About Swan-labelled

Boilers for solid biofuel

Version 2.0

Background for ecolabelling

Date 31/08/2006

Nordic Ecolabelling

Swan labelled Boilers for solid biofuel
Background for ecolabelling

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1 Summary

Nordic Ecolabelling recommends:

Tightened limit values for air emissions from pellet boilers
- CO recommended at 400 mg/m^3 at 10 % O_2,
- Particles at 40 mg/m^3 at 10 % O_2 and
- OGC at 25 mg/m^3 at 10 % O_2 .

Tightened limit values for air emissions from wood-fired boilers
- CO recommended at 1,500 mg/m^3 at 10 % O2.
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New limit value requirements for NOx of 340 mg NOx/m^3 at 10 % O_2 for both pellet and wood-fired boilers.

Tightened limit values for efficiency at a rated effect for both wood-fired and pellet boilers. In addition, requirements are introduced for efficiency such as an average value at low loads for pellet boilers.
At the time of the next review, requirements for seasonal performance efficiency should be considered.

2 Base facts on the criteria

2.1 Products that can be labelled

A heat source is classified as a primary heat source when **one** boiler provides the majority of heat, including hot water, in a house. A boiler heats water for distribution around a house. It is not designed to emit heat directly into a room. The size of the boiler is dependent on the heat and hot water requirement of the house. A wood-fired boiler is generally run periodically since the hot water is stored in an accumulator tank. Pellet boilers do not generally have an accumulator tank and are thus also fired at low loads.

Boilers that have a supplementary solar collector can be Swan-labelled and be marketed together. If a boiler is fitted with a solar collector, we also provide the opportunity of Swan-labelling a boiler fitted with a heating cartridge.

The product group comprises combined solid biofuel boilers/burners with an output of up to 300 kW. Solid biofuel refers to split logs, briquettes, pellets and chips as defined by EN 303-5. Straw is also a solid biofuel. The fuel can be fed manually or automatically.

Separate burners cannot normally be awarded the Swan label. If burners and defined boilers are tested together, the burner can be swan-labelled for sale together with the specified boiler. Single-room heat sources such as stoves, slow heat release fireplaces and open fireplaces are not covered by these criteria but by a separate criteria document.

2.2 Motives for Swan labelling

2.2.1 The role of the Swan and heat sources

In the light of the fact that several closely related methods or systems are in operation, a competitive situation may arise. However, many of the systems may be active as supplementary activities in a natural way.

The Nordic eco-label formulates requirements that are similar to those of other labels. However, we are alone in ecolabelling wood-fired boilers,
which has meant that manufacturers of efficient wood-fired boilers have been able to show that these in principle achieve emissions that are as equally low as those of medium-range pellet boilers.

In addition to the requirements for efficiency and emissions, the eco-label has been working to achieve a system approach for all the heating requirements in product groups like heat sources. This supplements the approach of using the results from life cycle analyses to see the consequences in its entirety, when selecting electricity or other energy carriers for heating. This also allows for optimal energy savings.

Furthermore, the EPDs also work based on life cycle analyses to the extent that these cover heat generation, that is to say district heating. This also allows for comparisons between different energy carriers for heating.

If the eco-label formulates criteria in an invitingly simple way, namely through unilaterally prioritising the use of renewable energy products and prioritising a reduction of the greenhouse effect in a way that is not properly thought out, this may have a conflicting outcome vis-à-vis eco-design and the EPDs. By way of example, favouring the use of peat will have a greater impact on the greenhouse effect than the use of fossil fuels. Biofuels may produce higher nitrogen emissions, higher particle emissions and result in a higher energy use without limiting the max values compared to the use of fossil fuels. Finally, the use of electricity can be promoted if a life cycle analysis of electricity generation is not included in the assessment. Promoting the use of electricity for heating conflicts with the European Commission's intentions of reducing the use of electricity to allow for the replacement of electricity generation.

