Mr. Rieke
BHSR Energie und Umwelttechnik	Extertal-Silixen	N.N.
Biomat Niederlassung D	Tholey	Mr. Schwarz
Buderus Heiztechnik GmbH	Wetzlar	Mr. Diebel
EconTech	Bobingen	N.N.
Energie & Umwelt Wolfram Bach	Forbach-Hundsbach	Mr. Bach
Fritz Grimm GmbH & Co. KG	Amberg	Mr. Grimm
HDG Bavaria		Mr. Ecker
Industrie Handelsvertretung Peters	Burgdorf	Mr. Peters
Innovative Haustechnik Heinz Keens	Bad Orb	Mr. Keens
Meier & Co. KG	Hüfingen	Mr. Meier
Nolting Feuerungstechnik		Mr. Wegner
Ofenfreund	Bad Kreuznach	N.N.
ÖkoFen Heiztechnik GmbH	Reichertshofen	Mr. Thomaschek
Paul Künzel	Prisdorf	Mr. Künzel
pro solar Energietechnik GmbH	Ravensburg	Mr. Döhr
Schulz Heizungs- und Sanitärmeisterbetrieb	Sontra-Wischmannshausen	Mr. Schulz
Solar Projekt Energiesysteme GmbH	Weingarten	Mr. Walser
Sonnenkraft GmbH	Neutraubling	Mr. Hartmannsgruber
Wagner & Co.	Cölbe/Marburg	Mr. Schabbach
Wamsler Haus- und Küchentechnik GmbH	Garching	Mr. Einhellig
Wodtke GmbH	Tübingen-Hirschau	Mr. Astfalk
Austria		
Biomassetechnik Ottowitz	Dornbirn	Mr. Ottowitz
Calimax	Rankweil	Mr. Kessler
Compact Heiz- und Energiesysteme	Gmunden	Mr. Schunn
Fröling	Grieskirchen	Mr. Mohnitzer
Guntamatic Heiztechnik	Peuerbach	Mr. Hurimer
Hager		Mr. Hager
Hargassner GmbH		Mrs. Hargassner
Herz Feuerungstechnik Ges.mbH	Sebersdorf	Mr. Ganster
Kalkgruber	Aschach/Steyr	Mr. Kerbler
KWB - Kraft und Wärme aus Biomasse	St.Margarethen/Raab 235	Mr. Jauschnegg
Lohberger Heiz- und Kochgeräte	Mattinghofen	Mr. Magister Scheicher
RIKA		Mr. Hellinger
sht Heiztechnik aus Salzburg GmbH	Salzburg-Bergtheim	Mr. Schruffner
Sommerauer & Lindner GmbH	St.Pantaleon	Mr. Lindner
Lichtenstein		
Hoval Werk Vaduz	Vaduz	Mr. Hegele
Czech		
Atmos		Mrs. Zebuckowa
Sweden		
EcoTec		Mrs. Anet

4. Table emission comparison wood heatings

	Pellet boiler[60]	Wood chip heating				Log wood heating				
		Jungmeier et al. 1999[61]	Hartmann et al. 1997[62]	Pfeiffer et al. 2000[63]	Hartmann et al. 2001	Jungmeier et al. 1999[64]	Hartmann et al. 1997[65]	Launhardt et al. 1998[66]	Pfeiffer et al. 2000[67]	Hartmann et al. 2001[68]
Efficiency factor	90%	89%			87%	87%				80%
CO [mg/MJ]	48	80	101	126	134	165	158	370	322	209
Dust [mg/MJ]	13	26	32	30	21	19	23	19	20	23
NO_x [mg/MJ]	75	85	86		91	86	99	107		82
C_{total} [mg/MJ]	2	2		4	<1	8		18	10	6

60 The values are the mean values of the pellet heatings investigated.

61 Mean values of the tested wood chips firings (1996 up to 1998 at the BLT Wieselburg)

62 Wood, 40-70 kW, converted out of mg/m³; cited according to: Launhardt 1998

63 State of the Art wood firing, automatically fed

64 Mean values of the tested log wood boilers (1996 up to 1998 at the BLT Wieselburg)

65 Log wood firing with an exhaust gas sensor, 20-50 kW, converted out of mg/m³; cited according to: Launhardt 1998

66 Fuel: beech

67 State of the art wood firing, manually fed

68 Modern log wood boilers were examined.

5. Participants in the discussion

The discussion took place on January 21st, 2002 in the Environmental Protection Agency. The following organisations and persons participated:

