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Background document to the proposed biofuel pellet criteria

Summary:

The ecolabelling of biofuel pellets ensures a high grade of fuel for Swan-labelled pellets boilers and stoves. High-grade biofuel pellets better enable optimum combustion, which means lower emissions and environmental impact.

High-grade pellets are of a uniform quality, meeting strict tolerances regarding parameters such as density, moisture content and size. This is especially important for stoves.
The fuel pellets must have a low ash content, and be sulphur and chlorine free. Pure wood raw material enables the manufacture of biofuel pellets of such a grade.

The ash melting point reveals whether sand has been mixed with the wood chips. This can cause sintering in the stove.

The biofuel pellets must also be transported and stored in purposed-designed systems to prevent crushing. Crushed pellets are difficult to load into a stove or boiler, which impedes combustion.

1. Summary

Swan Ecolabelling has chosen to establish criteria for biofuel pellets due to variations in a number of parameters between batches. This means that for optimum combustion the burner must be adjusted. We believe it unlikely that the user will do this. The technical specifications of the biofuel pellets must be made more accurate and provide less scope for variations that affect combustion. Similarly, transportation and storage facility design can be detrimental to fuel pellet grade. Requirements controlling delivery and customer information are thus necessary.

The criteria for biofuel pellets are the first criteria for fuel that Swan Ecolabelling has produced. They focus primarily on fuel grade, which is a key factor in minimising emissions from combustion. Other areas covered include the choice of raw materials, procedures to guarantee the purity of the raw material, and the limitation of the use of carbon dioxide producing fuels in the drying process. Another important aspect is the delivery of the ready fuel pellets to the customer.

The most significant difference between the criteria and requirements from other standards bodies is that Swan labelling limits the variation in moisture content and density. This ensures efficient combustion without requiring the burner to be adjusted between deliveries of fuel pellets. Furthermore, the requirements ensure a low ash content and high fuel grade. Requirements on sulphur and chlorine content ensure that the raw material meets standards.

An issue that requires special attention in the evaluation and review of the criteria is whether there are any environmental grounds for limiting the use raw materials other than by and waste products. If this proves to be the case, should a requirement of certified wood be introduced? Such requirements are not included in the criteria proposal since the raw material comprises entirely of by-products. In any case it is beneficial if the wood chips and shavings burnt. The method of forestry is not controllable so long as the raw material comprises solely by-products. However, controllability is introduced if virgin wood is felled for fuel pellet production (not windfall).

2. Background

There is no long-standing tradition of biofuel pellet manufacture. Production is as yet in its infancy, with continual development influenced by the availability of raw materials, energy prices and demand. The “packaging” of the biofuel in pellets form prior to transport is beneficial.

The market for biofuel pellets is also growing through diversification. For example, fuel pellets are used in district heating plants in Denmark. In Sweden, fuel pellets are primarily used for boilers and stoves for private use. The market for stoves is relatively new, and a special grade for stoves has not yet been standardised.

We consider there is a need for pelleted biofuel for Swan-labelled burners, stoves and boilers, if these in actual use are to maintain the low emissions limits set in criteria. The fuel must be of an even high grade and produced from specific, tested raw materials, with more restricted intervals than permitted by the European Standard currently under development. Such a fuel also improves the emissions from non-Swan-labelled burners.

3. Controllability

3.1 Important standards

3.1.1 European Standard CEN/TC 335

A European Standard is under development within TC 335. Some sections are already finalised. The section covering fuel specifications is presently under subject to formal voting. These specifications are intended to be normative, while certain other sections are informative. Birgitte Holm Christensen, who is involved in energy issues at Ecolabelling Denmark, has compiled the following summary:

Solid biofuels – Fuel Specifications and Classes. Final Draft prCEN/TS 14961

The standard specifies solid biofuels in two ways, by
1. *Origin and source*
2. *Major traded forms and properties*

Specifications for special high quality classes recommended for household usage in each of the traded forms of wood pellets, wood briquettes, wood chips and wood logs are given in an Annex A of the standard. The setting up of criteria for the swan label can use these as a base.

Origin and source as described in standard. The main origin-based solid biofuel groups in the standard are: w*oody biomass, herbaceous biomass, fruit biomass and blends and mixtures.* These are divided into different sources specifying whether the biomass is a by-product from the industry or if it is virgin material. These are further divided into subgroups identifying the biological type of biomass, for example deciduous wood or coniferous wood, whole plant, straw parts, grains or seeds for cereal crops.