In order for the eco-label to retain its special status when compared to other consumer communicated systems, and to ensure that resources are not squandered on data that has already been analysed, ecolabelling must be based on life cycle analyses similar to those of eco-design and EPDs. These are complemented with energy efficiency for electricity generation and requirements for optimising the heating system for the relevant climate zone. Our work will then result in genuine energy savings and peace of mind for the customer which should be expected to be a part of the task of the eco-label.

To sum up, Nordic Ecolabelling is of the opinion that ecolabelling of heat sources with respect to formulating all requirements are based on

- life cycle analyses including electricity generation,
- which comprises climate adjusted installation requirements and
- a system approach with respect to the heating of houses.

The results produce optimal energy savings and a reduced load on the environment which is comparable and quantifiable.

Having this kind of approach for basing the formulation of the actual requirements facilitates the process and ensures the licence procedure is kept as simple as possible.

The approach mentioned above is probably not familiar to everyone in the biofuel industry, but nevertheless by a significant proportion. The use of terms like system approach is not particularly prevalent in the sector unlike targets for high efficiency and emission requirements for low loads.
The aim is to select the right size of boiler that matches its expected use. Another solution is that the manufacturer has adapted the lowest loads in such a way that usage meets the same requirements as for a rated load.

Use of electricity in the heating system is normal for heating with biofuel. Circulation pumps as well as fuel feeders consume electricity in such a way that this even has an impact on the energy and emission outlook. It is therefore time to start thinking in terms of a system approach and seasonal performance efficiency. However, it is irrelevant at the current time to introduce requirements formulated as average values over a year, but the working formats for how generalisations are to come about and how calculation programs should be designed should be initiated.

2.2.2 General approach to heat sources

As early as 1996, work began at Nordic Ecolabelling on finding a uniform policy for assessing all heating systems that, wherever practically possible, have similar grounds for assessment for heating houses. The parameters that gave reason for consideration were deemed to be the emissions that the government of each country assessed as being detrimental to the environment and where decisions on plans of action had been taken. These were carbon dioxide, nitrogen oxide, sulphur oxides, hydrocarbons and particles. Energy savings were on the agenda but there was no framework in place to monitor this parameter. The issue was particularly awkward, especially in relation to how the assessment of electricity consumption was to be handled.

Nordic Ecolabelling has not had any standpoints over the period as to whether the selected emission parameters should be supplemented. However, the question of evaluating electricity consumption is constantly on the agenda.

What could then be a reasonable environmental load per kWh useable heat from eco-labelled heat sources? Traditionally the approach of the Nordic eco-label has been to set the limit value so that around 30 % of the boilers on the market can meet the requirements.

As regards efficiency, it is relatively difficult to assess. In the long-term therefore, it is reasonable to look at seasonal performance efficiency as the selection of products and systems affects the amount of energy raw material/carrier the consumer needs to buy to a great extent. Ecolabelling should inform the customer on this. Only determining the efficiency from the best feasible running is of no interest if, after installation, it is evident the heating system works for the most part under different conditions, such as

low loads that have a different and inferior level of efficiency and higher emissions. Assuming that the seasonal performance efficiency should amount to 80 % is relatively modest, but there are reasons for caution. The absolute biggest change at this time is trying to promote the development of manufacturers assuming more responsibility for, in one way or another overseeing the entire contract and being responsible for it being installed in the planned way.

2.2.3 Primary energy consumption

Boilers for solid biofuel have their primary energy supply from wood or pellets.

In the event of the introduction of seasonal performance efficiency on a later occasion, electricity consumption for pellet feeders and circulation pumps should also be included when calculating seasonal performance efficiency. As the EU commission approach is to assess electricity generation on a common European basis in a directive for energy end-use efficiency and energy services (10.12.2003 COM(2003) 739 final 2003/0300 (COD), it is appropriate to have the same approach when evaluating environmental factors for heat sources. A proposed factor in the directive is 2.5 which corresponds to an efficiency for electricity generation of 40 %.

Fuel consumption and electricity consumption together can form the basis for seasonal performance efficiency that can be calculated based on how much a selected boiler runs at low loads or rated effect. A reasonable starting point is to assume that an **eco-labelled heating system** should reach a level **of 80 % as seasonal performance efficiency.** It is not a particularly tough requirement, but rather a reasonable requirement for an initial phase.
With respect to boilers, the efficiency is normally measured at rated effect, which represents the best feasible operational conditions. However, the boiler may run at low loads for the majority of the time it is in use depending on the selection of output when installing. As regards boilers, we also recommend introducing requirements at low loads as a step along the way.