Organisation/Company	**Participant**
Biomasse Informationszentrum (Deutscher Energie-Pellet-Verband)	Mrs. Pilz
CARMEN e.V.	Gilbert Krapf
RWE Rheinbraun AG SLF-S Feuerstättenprüfstelle Sybilla	Mr. Heinen
TÜV Süddeutschland	Mr. Steiglechner
Windhager Zentralheizungen	Helmut Garhammer
Firma Fröling	Mr. Osterburg
Wodtke GmbH	Dierk Astfalk/ Mrs. Wodtke
Guntamatic Heiztechnik	Mr. R. Flack
HDG Bavaria	Martin Ecker
Calimax	Dietmar Kessler
Firma ÖkoFen Deutscher Energiepelletverband	Helmut Gastl
Environmental Protection Agency	Mrs. Seifert, Mrs. Böttcher- Tiedemann, Mr. Wagenknecht, Mr. Weiss, Mr. Schäl
Institute for Ecological Economy Research (IÖW) gGmbH	Mr. Hirschl, Mrs. Hoffmann, Mrs. Weiß

6. Draft for certification criteria for wood pellet boilers

Transcription of the symbol for environmental protection: “because low emission and energy efficient”

1. Introduction

Wood pellet firings enable an efficient and low emission use of regenerative fuels because of their high degree of automation and because of the use of fuels with uniform quality for heating purposes. Thereby, they make a contribution to the climate protection and to the decrease of the use of non-renewable primary energy. The above-shown ecolabel may be used for marking of wood pellet boilers, as specified in Scope, which make efficient use of fuel and cause clearly lower pollutant emissions than admissible according to valid DIN standards and the 1. BImSchV.

2. Scope

This criteria applies to wood pellet boilers according to DIN EN 303-5 with a nominal load up to and including 50 kW which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. ÖNORM M 7135).

3. Requirements

The ecolabel illustrated above may be used for the marking of the wood pellet firings specified in scope provided that they meet the following requirements:

3.1 General Requirements

Beside the following requirements on energy efficiency and emissions the compliance with the demands of the DIN EN 303-5 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[69]

A central request on a product distinguished with an ecolabel is that it operates efficiently and low on emission during service life. Thus, only such devices are to be included in the scope of the ecolabel:

- which are exclusively operated with wood pellets, in order to exclude degradations of the efficiency and the emission behaviour by the application of qualitatively worse fuels (exclusion of combination boilers)
- in which the ignition, performance and combustion regulation as well as the heat exchanger cleaning take place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers))
- which represent a complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners)

[69] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet boilers.

3.2 Efficient Energy Utilisation

The efficiency factors are to be determined in accordance with DIN EN 303-5 at nominal load as well as at partial load (minimal adjustable performance).

The efficiency factor in accordance with DIN EN 303-5 must not be lower than 90% at nominal load and 88% at partial load.

3.3 Supplementary Electrical Consumption

Supplementary electrical consumption of the systems are to be determined in accordance with specification in annex 1 to the certification criteria. It may not exceed 1% of the produced thermal output during nominal load.

Supplementary electrical consumption at partial load operation (minimal adjustable performance), at stand-by (stand-by without heat production) and for the ignition process are to be determined and documented in the test report.

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

3.4 Emission requirements

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in para. 4.

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 100 mg/Nm^3 at nominal and 250 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 5 mg/Nm^3 at nominal and partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 30 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

3.5 Services

The environmentally sound operation of a wood pellet heating is substantially influenced by the behaviour of the users. In order to positively influence this, the producer or service partners should offer specific services when selecting and installing a system as well as during operation:

- technical training for fitters and salesmen
- consultation and supply for the installation of an accumulator tank
- consultation for the installation of the exhaust system
- offering of the initial operation of the boiler and explanation of the parameters for an efficient, low emission combustion as well as the controlling of the firing (customer training)
- offering of a maintenance service available at usual customer service times
- offering of an annual examination of the heating
- availability of equivalent spare parts for at least 10 years

3.6 Adjusting and operating instruction

The instruction manual must include precise and definite information on the proper adjustment of the wood pellet firing by an expert. Adjustment according to the instruction manual must enable the operator to meet the requirements under paras. “Energy Efficiency” and “Pollutant Emissions” during operation. The instruction manual must include detailed information on how to adapt the pellet firing to the exhaust gas system as well as the combination with an accumulator tank.