Specification of solid biofuels based on **traded forms and properties** as in standard size and shape of the fuel, influence the handling of the fuel as well as its combustion properties. Pellets are described as having a diameter of less than 25 mm and briquettes as larger. Both are made by mechanical compression. The standard identifies which parameters are to be specified (normative) and which are voluntary (informative). For pellets, the following are normative:

Dimensions
Mechanical durability
Moisture
Ash
Additives (declaration)
Sulphur
Nitrogen

and the following informative:

Net calorific value or energy density
Bulk density
Chlorine

The standard gives recommendations for wood briquettes, wood pellets, wood chips and wood logs. Example of specifications for high quality classes of wood pellets recommended for household usage:

Origin ***1.2.1.1 Chemically untreated wood, wood excluding bark***

Dimensions	*D06: Diameter ≤6 mm ± 0.5 mm and Length ≤5 x Diameter or* *D08: Diameter ≤8 mm ± 0.5 mm and Length ≤5 x Diameter*
Energy density	*E4.7 (Ear* ***≥4.7 kWh/kg*** *= 16.9 MJ/kg* *Ear is Net calorific value (MJ/kg as received) or energy density (kWh/m^3 loose)*
Mechanical durability	*DU97.7 means* ***better than 97.7 % w-% of pellets after testing***
Moisture content	*M10, means* ***≤10 % (w-% as received)***
Ash content	*A0.7 means* ***≤0.7 w-% of dry basis***
Additives	***<2 w% of dry basis****. Only products from the primarily agricultural and forest property biomass that are not chemically modified are approved to be added as a pressing aid. Type and amount of additive has to be stated.*
Sulphur content	*S0.05 means* ***≤0.05 w-% of dry basis***

Standardisation work is also underway to develop and establish test methods.

Table 1

Parameter	Normative	Unit	Limit value	Method
Origin	Normative			TS 14 961
Dimensions: Diameter (∅); length (l)	Normative	mm	∅≤6± 0.5; *l* ≤5 x ∅ ∅≤8± 0.5; *l* ≤5 x ∅	TS 14 961
Energy density	Discretionary	kWh/kg	(4.7)	TS 14 918
Bulk density	Discretionary	kg/m^3		prCEN/TS 15 103
Mechanical durability	Normative	% by weight	97.7	Formal vote
Moisture content in traded form	Normative	% by weight	≤ 10	TS 14 774-1
Ash content	Normative	% by weight of dry matter	≤ 0.7	TS 14 775
Additives content	Normative	% by weight of dry matter	<2 *	
Sulphur content	Normative **	% by weight of dry matter	≤ 0.05	Finalised in Oct.
Chlorine	Discretionary			Finalised in Oct.
Nitrogen	Normative **			PrCEN/TS 15 104

** Only products from primarily agricultural and forest property biomass that are not chemically modified are approved to be added as a pressing aid. The type and amount of additive must be stated.*
*** Only normative if additives present.*

3.1.2 Swedish Standard SS 18 71 20

Swedish Standard SS 18 71 20 deals with fuel pellets. It contains limit values for chemical and physical properties. This standard is not based on the use of wood as the raw material (see the definition in the section on raw material). Almost all pellets sold to households in Sweden are manufactured from pure wood.
The standard defines three groups. Group 1 is the top group and most relevant for comparison with Swan label criteria.

Table 2

Property	Unit	**Group 1**	*Group 2*	*Group 3*	*Method*
Dimensions: diameter length (in mfg stock)	mm	**specified by manufacturer** **max. 4 x ∅**	*specified by manufacturer*	*specified by manufacturer*	

			max. 5 x ∅	*max. 5 x ∅*	
Energy density *(in traded form)*	MJ/kg	**–{}–≥ 16.9**	*–{}–≥ 16.9*	*–{}–≥ 15.1*	*SS ISO 1928*
	kWh/kg	**–{}–≥ 4.7**	*–{}–≥ 4.7*	*–{}–≥ 4.2*	
Bulk density	kg/m^3	**–{}–≥ 600**	*–{}–≥ 500*	*–{}–≥ 500*	*SS 18 71 78*
Mechanical durability. (in mfg stock)	Fines content * % by weight <3 mm	**–{}–≤ 0.8**	*–{}–≤ 1.5*	*–{}–> 1.5*	*SS 18 71 80*
Moisture *(in traded form)*	% by weight	**–{}–≤ 10**	*–{}–≤ 10*	*–{}–≤ 12*	*SS 18 71 70*
Ash content	% by weight of dry matter	**–{}–≤ 0.7**	*–{}–≤ 1.5*	*–{}–> 1.5*	*SS 18 71 71*
Sulphur	% by weight of dry matter	**–{}–≤ 0.08**	*–{}–≤ 0.08*	*specified by manufacture r*	*SS 18 77 77*
Chlorine	% by weight of dry matter	**–{}–≤ 0.03**	*–{}–≤ 0.03*	*specified by manufacture r*	*SS 18 71 85*
Ash melting behaviour	Degrees C	**specified by manufacturer**			*SS –ISO 540*

** The method of measuring fines content specified in the Swedish standard differs from that discussed by CEN.*

A standard is also under development in Finland. The Swedish standard is also used in Norway under the designation NS 3165. Denmark does not have its own standard.