A **supplementary heat source** will seldom reach the same level of efficiency as the possibility for optimisation is not available to the same extent, nor as a rule is it great enough to attain optimal combustion. It is therefore reasonable to set lower requirements. However, supplementary heat sources should also be tested in relation to the relevant climate zone as low loads as a rule produce inferior environmental performance and even supplementary heat sources are affected by the ambient climate. It is therefore reasonable to have lower requirements for supplementary heat sources as a goal. However, an efficiency of **70 % should be possible as a seasonal performance factor.**

Conclusion: Initially it is appropriate to use 80 % and 70 % as the starting points for setting requirements for seasonal performance efficiency for ecolabelling of heating systems and supplementary heat sources. The formulation of the actual requirement is adapted to suit the relevant testing methods of each heat source. In this case the requirements are formulated as limit values for rated effect and as an average value for defined low loads.

2.2.4 Impacts on the greenhouse effect

As the principal energy supply comes from biofuel, the net emissions of carbon dioxide are zero. In a fully developed line of argument, carbon dioxide emissions from the electricity consumption of driers and pellet can be taken into account.

By multiplying the amount of kWh of electricity by a factor for carbon dioxide that represents an average kWh of electricity in Europe, we can calculate the impact on the greenhouse effect over a year and for an average kWh of heat. A representative factor for electricity generation is 362 - 385 g carbon dioxide per kWh of electricity. (Ref. IEA and IPCC) The differences are due to different ways of allocating. Both methods have disadvantages and advantages and it is recommendable to use the higher value, that is to say 385 g/kWh of electricity

As a starting point for setting limit values for a **heating system**, it is recommended that impacts on the greenhouse effect do not exceed **200 g carbon dioxide/ kWh heat over the course of a year**.

Conclusion: Initially it is appropriate to use 200 g carbon dioxide/kWh heat for a year. The formulation of the actual requirement is adapted to suit the relevant testing methods of each heat source.

In the case of boilers for solid biofuel, the emissions from the boilers do not come anywhere near a general limit value, as the fuel is made up of biofuel.

2.2.5 Other emissions

At a rough estimate, it is the primary energy consumption and carbon dioxide that are vital for where the limit values should be set in general terms. Nitrogen oxides, sulphur oxides, hydrocarbons and particles are important parameters for the local environment and the limit values must be stringent enough to eliminate the risk of causing health problems following exposure to the local environment. Checks should also be made of the nitrogen oxide emissions that may be sufficiently large enough to have an effect at a regional level.

2.2.6 Surface treatment

We have included in the criteria for heat sources how the product is to be surface treated. As regards paint, there is a requirement that certain solvents and heavy metals may not be included in the paints, where this can be dealt with technically. However, the dry method cannot be used for surfaces that have very high temperatures. This means that stoves cannot be painted using paint without solvent. In addition, there are requirements for paint with less than 5 % solvent. The reason for this is to reduce solvent emissions.

Requirements on heavy metals in paint are covered by the RoHS directive, but we set our own requirements despite this. This is on the behest of a range of authorities.

2.2.7 Dangerous chemicals in plastic

Dangerous chemicals in the form of fire-retardant products, phthalates and heavy metals may be used in plastics. Many of these substances are covered by the RoHS

directive. The requirements are not included in the criteria. There are extremely few plastic components in the products and a negligible amount of electronics. Manufacturers are therefore very small customers of plastic and electronic suppliers and these have therefore difficulties with respect to receiving information. If requirements are in place, this could lead to the ecolabelling not leveraging gains to the environment as the lack of information on plastics might delay a licence application.

2.3 Criteria version and validity

The criteria were set December 14, 2000. The criteria were modified in 2001. The document was extended. In 2003 the criteria were extended to cover the period up to December 2006. The criteria were evaluated in the autumn of 2005. The text was added to a new template and certain requirements were modified in line with other criteria for heat sources. The criteria were also extended up to the current validity period 31/12/07.