Additionally, one has to point out that in Germany only wood pellets according to DIN 51731 or wood pellets with an equal quality (e.g. according to ÖNORM M 7135) are to be used in combustion plants in the private households.

The documents have to correspond at least to the standards of EN 303 part 5.

4. Testing

4.1 Testing Institutes

The testing is to be executed either by a neutral testing institute that is certified for testing “boilers for solid fuels” according to DIN EN 45001 or DIN EN ISO 17025 or by a testing institute that is accredited by the German Institute for Civil Engineering (Deutsches Institut für Bautechnik) as testing institute for firings of solid fuels. Testing covers the complete evidences in accordance with paragraph 3.1 to 3.6.

4.2 Testing methods

The measurements are to be made in each case at nominal load and partial load (minimal adjustable performance).

The testing, in particular the examination of the efficiency and emission request after paras. 3.2 and 3.4 are to be executed according to DIN EN 303-5.

Wood pellets according to DIN 51731 or equivalent quality (e.g. in accordance with OENORM M 7135) are to be used for the emission measurements.

4.3 Calibration gases and measuring instruments

Certified calibration gases are to be used for the calibration of the measuring devices. The certificates are to be attached to the test documents. Calibration gas generators must not be used.

5. Evidences

When applying for the certification of a product according to the ecolabel the following evidences must be provided:

5.1 The test report about the assessment of the devices including the affirmation of the fulfilment of the criteria specified in paras. 3.1 to 3.6 in combination with para. 4.

5.2 The instruction manual including the statements in accordance with para. 3.6.

5.3 The compilation of the examination results according to para. 3.3 with regard to determined supplementary electrical consumption, the power input and the water-side flow resistance

5.4 For the supply of the services indicated in para. 3.5 a declaration of commitment is to be submitted.

Annex 1 to the certification criteria

Measurement of Supplementary electrical consumption during different operating conditions

1. Supplementary electrical consumption in the operating conditions

During the measurements of supplementary electrical consumption in the operating condition the power input of the pellet boiler is to be determined with each nominal load operation, and partial load operation (minimal adjustable performance).

For this, the electrical consumption of the system (without consideration of the heating water circulation pump and the fuel delivering system) is to be determined over a measuring period of at least six hours according to DIN EN 303-5 for the technical test and, related to the measuring period indicated as average power input in Watts.

2. Supplementary electrical consumption in the stand-by mode (without heat production)

During the measurements of the supplementary electrical consumption in the stand-by mode, the power input of the pellet boilers is to be determined, as no heat request exist and only electrical consumers are switched on for the maintenance of the operational readiness.

For this, the electrical consumption of the system is to be measured over a time of at least 10 minutes. If processes of control and steering influence the electrical consumption, a longer measuring time can be necessary.

The determined electrical consumption is, related to the measuring period, to be indicated as average power input in Watts.

3. Supplementary electrical consumption for the ignition process

Supplementary electrical consumption of the firing device is to be determined for the duration of the ignition process and to be indicated as electrical work in Watt hours.

4. Power input of central components

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

5. Water-side flow resistance

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

Specifications are necessary for the type of regulation of the pump (multi-level with number of pump performance levels or automatically adjustably with specification of the range of control in %).

6. Draft for certification criteria for wood pellet furnaces

Transcription of the symbol for environmental protection: “because low emission and energy efficient”

1. Introduction

Wood pellet firings enable an efficient and low emission use of regenerative fuels because of their high degree of automation and because of the use of fuels with uniform quality for heating purposes. Thereby, they make a contribution to the climate protection and to the decrease of the use of non-renewable primary energy. The above-shown ecolabel may be used for marking of wood pellet furnaces, as specified in Scope, which make efficient use of fuel and cause clearly lower pollutant emissions than admissible according to valid DIN standards and the 1. BImSchV.

2. Scope

This criteria applies to wood pellet furnaces according to DIN 18894 (draft) with a nominal load up to and including 15 kW which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. ÖNORM M 7135).