3.1.3 Austrian Ecolabelling UZ 38/ ÖNORM M7135

Austria has ecolabelling standards for compressed wood and bark biomass. The wood biomass standard includes two pellet grades and one briquette grade. One difference between the grades is size. The top grade is of a smaller size.

Table 3

Property	**HP1**	HP2
Diameter D (mm)	**4 <D <10**	10 <D <40
Length (mm)	**= 5 x D**	= 4 x D
Energy density (MJ/kg)	**=18.0** (5 kWh/kg)	=18.0
Particle density (kg/dm^3)	**=1.12**	=1.00
Dust weight (%)	**=2.3**	
Durability weight (%)	**97.7**	-
Moisture -”-	**=10.0**	=10.0
Ash content -”-	**=0.50**	=0.50
Compression additives -”-	**=2.0**	=2.0
Sulphur -”-	**=0.04**	0.04 – 0.80 *
Nitrogen -”-	**=0.30**	=0.30
Chlorine -”-	**=0.02**	=0.02
Chromium (mg/kg)	**=8**	=8
Copper (mg/kg)	**=5**	=5

** Limit of 0.80 permitted if the woody raw material itself naturally influences the ash content.*

3.1.3 German Standard DIN 51731 (briquettes and pellets)

Table 4

Property	**HP1**
Diameter D (mm)	**4 <D <10**
Length (mm)	**<50 mm**
Energy density (MJ/kg)	**≥17.5 and ≤ 19.5 (MJ**/kg)
Particle density (kg/dm^3)	**≤ 1.0 and ≤ 1.5**

Dust weight (%)	
Durability weight (%)	
Moisture -"-	**≤12 %**
Ash content -"-	**≤1.5**
Compression additives -"-	
Sulphur -"-	**≤0.08**
Nitrogen -"-	**≤0.30**
Chlorine -"-	**≤0.03**

4 Market overview

4.1 Manufacture and consumption

The following data has been taken from the website of the European Pellet Centre[1]. The tables for each country describe manufacture, consumption and trade in 1,000 tonnes per year. The situation in the Nordic countries vary. Figures are given for the last four years to allow an assessment of how and at what pace the market is developing.

4.1.1 Denmark

Denmark consumes its entire supply of domestically produced fuel pellets and also imports large quantities.

Table 5: (1,000 tonnes/year)

	2001	2002	2003	2004
Capacity	300	330*	330	480
Production	173	181	270	420
Export	0	0	0	0
Domestic consumption	371	396	593	748
Import	200	215	323	328
Storage	27	?	?	?

4.1.2 Finland

The figures from Finland, somewhat surprisingly, show a capacity similar to Denmark. Domestic consumption is marginal.

Table 6: (1,000 tonnes/year)

	2001	2002	2003	2004
Capacity	?	?	330	410*
Production	75	126	173	240*
Export	60	97	134	?
Domestic consumption	11	24	39	?

[1]European Pellet Centre. http://www.pelletcentre.info/ 2005.01.30

Import	?	?	?	?
Storage	4	5	0	?

4.1.3 Norway [2]

The combined production of fuel pellets in Norway was approximately 20,000 tonnes (approx. 0.1 GWh) in 2003. There was a considerable increase in production in 2004 (see Table 7.1). The figures for the various manufacturers are however somewhat uncertain. Table 7.1 lists Norwegian fuel pellet manufacturers, manufactured quantities and capacity.

Table 7 Quantities manufactured by Norwegian fuel pellets manufacturers (tonnes)

Manufacturer	2001	2002	2003	2004	Capacity
Statoil	7,500	7,500	10,000	9,000	20,000
Norsk Pellets AS	6,000	2,000	3,000	20,000	50,000
Vi- Tre AS	1,500	1,600	1,600	4,500	
Vaksdal Biobrensel AS	1,000	1,200	1,600	1,600	10,000
Frya Bioenergi AS	0	1,500	3,550	5,000	8-10,000
NorPellets AS Testproduksjon				5,000	10,000
Møre Biovarme				4,000	7,000
Total	**16,000**	**13,800**	**19,750**	**49,100**	**107,000**

Fuel pellets production in Norway is on the rise. New manufacturers are entering the market and established manufacturers are increasing their output. The capacity of all the facilities listed is larger than current production and many producers presently have full stocks. The main reason why manufacturers are unable to take advantage of this capacity is the low demand and insufficient quantities of raw material at a reasonable price. Since demand for fuel pellets is high in Sweden and other neighbouring countries, production could exceed domestic demand if Norwegian fuel pellet manufacturers are able to compete with foreign manufacturers with regard to price, grade and transport costs. Presently, only Norsk Pellets AS exports fuel pellets to Sweden.