2.4 The Nordic market

Brief description of the industry in the Nordic market.

2.5 Other labels and regulations

2.5.1 Regulations

Regulations for emissions from fireplaces and boilers have been set in the Nordic countries apart from Finland. These regulations are currently being reviewed and developed. Regulating emissions is recommended in the building regulation ”D8:Emissions and efficiency from heat sources for wood fuel, regulations 2008; Ministry of the Environment”.
The proposal contains regulations for heat sources with a maximum output of 300 kW. The fuels in question are wood, wood briquettes and wood pellets. The regulations are due to come into force on January 1, 2008.

The limit values in the review for the Swan eco-label are more stringent than what is recommended in the building regulations in Finland. These limit values are recommended as follows at 10 % O2:

Output (kW)	CO mg/m3	OGC mg/m3
< 50	3,000	100
50-150	2,500	80
> 150	1,200	80

The requirement for efficiency amounts to > 67 + 6 logP

2.5.2 Important standards

EN 303-5 is the standard used for testing. There are no plans to review the standard, but a low load of 30 % has been discussed. The current standard for pellet burners is EN 15 270.

2.5.3 Other consumer communicated systems

Energy labelling, Ecodesign and Environmental Product Declarations currently do not have criteria for labelling solid fuel boilers.

2.5.4 Other eco-labels

2.5.3.1 The Flower

Criteria are currently being developed for ecolabelling heat pumps. The task was performed based on the criteria being formulated in such a way that the requirements and method could also be used as criteria for other heat sources. The requirements are based on the relevant parameters in a life cycle analysis that impact on the environment. It is likely that the development of criteria will take place for other product groups for heat sources. However, there are currently no criteria for boilers for solid biofuels.

2.5.3.2 P-labelling

SP has P labelling of pellet fired boilers, but not wood-fired boilers. It is also possible to P label separate pellet burners. The P labelling sets requirements for both efficiency and emissions. However, there are no requirements for NOx emissions. The requirements are set with an oxygen content of 10 %. The limit value is set as an average value of several test points.

The limit value for OGC is 75 mg/m^3 and for CO is 2,000 mg/m^3. The following boilers are P labelled. Baxi, Multiheat 1.5; Passat Energi, Compact C1,2,4,6 and Thermia, Biomatic+, Bionet+.

2.5.3.3 The Blue Angel

The German eco-label the Blue Angel has criteria for pellet boilers. The requirements are tough and manufacturing of boilers in Germany give the impression of meeting a higher requirement level than Scandinavian manufacturing does in general.

The tests are made with an oxygen content of 12 %. The requirements are set in relation to rated load and at a partial load of 30 % of the rated load.

	Efficiency	CO mg/m^3	C mg/m^3	NOx mg/m^3	Particles mg/m^3
Rated loadt	90 %	100	5	150	30
Low load	88 %	300 (< 15 kW) 250 (15-50 kW)	5		

The following licences have been registered.

Biotech	Type PZ15RL; Wärmeleistungsbereich: 4.5 - 14.9 kW
	Type PZ25RL; Wärmeleistungsbereich: 6.7 - 25.0 kW
Guntamatic- Heiztechnik	Bio Star 23, 23 kW; 6.9-22.2 kW
KWB Kraft und Wärme aus Biomasse	KWB USB 20

WHG Heiztechnik	Lino Star 15, 4.0-14.9 kW
SOLARvent Biomasse Heizsystem	Solarvent IQ 150, 4.0-14.9 kW
SOLVIS & CO KG	Sovis Lino LI 20

2.5.3.4 Austrian standard

There is a special provision for Salzburg which has particularly stringent limit values, Verordnung der Salzburger Landesregierung vom 6 nov 2001 uber das Inverkehrbringen, die Errichtung, die Ausstattnung und den Betrieb von Feuerungsanlagen. It includes limit values for CO, OGC, NOx and particles, both for new installations and for checking installed boilers, known as surveying.