3. Requirements

The ecolabel illustrated above may be used for the marking of the wood pellet firings specified in scope provided that they meet the following requirements:

3.1 General Requirements

Beside the following requirements on energy efficiency and emissions the compliance with the demands of the draft of DIN 18894 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[70]

A central request on a product distinguished with an ecolabel is that it operates efficiently and low on emission during service life. Thus, only such devices are to be included in the scope of the ecolabel:

- which are exclusively operated with wood pellets, in order to exclude degradations of the efficiency and the emission behaviour by the application of qualitatively worse fuels (exclusion of combination boilers)
- in which the ignition and the burn regulation takes place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers)).
- which represent a complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners)

3.2 Efficient Energy Utilisation

The efficiency factors are to be determined in accordance with DIN 18894 (draft) at nominal load as well as at partial load (minimal adjustable performance).

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[70] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet furnaces.

The efficiency factor in accordance with DIN 18894 (draft) must not be lower than 90% at nominal load and at partial load.

3.3 Supplementary Electrical Consumption

Supplementary electrical consumption of the systems are to be determined in accordance with specification in annex 1 to the certification criteria. It may not exceed 1% of the produced thermal output during nominal load.

Supplementary electrical consumption at partial load operation (minimal adjustable performance), at stand-by (stand-by without heat production) and for the ignition process are to be determined and documented in the test report.

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

For water-based pellet furnaces the water-side flow resistance is to be determined in accordance with DIN 18894 (draft) and documented in the test report. If the device includes a heating water circulation pump, the electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

3.4 Emission requirements

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in para. 4.

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 200 mg/Nm^3 at nominal and 400 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 10 mg/Nm^3 at nominal and 15 mg/Nm^3 at partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 35 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

3.5 Services

The environmentally sound operation of a wood pellet heating is substantially influenced by the behaviour of the users. In order to positively influence this, the producer or service partners should offer specific services when selecting and installing a system as well as during operation:

- technical training for fitters and salesmen
- consultation and supply for the installation of an accumulator tank
- consultation for the installation of the exhaust system
- offering of the initial operation of the furnace and explanation of the parameters for an efficient, low emission combustion as well as the controlling of the firing (customer training)
- offering of a maintenance service available at usual customer service times
- offering of an annual examination of the heating
- availability of equivalent spare parts for at least 10 years

3.6 Adjusting and operating instruction

The instruction manual must include precise and definite information on the proper adjustment of the wood pellet firing by an expert. Adjustment according to the instruction manual must enable the operator to meet the requirements under paras. “Energy Efficiency” and “Pollutant Emissions” during operation. The instruction manual must include detailed information on how to adapt the pellet firing to the exhaust gas system as well as the combination with an accumulator tank.

Additionally, one has to point out that in Germany only wood pellets according to DIN 51731 or wood pellets with an equal quality (e.g. according to ÖNORM M 7135) are to be used in combustion plants in the private households.

The documents have to correspond at least to the standards of DIN 18894 (draft).

4. Testing

4.1 Testing Institutes

The testing is to be executed either by a neutral testing institute that is certified for testing “boilers for solid fuels” according to DIN EN 45001 or DIN EN ISO 17025 or by a testing institute that is accredited by the German Institute for Civil Engineering (Deutsches Institut für Bautechnik) as testing institute for firings of solid fuels. Testing covers the complete evidences in accordance with paragraph 3.1 to 3.6.

4.2 Testing methods

The measurements are to be made in each case at nominal load and partial load (minimal adjustable performance).

The testing, in particular the examination of the efficiency and emission request after paras. 3.2 and 3.4 are to be executed according to DIN 18894 (draft).

In addition to DIN 18 894 (draft), emission measurement of dust, nitrogen oxides and total carbon, have to be executed according to the measuring procedure in DIN EN 303-5, part 5.2, part 5.1.9.2 and part 5.1.0.4 considering the definition of a reference oxygen content of 13%. Deviating from DIN EN 303-5 the measurement of the dust content is to repeat after 1,5 hours of actual working time (measur-

ing period 0.5 hours) up to the end of the duration of test according to DIN 18 894. At least two dust measurements are to be executed.

Wood pellets according to DIN 51731 or equivalent quality (e.g. in accordance with ÖNORM M 7135) are to be used for the emission measurements.

4.3 Calibration gases and measuring instruments

Certified calibration gases are to be used for the calibration of the measuring devices. The certificates are to be attached to the test documents. Calibration gas generators must not be used.

5. Evidences

When applying for the certification of a product according to the ecolabel the following evidences must be provided:

5.5 The test report about the assessment of the devices including the affirmation of the fulfilment of the criteria specified in paras. 3.1 to 3.6 in combination with para. 4.