The annual production of fuel pellets varies widely between manufacturers. In international terms, the Norwegian plants are relatively small. For example, Sweden has plants with an annual capacity of 300,000 tonnes. Enova has in its present project portfolio a planned production capacity of about 120,000 tonnes. This figure is based on the capacity of the present and planned plant. It assumes that plant capacity is utilised to the full. Production is estimated to grow to 100,000 tonnes in the course of three years.

4.1.4 Sweden

The data on Sweden is less comprehensive than that for the other countries. Sweden produces the largest quantity of fuel pellets among Nordic countries. No capacity figures are given.

Table 8: (1,000 tonnes/year)

	2001	2002	2003
Capacity	?	?	?

[2] Muligheter og barrierer for utvikling av et norsk trepelletmarked, H.Nashoug, F. Dahl-Paulsen Pedersen

Production	782.0	766.5	869.0
Export	49.4	36.1	5.8
Domestic consumption	906.3	902.3	1128.8
Import	173.6	172.0	265.5
Storage	?	?	?

4.1.5 Europe

Austria

Table 9: (1,000 tonnes/year)

	2001	2002	2003	2004
Capacity	130	160	240	370*
Production	110	140	180	270*
Export	30	30	40	60*
Domestic consumption	80	110	140	210*

Germany

Table 10: (1,000 tonnes/year)

	2001	2002	2003	2004
Capacity	23	72	123	227*
Production	?	65	90	200*
Export	2.6	10.5	13.5	?
	24	67	91	140*
Import	14.5 - 30*	18 - 30*	25*	<25*
Storage	?	11.5*	10.5*	?

4.1.6 The Baltic States

SIS Ecolabelling commissioned a small-scale market survey of manufacturing in the Baltic States and neighbouring countries. Henry Kenamets from Bokskogen has conducted the survey[3].

There is a possibility of receiving license applications from a couple of companies in Estonia and Latvia, a new large firm in Lithuania, and three or four manufacturers in Poland. The industry is experiencing strong growth and it is highly likely that there will soon be new

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[3] *Market survey for Swan Ecolabelling of fuel pellet production in Estonia, 12 October 2004.*

prospective license applicants in Poland. The situation in Poland is difficult to evaluate due to the country's geographical size.
The fuel pellets trade has become increasingly international. Biofuel pellets are currently imported to Sweden from Canada, and most likely from other European countries than the abovementioned, such as Slovakia, Slovenia and Rumania.

With regard to neighbouring countries, **Latvia** is the most prominent producer and exporter of biofuel pellets. The largest manufacturer, owned by Swedish Brikettenergi AB, most likely produces in excess of 40,000 tonnes/year. Several other large players are fully or partly owned by German and Danish enterprises. A new plant projected for 60,000 tonnes/year is being built in the autumn 2004 in Ventspils.

Lithuania is in a stage of infancy. A large plant is currently being built. There are ten or so suppliers with an annual production of up to 10,000-15,000 tonnes.

The situation in **Poland** has until recently been comparable to that in Lithuania, with a similar number of companies of a similar size. The change has however been explosive. Two companies have entered the market and already have a purported annual production of 60,000 tonnes. There is a further plant, planned to start up in December 2003, with a capacity of 60,000 tonnes/year for export to Scandinavia and Western Europe. This latter plant, Krojanty, had in October 2004 reached 80% capacity. A further new plant close to the German border now produces 100,000 tonnes/year.

The **Czech Republic** has an annual production of 140,000 tonnes, of which a large proportion is exported.

Germany and **Austria** ought to be the largest importers.

Production in **Russia** is comparatively small. It totals 115,000 tonnes/year distributed relatively evenly between six companies, all Russian owned and located in the St. Petersburg area.
According to one source, second-hand agrarian equipment has been used thus far, but new plants with modern equipment are planned for construction. One of the Estonian manufacturers was approached by a Russian manufacturer offering to sell pellets for further export.