The limit values apply to rated load as well as partial loads. 4- 400 kW

	CO (mg/MJ)	NOx (mg/MJ)	OGC (mg/MJ)	Particles (mg/MJ)
Manual feed	1,100	150	80	60
Automatic feed	500*	150	40	60

For a partial load of 30 %, the limit value may be exceeded by 50 %.

3 About the development of criteria / review

3.1 Targets with criteria development / review

The following issues have been set for prioritising during the evaluation:

1/Is there justification for tightening the limit values for emissions from pellet boilers?
2/Is there justification for introducing limit values for NOx?
3/Is there justification for expanding the product group to include separate pellet burners?

3.2 About this criteria development / review

The Project group has come to the conclusion that a minor review should be made between the secretariats in 2006. The appointed secretariat is SIS Ecolabelling and the appointed Project Manager is Marianne Pettersson. Birgitte Holm Christensen, Denmark, Harri Hotulainen, Finland and Randi Rödseth, Norway have been Product Group Managers in each country.
The review has been made internally but included communications with manufacturers and other interested parties, albeit relatively infrequent.

4 Substantiation of requirements

4.1 Efficiency

Current requirements for boilers adhere to the power output for nominal running. See the formulation of the requirement below:

Boiler efficiency, η_k is to amount to:

Manually fed boilers: $\eta_k = 69 + 6 \log Q_N$

Automatically fed boilers: $\eta_k = 72 + 6 \log Q_N$, where Q_N stands for the boiler's rated effect.

A Swan labelled wood boiler is always fitted with a dimensioned accumulator tank and the boiler will therefore be fired at a rated load when in use. The efficiency that is of interest is therefore always at full load. It is our understanding that it is appropriate to tighten the requirements at rated load for wood boilers.

Manually fed boilers: $\eta_k = 73 + 6 \log Q_N$

where Q_N stands for output at rated load

A pellet boiler also runs at low loads depending on how large the heating needs are. This varies over the year and the boiler will run more frequently at a low load over the summer when the need for heat is low, while it will have higher loads more often during the winter when the need for heat is greatest. It is therefore relevant to even include requirements for efficiency at lower loads for pellet boilers. It is important to the customer to receive relevant information on efficiency in order to get an understanding of the costs of purchasing fuel.

It is appropriate to measure efficiency for the same low loads that were measured for the emissions. These are 20, 40 and 60 %. The limit value is set as an average value of the measured efficiencies.

We recommend a tightening for

Automatically fed boilers: $\eta_k = 75 + 6 \log Q_N$ rated load

and $\eta_x \geq 86\ \%$ low loads

where $\eta_x = (\eta_{20} + \eta_{40} + \eta_{60}) / 3$

where η_{20}, η_{40} , η_{60} stands for the measured efficiency at 20, 40 and 60 % loads.

Conclusion: It is appropriate to expand the requirements for efficiency for pellet boilers by an average value for measured efficiencies for three low loads.

SPF: Seasonal Performance Factor

A pellet boiler is fitted with a screw that feeds the fuel. It is run by an electric motor. The heating system is also fitted with pumps to circulate hot water around the house. Making these motors more efficient leads to a drop in electricity needs. What is ultimately of interest is the energy consumption for the entire heating system in a house. The energy needs vary over the year depending on the climate and size of the boiler. For a strict optimisation, an assessment should be made for the whole system in relation to the relevant climate and house. The customer can then attain relevant information on the amount of fuel and electricity that needs to be purchased. Efficiency of this type is called seasonal performance efficiency. A reasonable requirement is reaching a level for seasonal performance efficiency of 80 %. However, it is appropriate to make manufacturers aware that a requirement of this

type needs to be discussed before a change of this type is made. Principles for handling data in the industry need to be discussed.

Conclusion: At the time of the next review, requirements for seasonal performance efficiency should be considered.

4.2 Emission requirements

Manually fed boilers, that is to say wood-fired boilers are only measured at rated load. Pellet fired boilers or automatically fed boilers are also measured at three low loads (20, 40 and 60 %). The requirement must be met at a rated effect and as an average value of the results of the three measurements at low load.

Table 1: Limit values for air emissions.