5.6 The instruction manual including the statements in accordance with para. 3.6.

5.7 The compilation of the examination results according to para. 3.3 with regard to determined supplementary electrical consumption, the power input and the water-side flow resistance

5.8 For the supply of the services indicated in para. 3.5 a declaration of commitment is to be submitted.

Annex 1 to the certification criteria

Measurement of Supplementary electrical consumption during different operating conditions

1. Supplementary electrical consumption in the operating conditions

During the measurements of supplementary electrical consumption in the operating condition the power input of the pellet furnace is to be determined with each nominal load operation, and partial load operation (minimal adjustable performance).

For this, the electrical consumption of the system (without consideration of the heating water circulation pump and the fuel delivering system) is to be determined over a measuring period of at least one hour according to DIN 18894 (draft) for the technical test and, related to the measuring period indicated as average power input in Watts.

2. Supplementary electrical consumption in the stand-by mode (without heat production)

During the measurements of the supplementary electrical consumption in the stand-by mode, the power input of the pellet furnaces is to be determined, as no heat request exist and only electrical consumers are switched on for the maintenance of the operational readiness.

For this, the electrical consumption of the system is to be measured over a time of at least 10 minutes. If processes of control and steering influence the electrical consumption, a longer measuring time can be necessary.

The determined electrical consumption is, related to the measuring period, to be indicated as average power input in Watts.

3. Supplementary electrical consumption for the ignition process

Supplementary electrical consumption of the firing device is to be determined for the duration of the ignition process and to be indicated as electrical work in Watt hours.

4. Power input of central components

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

5. Water-side flow resistance

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

Specifications are necessary for the type of regulation of the pump (multi-level with number of pump performance levels or automatically adjustably with specification of the range of control in %).

Draft for certification criteria for wood pellet boilers

Transcription of the symbol for environmental protection: “because low emission and energy efficient”

1. Introduction

Wood pellet firings enable an efficient and low emission use of regenerative fuels because of their high degree of automation and because of the use of fuels with uniform quality for heating purposes. Thereby, they make a contribution to the climate protection and to the decrease of the use of non-renewable primary energy. The above-shown ecolabel may be used for marking of wood pellet boilers, as specified in Scope, which make efficient use of fuel and cause clearly lower pollutant emissions than admissible according to valid DIN standards and the 1. BImSchV.

2. Scope

This criteria applies to wood pellet boilers according to DIN EN 303-5 with a nominal load up to and including 50 kW which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. ÖNORM M 7135).

3. Requirements

The ecolabel illustrated above may be used for the marking of the wood pellet firings specified in scope provided that they meet the following requirements:

3.1 General Requirements

Beside the following requirements on energy efficiency and emissions the compliance with the demands of the DIN EN 303-5 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[69]

A central request on a product distinguished with an ecolabel is that it operates efficiently and low on emission during service life. Thus, only such devices are to be included in the scope of the ecolabel:

- which are exclusively operated with wood pellets, in order to exclude degradations of the efficiency and the emission behaviour by the application of qualitatively worse fuels (exclusion of combination boilers)
- in which the ignition, performance and combustion regulation as well as the heat exchanger cleaning take place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers))
- which represent a complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners)

[69] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet boilers.

3.2 Efficient Energy Utilisation

The efficiency factors are to be determined in accordance with DIN EN 303-5 at nominal load as well as at partial load (minimal adjustable performance).

The efficiency factor in accordance with DIN EN 303-5 must not be lower than 90% at nominal load and 88% at partial load.

3.3 Supplementary Electrical Consumption

Supplementary electrical consumption of the systems are to be determined in accordance with specification in annex 1 to the certification criteria. It may not exceed 1% of the produced thermal output during nominal load.

Supplementary electrical consumption at partial load operation (minimal adjustable performance), at stand-by (stand-by without heat production) and for the ignition process are to be determined and documented in the test report.

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

3.4 Emission requirements

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in para. 4.