5 Environmental impact and possible requirements

5.1 Raw materials

The most common raw materials used in fuel pellets are logging waste, by-products from forestry and wood industries, straw, paper, and similar. Fuel pellets comprise compressed pulverized dry matter and have a maximum diameter of 25 mm.

The line of argument in this section is based on the best possible grade for Swan labelling, taking into account the supply of good raw materials, possible production methods and low emissions from household boilers and stoves. It must be possible to use such a grade in Swan-labelled and other burners. The product group provides scope for the use of pure wood as the raw material.

Additives are not permitted though exceptions may be made. The manufacturer must in such a case engage a certified laboratory to investigate whether the additive can be used without affecting emissions. Additives must not exceed 2% by weight of fuel, in line with the CEN standard.

For the draft of the criteria, the expert group proposed requirements on forest stewardship by requiring the use of **certified wood**. It was proposed that 20% of the wood should come from certified forest. Following further discussions, we found that this requirement would not produce environmental gains so long as the raw material comprises wood chips and other wood industry by-products. If, however, the raw material comprises virgin wood other than windfall, requiring certified wood would produce environmental gains.

According to data from the manufacturers, all presently use by-products as their raw material. There is therefore no reason to include requirements on certified wood in the first edition of the criteria. This issue should be reviewed when the criteria are revised.

Waste is not permitted as a raw material for fuel pellets. The residual products listed below and defined according to the list of wastes are permitted for use. Others are prohibited on various grounds. For example it is prohibited to burn waste in small-scale facilities since the resulting emissions can be a hazard to the environment and health.

Waste is defined in accordance with Commission Decision of 16 January 2001 amending Decision 2000/532/EC as regards the list of wastes (2001/118/EC). The waste list was previously called the European Waste Catalogue, hence EWC codes.
The types of waste that could theoretically be include in biofuel pellets are:

- *Chapter 3: Wastes from wood processing, etc. 03:0105 other sawdust, shavings, cuttings, wood, particle board and veneer (N/A hazardous substances).*
- *Chapter 17: Construction and demolition waste 17:0201 wood.*
- *Chapter 20: Municipal waste 20:0138 separated, collected wood (untreated).*

In Denmark, the use of residual products in the manufacture of biofuel pellets is regulated. This means that waste products classified under Chapter 17 are not permitted. Danish regulations also include a definition of “non-hazardous substances” for the waste products defined in Chapter 3. The criteria should include this definition. This means that waste wood from the production and working of pure glued wood that has an adhesive content of less than 1% by weight of dry matter (phenol resorcinol, polyvinyl acetate, urea formaldehyde, polyurethane or melamine urea formaldehyde adhesive) can be used for fuel pellet production.

5.2 Transportation and handling

5.2.1 Delivery and handling of the raw material

Contaminated raw material has a negative effect on the environment. It is therefore vital that the manufacturer of Swan-labelled pellets is well acquainted with how the supplier handles the raw material. The manufacturer may specify handling requirements, such as precluding the storage of the raw material directly on the ground to avoid the risk of contamination with earth and sand. Nor should cutting piles stand too long.

Requirements regarding these issues should exist so that the manufacturer has procedures for:

1. Identifying which supplier has supplied the raw material.
2. Visiting suppliers.

3. Setting standards for the suppliers to guarantee the quality of the raw material. Such requirements must be specified in the application.

5.2.2 Delivery of biofuel pellets to the consumer

Biofuel pellets for stoves are normally bought in sacks. The grade of the pellets is not significantly affected by transport in sacks.

Biofuel pellets for boilers are often bought loose in bulk. The transport of loose fuel pellets will therefore also be covered by the criteria. The type of transport vehicle and handling influence the grade of the pellets before they reach the burner. Incorrect unloading or a poorly designed storage area can cause the pellets to disintegrate. This will make it more difficult to load the stove or boiler which in turn can affect combustion.

In Sweden, pellets bought in bulk are cheapest. A standard delivery is three tonnes, which requires a storage area of approximately 7-8 m^3. The standard limits the possibility of selling pulverised pellets but the limit value is set for fines content in the manufacturers stocks. There are no guarantees for how transportation and the storage solution will affect pellet grade prior to use.

A study[4] has been conducted that compares the grade of pellets delivered in bulk and in sacks. This study shows that the mode of transport has no effect on the fines content of the four grades tested.

Another project (Ref 2) highlights the change in fuel pellet grade from the plant to the burner. Pellet samples have been taken directly from the plant and from the same batch after delivery to the consumer. Samples have been taken from 2-4 consumers with deliveries from six different pellet suppliers. The samples were taken after the pellets had passed through the storage area and screws and arrived at the burner. There are various reasons that may lie behind the changes in grade.
For this reason, the analysis results of the samples that were least affected are given. The common denominator is that the pellets have been transported to a storage area.