Boiler heat output	**x ≤ 100 kW**	**100 < x ≤ 300 kW**
OGC (mg/m^3 tg at 10 % O_2)	70	50
CO (mg/m^3 tg at 10 % O_2)	1,000* / 2,000**	500* / 1,000 **
Particles (mg/m^3 tg at 10 % O_2)	70	70

*automatically fed boilers
** manually fed boilers

The measurements are made at 10 % oxygen and in the chimney. The results are therefore presented as a concentration of an air test in mg/m^3. The limit values for the different tests are presented with varying oxygen content and also for a unit of fed fuel. All limit values are therefore recalculated to MJ fed fuel for comparison purposes.

mg/ MJ fed fuel	**CO**	**OGC**	**particles**	**NOx**
Swan wood (rated) (<100 kW) / (100<x<300kW)	877 / 438	31 / 22	31	-
Swan pellets (rtd., av. lwload) (<100 kW) / (100<x<300kW)	438 / 219	31 / 22	31 Only rated	-
P- pellets	877	33	-	-
Blue Angel (< 50 kW) pellets rated	54		16	80
Blue Angel (< 50 kW) low load	160 / 134		-	-
Salzburg wood 4- 400 kW Lab: rated, low load	1,100	80	60	150
Salzburg pellets 4-400 kW Lab: rated, low load	500	40	60	150
Swan recommendation pellets	175	11	18	150
Swan recommendation wood-fired boilers (<100 kW/100-300kW)	656 / 438	31/22	32	150

At Swan labelling we have concluded that we have the opportunity to tighten the limit values. The information we have used includes data from the Danish Technological Institute. http://www.biomasse.teknologisk.dk/kedler/index.htm

Pellet boilers: We recommend a limit value of 400 mg CO/m^3 at 10 % O_2, 40 mg particles and 25 mg OGC recalculated as per the table above. The limit values must be

met at a rated load and as an average value of the measured results at the three low loads.

Wood-fired boilers: We recommend a limit value of 1,500 mg (< 100 kW) and 1,000 mg (100-300 kW) CO/m^3 at 10 % O_2. The limit value for particles and OGC is not tightened for wood-fired boilers but stays at 70/50 mg for OGC and 70 mg for particles.

Emissions of nitrogen oxides are important as a rise in the nitrogen oxide content is not a preferred option from the sector for heating houses. The higher the requirement for good combustion the higher the risk of an increase in emissions of nitrogen oxide. One consequence would be the need to introduce requirements for nitrogen oxide. As this is the first time requirements are set for Nordic Ecolabelling there are reasons for caution. Manufacturers must be able to adapt their production. It is appropriate as an initial step to introduce a requirement in line with the Salzburg range of 150 mg / MJ fuel recalculated to 342 mg NOx/m^3 at 10 % O_2.

Conclusion: Recommendation for tightened limit values for CO and particles of 400 mg CO/m^3 at 10 % O_2, 40 mg particles and 25 mg OGC for pellet boilers, and the recommendation for tightening the limit value for wood-fired boilers with respect to CO to 1,500 mg for the smaller boilers.
Recommendation for introducing a limit value for NOx of 340 mg NOx/m^3 at 10 % O_2 for all boilers.

5 Changes from previous version

It is appropriate to measure efficiency for the same low loads that were measured for the emissions. These are 20, 40 and 60 %. The limit value is set as an average value of the measured efficiencies.

Recommendation for tightened limit values for CO and particles of 400 mg CO/m^3 at 10 % O2, 40 mg particles and 25 mg OGC for pellet boilers, and the recommendation for tightening the limit value for wood-fired boilers with respect to CO to 1,500 mg for the smaller boilers.

Requirement for limit value for NOx has not previously been set. This is recommended for introduction, see previous chapter.

6 New criteria

At the time of the next review, requirements for seasonal performance efficiency should be considered.

7 References

The German eco-label the Blue Angel (www.blauer-engel.de)
The European eco-label; the Flower http://ec.europa.eu/environment/ecolabel/
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IPCC-TEAP report on Ozone and Climate, chapter methodologies
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