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 100 mg/Nm^3 at nominal and 250 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 5 mg/Nm^3 at nominal and partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 30 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

3.5 Services

The environmentally sound operation of a wood pellet heating is substantially influenced by the behaviour of the users. In order to positively influence this, the producer or service partners should offer specific services when selecting and installing a system as well as during operation:

- technical training for fitters and salesmen
- consultation and supply for the installation of an accumulator tank
- consultation for the installation of the exhaust system
- offering of the initial operation of the boiler and explanation of the parameters for an efficient, low emission combustion as well as the controlling of the firing (customer training)
- offering of a maintenance service available at usual customer service times
- offering of an annual examination of the heating
- availability of equivalent spare parts for at least 10 years

3.6 Adjusting and operating instruction

The instruction manual must include precise and definite information on the proper adjustment of the wood pellet firing by an expert. Adjustment according to the instruction manual must enable the operator to meet the requirements under paras. “Energy Efficiency” and “Pollutant Emissions” during operation. The instruction manual must include detailed information on how to adapt the pellet firing to the exhaust gas system as well as the combination with an accumulator tank.

Additionally, one has to point out that in Germany only wood pellets according to DIN 51731 or wood pellets with an equal quality (e.g. according to ÖNORM M 7135) are to be used in combustion plants in the private households.

The documents have to correspond at least to the standards of EN 303 part 5.

4. Testing

4.1 Testing Institutes

The testing is to be executed either by a neutral testing institute that is certified for testing “boilers for solid fuels” according to DIN EN 45001 or DIN EN ISO 17025 or by a testing institute that is accredited by the German Institute for Civil Engineering (Deutsches Institut für Bautechnik) as testing institute for firings of solid fuels. Testing covers the complete evidences in accordance with paragraph 3.1 to 3.6.

4.2 Testing methods

The measurements are to be made in each case at nominal load and partial load (minimal adjustable performance).

The testing, in particular the examination of the efficiency and emission request after paras. 3.2 and 3.4 are to be executed according to DIN EN 303-5.

Wood pellets according to DIN 51731 or equivalent quality (e.g. in accordance with OENORM M 7135) are to be used for the emission measurements.

4.3 Calibration gases and measuring instruments

Certified calibration gases are to be used for the calibration of the measuring devices. The certificates are to be attached to the test documents. Calibration gas generators must not be used.

5. Evidences

When applying for the certification of a product according to the ecolabel the following evidences must be provided:

5.1 The test report about the assessment of the devices including the affirmation of the fulfilment of the criteria specified in paras. 3.1 to 3.6 in combination with para. 4.

5.2 The instruction manual including the statements in accordance with para. 3.6.

5.3 The compilation of the examination results according to para. 3.3 with regard to determined supplementary electrical consumption, the power input and the water-side flow resistance

5.4 For the supply of the services indicated in para. 3.5 a declaration of commitment is to be submitted.

Annex 1 to the certification criteria

Measurement of Supplementary electrical consumption during different operating conditions

1. Supplementary electrical consumption in the operating conditions

During the measurements of supplementary electrical consumption in the operating condition the power input of the pellet boiler is to be determined with each nominal load operation, and partial load operation (minimal adjustable performance).

For this, the electrical consumption of the system (without consideration of the heating water circulation pump and the fuel delivering system) is to be determined over a measuring period of at least six hours according to DIN EN 303-5 for the technical test and, related to the measuring period indicated as average power input in Watts.

2. Supplementary electrical consumption in the stand-by mode (without heat production)

During the measurements of the supplementary electrical consumption in the stand-by mode, the power input of the pellet boilers is to be determined, as no heat request exist and only electrical consumers are switched on for the maintenance of the operational readiness.

For this, the electrical consumption of the system is to be measured over a time of at least 10 minutes. If processes of control and steering influence the electrical consumption, a longer measuring time can be necessary.

The determined electrical consumption is, related to the measuring period, to be indicated as average power input in Watts.

3. Supplementary electrical consumption for the ignition process

Supplementary electrical consumption of the firing device is to be determined for the duration of the ignition process and to be indicated as electrical work in Watt hours.

4. Power input of central components

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

5. Water-side flow resistance

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

Specifications are necessary for the type of regulation of the pump (multi-level with number of pump performance levels or automatically adjustably with specification of the range of control in %).

Draft for certification criteria for wood pellet furnaces

Transcription of the symbol for environmental protection: “because low emission and energy efficient”

1. Introduction

Wood pellet firings enable an efficient and low emission use of regenerative fuels because of their high degree of automation and because of the use of fuels with uniform quality for heating purposes. Thereby, they make a contribution to the climate protection and to the decrease of the use of non-renewable primary energy. The above-shown ecolabel may be used for marking of wood pellet furnaces, as specified in Scope, which make efficient use of fuel and cause clearly lower pollutant emissions than admissible according to valid DIN standards and the 1. BImSchV.