Requirements regarding these issues should exist so that the manufacturer has procedures for:

1. Specifying requirements on vehicles and handling of the biofuel pellets.
2. Informing the customer of how the storage solution should be constructed.

The Swedish trade association is currently establishing recommendations for how the pellets should be transported and unloaded.

5.3 Manufacture

Biofuel pellet manufacture involves milling dried wood chips and cuttings. Sawdust does not generally require drying prior to milling. This information refers to new raw material.

When the raw material arrives at the plant the entire truck or trailer is weighed. The moisture content is tested. In Sweden, more new wood chips are used than in Denmark, where a greater proportion of residual wood, which is dryer, is used. Material form various tree types are mixed to achieve an optimum mixture. If the material is still rough, oats are added as a

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[4] *)"Fältundersökningar av olika pelletskvaliteter vid utleverans och värmekälla", Äfab on assignment from the Swedish Consumer Agency*

lubricant. Drying aims to achieve a moisture content of <13%, ideally 12%. Dry material is preferably mixed with more moist chips. In the absence of moist chips, steam is generally added to soften the material. Roughly 4% of the moisture disappears during pelleting.

The chips are milled for 4-5 minutes and then compacted into pellets. Lignin may be added if the wood mixture is incorrect (0.2-0.5%). This is also used if the moisture content is high. The pelleting process involves heat. The moisture content of Swedish fuel pellets is normally 7 to 9%. Pellets produced in Denmark are by and large dryer since the raw material is generally dryer.

5.3.1 Energy consumption during manufacture

Energy consumption is an important parameter with regard to manufacturing. Energy is required for the dryers, which are generally fired with biomass, and for the mill and presses, which are powered by electricity.
The use of residual products, which are dryer than new raw material, eliminates the need to dry the raw material. However, energy may be required to produce steam to moisten the raw material, and the presses may also require more energy.

The dryers in Sweden are most often fired with wood chips or powder, though some manufacturers use oil. In Denmark, dry raw material is generally used. Peat is also used as an energy source in Sweden and Finland. Some manufacturers use oil to start up the dryers, others wood chips. The energy requirement depends on the moisture content of the raw material. If the raw material contains 50% moisture, 1 m^3 of drying fuel (wood chips) or 600 kWh is required per tonne pellets to produce pellets with a 10% moisture content.

Mills and presses use electricity. A rough figure is 105-115 kWh of electricity per tonne of pellets. Annual consumption can be considered relatively even. More energy is required during the winter than during the summer since the raw material has a higher moister content.

Swedish engineering consultants ÅF were given the task of gathering data for setting energy requirements[5]. Manufacturers in all the Nordic countries were contacted regarding energy consumption during production. All the manufacturers contacted submitted details of energy consumption. The figures are presented anonymously.

The energy requirement is given in kWh per tonne of pellets manufactured, and in kWh per kWh of pellets. The energy content of the pellets depends on the moisture content. Some of the energy in pellets produced from new raw material is consumed in drying the pellets. The majority of fuel pellets produced in the Nordic countries are made from new wood in the form of sawdust, a by-product from sawmills.

Table 11

Manf	**Fuel type**	**Heat requirement** kWh/tonne	**Electricity for presses** kWh/tonne	**Production** tonnes/year	**Moisture content** raw material for pellets
A	Waste wood, peat	540	200	130,000	12% to 8%
B1	Wood powder	700	100-110	40,000	12% to 8%
B2		-	75-80	110,000	8.12% to 10%
B3		-	75-80	40,000	8.12% to 10%

[5] *Underlag för miljömärkning av pellets, ÅF-Process AB, Stockholm, January 2005*

C1	Wood powder(50%), EO1(50%)*	700	80-100	36,000	50-53% to 8-10%
C2		-	80-100	20,000	12% to 10%
C3		-	80-100	10,000	12% to 10%
D.	Sawdust	1000	140	42,000	6-15%,50% to 8-9%
		”	”	45,000	
		”	”	12,000	
		”	”	40,000	
E	Wood powder	600	200	80,000	50-60% to 8%
F1			75-110	200,000	8-14% to 10%
F2	Bark, chips, sawdust	600	105-110	190,000	50-60% to 10%

*EO1 is a grade of light oil sold in Sweden.

5.3.2 Energy requirements

Limitation of energy consumption

The energy required by the driers depends on the moisture content of the raw materials. This may vary from 8% for dry chips to over 50% for new raw material. There are no environmental gains in influencing manufacturers into using solely dry wood. There are no environmental gains to be had from depositing sawdust from sawing greenwood. Furthermore, fuel pellet grade is influenced by the moisture content. Pellet grade influences emissions, which is a valid reason for controlling the moisture content of the fuel pellets. See 5.3.1 under section 5. Theoretically, it is possible to set requirements of the efficiency of the dryers. This is however an issue for the future.

In the majority of cases, the dryers are powered by biofuel. Even bark can be used. Bark is not an alternative raw material for the fuel pellets since it lowers pellet quality.

Fossil fuels

The majority of manufacturers that we have asked do not use oil or coal for their driers. Oil is however used by several to start up the dryers. Nor do any of the Danish manufacturers report using natural gas. The raw material for the fuel pellets, however, comprises of 100% dry wood chips. Though if the Danish manufacturers start to use new wood as a raw material, it is more likely that gas will be used if biofuel cannot. By way of conclusion, we consider it appropriate to set a limit for the use of fossil fuels in this version of the criteria.
The limit aims to prohibit the use of coal and oil as a fuel for the dryers, with the exception of the start-up phase. Consequently, one of the consulted manufacturers will be unable to Swan label its fuel pellets.

Table 12: Carbon dioxide emissions

Fuel	Energy density (MJ/kg)	Density (kg/m^3)	CO_2 (g/MJ fuel)	CO_2 (g/kWh fuel)
EO1	42.7	840	75.3	21
Natural gas	52	0.75	56.5	16
Peat	11	370	107.3 *	30
Powder	18	210	0	0

** Other figures exist, such as 91-96 g/MJ for 6-50% moisture content. The Swedish National Environmental Protection Agency emission quotas state 106 g/MJ for peat.*

Peat produces greater amounts of carbon dioxide that oil. The criteria should thus prohibit the use of peat in dryers.

If one of the prohibited fuels is used at other facilities and excess heat is used for the driers, it should be possible to allocate fuel use. The manufacturer is fully responsible for such an allocation, in contrast to certified electricity and trading with emission rights.

Electricity consumption
The electricity consumption of presses and mills should be followed up. The criteria are first and foremost designed to oblige the manufacturer to measure the electricity consumption and perform documented follow-ups. According to information received, the presses require slightly more electricity during the winter.

Expert group conclusions: The criteria should contain energy requirements to limit the use of non-renewable energy sources, to reduce energy consumption, and as far as possible eliminate carbon dioxide emissions. The use of electricity for the dryers should be prohibited.

5.4 Fuel pellet grade

Fuel pellet grade is affected by transportation and unloading in the consumer's storage facilities. Who is responsible for changes in grade from the manufacturer's stocks to the feeding in to the burner is a matter of discussion. We have decided that samples should initially be taken from the manufacturers stocks, since it must be possible to guarantee and perform inspections in a viable manner. To meet the wishes of boiler and stove manufacturers, the criteria require:

- An adequate method of transport.
- The manufacturer to inform customers of how storage facilities should be built and kept clean.

This enables a degree of control over the maintenance of fuel pellet grade.

Listed below are the most important parameters for biofuel pellets, what these mean and the current market situation. Pellet samples have been taken from the plants of nine different Swedish manufacturers and one Baltic manufacturer for analysis and establishing physical properties. The samples have been taken under similar conditions[6].

The results of the study are followed by comments on the need to control each parameter. The comments also disclose the result of reference group discussions.

The proposed test methods are also presented under each parameter. In cases where European Standard test methods already exist, these have been adopted by Swan labelling.
If the test methods are under development, these are proposed provided that there is general agreement.

5.4.1 Physical properties

1. Dimensions

Swedish biofuel pellets are general 8 mm in diameter, with the exception of a few which are 6 mm in diameter. 6 mm diameter pellets are more common in Denmark.

[6] *)"Fältundersökningar av olika pelletskvaliteter vid utleverans och värmekälla", Äfab on assignment from the Swedish Consumer Agency*

Boilers and stoves made in Sweden are designed for 8 mm pellets. However, Austrian and German burners are more often designed for 6 mm diameter pellets. The feed settings on the burner are important for optimum combustion. A change of fuel pellets can effect emissions. A direct reflection is that there is a need for two grades: one for stoves and one for boilers. Swan-labelled boilers general have an oxygen sensor which means they can better handle different fuel pellet sizes. Stoves are however more sensitive.

The burners are more sensitive to variations in length. Stove manufacturers recommend lengths below 12 mm. It is not in the interest of pellet manufacturers to produce a range of grades. Three times the diameter is considered too stringent. A maximum length of 7.5 times the diameter is also proposed.