2. Scope

This criteria applies to wood pellet furnaces according to DIN 18894 (draft) with a nominal load up to and including 15 kW which are exclusively suitable for the application of wood pellets according to DIN 51731 or equivalent quality (e.g. ÖNORM M 7135).

3. Requirements

The ecolabel illustrated above may be used for the marking of the wood pellet firings specified in scope provided that they meet the following requirements:

3.1 General Requirements

Beside the following requirements on energy efficiency and emissions the compliance with the demands of the draft of DIN 18894 concerning construction and safety engineering is to be proved (avoidance of critical operating conditions with normal operation and with disturbed operation, limitation of the surface temperatures, possibility to switch off, electrical security).[70]

A central request on a product distinguished with an ecolabel is that it operates efficiently and low on emission during service life. Thus, only such devices are to be included in the scope of the ecolabel:

- which are exclusively operated with wood pellets, in order to exclude degradations of the efficiency and the emission behaviour by the application of qualitatively worse fuels (exclusion of combination boilers)
- in which the ignition and the burn regulation takes place fully automatically, in order to avoid errors by inappropriate operation (exclusion of systems with manual working operating controls (e.g. the adjustment of the combustion air supply by setting levers)).
- which represent a complete system and thus enable the evaluation of the system efficiency and the emissions of the system (exclusion of pellet burners)

3.2 Efficient Energy Utilisation

[70] Due to the legal bases further applicable EEC guidelines are e.g. the EMC guideline (EEC Directive 89/336/EEC on electromagnetic compatibility about the adjustment of the relevant law of the member states) are to be considered with the use of pellet furnaces.

The efficiency factors are to be determined in accordance with DIN 18894 (draft) at nominal load as well as at partial load (minimal adjustable performance).

The efficiency factor in accordance with DIN 18894 (draft) must not be lower than 90% at nominal load and at partial load.

3.3 Supplementary Electrical Consumption

Supplementary electrical consumption of the systems are to be determined in accordance with specification in annex 1 to the certification criteria. It may not exceed 1% of the produced thermal output during nominal load.

Supplementary electrical consumption at partial load operation (minimal adjustable performance), at stand-by (stand-by without heat production) and for the ignition process are to be determined and documented in the test report.

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

For water-based pellet furnaces the water-side flow resistance is to be determined in accordance with DIN 18894 (draft) and documented in the test report. If the device includes a heating water circulation pump, the electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

3.4 Emission requirements

The emission values specified below – related to exhaust gas under standard conditions (0°C, 1013 mbar) with an oxygen volume content of 13% – must not be exceeded. The measuring unit of the emission values (mg/Nm^3) must be understood as mg of pollutant per standard cubic meter of exhaust gas. Testing shall be done according to the measuring methods listed in para. 4.

Nitrogen oxides (NO_x)

The content of nitrogen monoxide and nitrogen dioxide in the exhaust gas at nominal load must not exceed 150 mg/Nm^3, given as nitrogen dioxide.

Carbon monoxide (CO)

The content of carbon monoxide in the exhaust gases may not exceed 200 mg/Nm^3 at nominal and 400 mg/Nm^3 at partial load (minimal adjustable performance).

Hydrocarbons

The content of hydrocarbons in the exhaust gas must not exceed 10 mg/Nm^3 at nominal and 15 mg/Nm^3 at partial load (minimal adjustable performance), indicated as total carbon (Total-C).

Dust

The content of dust emissions in the exhaust gas must not exceed 35 mg/Nm^3 at nominal load. The dust content in the exhaust gas at partial load (minimal adjustable performance) is to be indicated.

3.5 Services

The environmentally sound operation of a wood pellet heating is substantially influenced by the behaviour of the users. In order to positively influence this, the producer or service partners should offer specific services when selecting and installing a system as well as during operation:

- technical training for fitters and salesmen
- consultation and supply for the installation of an accumulator tank
- consultation for the installation of the exhaust system
- offering of the initial operation of the furnace and explanation of the parameters for an efficient, low emission combustion as well as the controlling of the firing (customer training)
- offering of a maintenance service available at usual customer service times
- offering of an annual examination of the heating
- availability of equivalent spare parts for at least 10 years

3.6 Adjusting and operating instruction

The instruction manual must include precise and definite information on the proper adjustment of the wood pellet firing by an expert. Adjustment according to the instruction manual must enable the operator to meet the requirements under paras. “Energy Efficiency” and “Pollutant Emissions” during operation. The instruction manual must include detailed information on how to adapt the pellet firing to the exhaust gas system as well as the combination with an accumulator tank.

Additionally, one has to point out that in Germany only wood pellets according to DIN 51731 or wood pellets with an equal quality (e.g. according to ÖNORM M 7135) are to be used in combustion plants in the private households.

The documents have to correspond at least to the standards of DIN 18894 (draft).

4. Testing

4.1 Testing Institutes

The testing is to be executed either by a neutral testing institute that is certified for testing “boilers for solid fuels” according to DIN EN 45001 or DIN EN ISO 17025 or by a testing institute that is accredited by the German Institute for Civil Engineering (Deutsches Institut für Bautechnik) as testing institute for firings of solid fuels. Testing covers the complete evidences in accordance with paragraph 3.1 to 3.6.

4.2 Testing methods

The measurements are to be made in each case at nominal load and partial load (minimal adjustable performance).

The testing, in particular the examination of the efficiency and emission request after paras. 3.2 and 3.4 are to be executed according to DIN 18894 (draft).

In addition to DIN 18 894 (draft), emission measurement of dust, nitrogen oxides and total carbon, have to be executed according to the measuring procedure in DIN EN 303-5, part 5.2, part 5.1.9.2 and part 5.1.0.4 considering the definition of a reference oxygen content of 13%. Deviating from DIN EN 303-5 the measurement of the dust content is to repeat after 1,5 hours of actual working time (measuring period 0.5 hours) up to the end of the duration of test according to DIN 18 894. At least two dust measurements are to be executed.

Wood pellets according to DIN 51731 or equivalent quality (e.g. in accordance with ÖNORM M 7135) are to be used for the emission measurements.

4.3 Calibration gases and measuring instruments

Certified calibration gases are to be used for the calibration of the measuring devices. The certificates are to be attached to the test documents. Calibration gas generators must not be used.

5. Evidences

When applying for the certification of a product according to the ecolabel the following evidences must be provided:

5.5 The test report about the assessment of the devices including the affirmation of the fulfilment of the criteria specified in paras. 3.1 to 3.6 in combination with para. 4.

5.6 The instruction manual including the statements in accordance with para. 3.6.

5.7 The compilation of the examination results according to para. 3.3 with regard to determined supplementary electrical consumption, the power input and the water-side flow resistance

5.8 For the supply of the services indicated in para. 3.5 a declaration of commitment is to be submitted.

Annex 1 to the certification criteria

Measurement of Supplementary electrical consumption during different operating conditions

1. Supplementary electrical consumption in the operating conditions

During the measurements of supplementary electrical consumption in the operating condition the power input of the pellet furnace is to be determined with each nominal load operation, and partial load operation (minimal adjustable performance).

For this, the electrical consumption of the system (without consideration of the heating water circulation pump and the fuel delivering system) is to be determined over a measuring period of at least one hour according to DIN 18894 (draft) for the technical test and, related to the measuring period indicated as average power input in Watts.

2. Supplementary electrical consumption in the stand-by mode (without heat production)

During the measurements of the supplementary electrical consumption in the stand-by mode, the power input of the pellet furnaces is to be determined, as no heat request exist and only electrical consumers are switched on for the maintenance of the operational readiness.

For this, the electrical consumption of the system is to be measured over a time of at least 10 minutes. If processes of control and steering influence the electrical consumption, a longer measuring time can be necessary.

The determined electrical consumption is, related to the measuring period, to be indicated as average power input in Watts.

3. Supplementary electrical consumption for the ignition process

Supplementary electrical consumption of the firing device is to be determined for the duration of the ignition process and to be indicated as electrical work in Watt hours.

4. Power input of central components

The power input to the following integrated components (if available) is to be indicated separately in Watts:

- blower engine(s)
- engine(s) for heat exchanger cleaning
- engine(s) for ash removal and fuel augers

If the device is equipped with a fuel delivering system (mechanical or pneumatic transport system), the power input to the engine(s) is to be indicated.

5. Water-side flow resistance

The water-side flow resistance is to be determined in accordance with DIN EN 303-5 and documented in the test report. The electrical consumption (min/max values) for the heating water circulation pump is to be indicated in the test report.

Specifications are necessary for the type of regulation of the pump (multi-level with number of pump performance levels or automatically adjustably with specification of the range of control in %).