An early draft proposed a requirement of a maximum length of three times the diameter. This means that for 6 mm can be max. 18 mm long and 8 mm pellets max. 24 mm long. By way of comparison, the Swedish standard limits the length to four times the diameter and CEN proposal to five times the diameter. This gives a maximum length of 30 mm or 32 mm. The Austrian standard specifies a maximum length of five times the diameter, but permits a diameter of 4 mm, which means a length of 20 mm. This meets the wishes of the stove manufacturers.

A tolerance limit has been proposed. The proposal means that 20% of the fuel pellets may be longer than the limit value. There is an established European Standard test method. Classification TS 14 961.

During the final stages of the criteria work, manufacturer representatives in the reference group have suggested a length of five times the diameter, in line with the CEN proposal. This is however problematic, especially since the Swedish standard specifies a maximum length of four times the diameter. It is therefore particularly important that review bodies take a stand on this issue.

Conclusion: After discussions within the reference group, it was decided to propose the maximum length specified in the CEN standard. There is also a possibility of having an additional, shorter limit, if there is a demand for Swan labelling such a length.

2. Energy density

The Swedish standard specifies a minimum energy density of 4.7 kWh/kg for biofuel pellets in group 1. There is no upper limit, which means the standard permits a spread. The Austrian standard specifies that the pellets must have an energy density of 5 kWh/kg.

The results from Äfab’s survey show that all samples fulfilled the requirements of the Swedish standard, with a spread from 4.68–4.96 kWh/kg. The mean value was 4.84 kWh/kg.

The Norwegian grade had an energy density of 4.90 kWh/kg. Higher energy densities are common in Denmark. It is likely that the imported fuel pellets from Canada have a higher energy density.

The reference group has discussed a proposed limit of 17.2 MJ/kg, which is equivalent to 5 kWh/kg of pellets. One advantage would be a reduction in transportation needs. However, the proposal appears to be impossible since energy density is primarily influenced by the type of wood in the raw material, the age of the wood chips and the moisture content. The parameter that is controllable is moisture content. The gains of a high energy density may to some extent be lost due to the wood chips requiring more drying.

Conclusion: *The reference group proposes that the criteria primarily control grade by other means than energy density. Suitable requirements for moisture content, ash content and wood raw material mean lead to favourable environmental effects and a superior energy density. The minimum limit for energy density is set to 4.7 kWh/kg or 16.9 MJ/kg.*

A test method, prCEN/TS 14 918, has recently been established but is yet to be published (2004-11-16). This refers to the net energy density, which is defined as follows: Net caloric value, $q_{p,net,ar}$ (KJ/kg as received)

3. Bulk density

The Swedish standard specifies a minimum bulk density of 600 kg/m^3. There is no upper limit. Density affects how the feeder in the stove/boiler should be set. Variations in density may cause operational problems and/or lower efficiency.

The results of the survey show that all samples meet this limit. There was a spread of densities from 650 kg/m^3 to 730 kg/m^3. This spread is too large, and it is therefore necessary to introduce an upper limit.

The Norwegian pellets had a bulk density of 769 kg/m^3.

The CEN group has drafted a proposal and sent this for formal vote.

The numerical results depend on the test method and the size of the sample.

Conclusion: *The reference group proposes that the criteria establish a range of 630-700 kg/m^3. If the new test method gives different results than the Swedish standard, these figures will be adjusted prior to adoption.*

4. *Durability: mechanical durability and fines content*

Mechanical durability: CEN has drafted a proposal that is to be sent for formal vote. It is a new method and the criteria proposal should therefore use the same limit values as the proposed CEN standard of 97.5% w/w.

This value is numerically lower than that in the Swedish standard, though how the test methods compare is unknown.

Fines content: The Swedish standard specifies an accepted limit for fines content in the manufacturers stocks. Fines content refers to particles smaller than 3 mm. A high fines content can cause problems with the burner’s feeder and even stoppages. There is no existing standard that limits the fines content on delivery. There are a number of factors that can influence the quantity of fine particles prior to combustions: transportation, consumer storage and feeder screws in the boiler or stove.

All samples except one met the test limits. Even the worst sample would have fulfilled the standard if the test conditions had been more accurate. The fines content varied from 0.3 to 3.9% by weight, with particles up to 4 mm measured instead of 3 mm. Three other samples also failed the test but would have met the limit value had the correct sieve been used. There was a large proportion of particles in the samples prior to delivery.

The CEN method is ready for formal vote. The reference group considers it unnecessary to set more stringent limits for this particular parameter. The group therefore proposes a limit value of <2% at the manufacturer's site.

***Conclusion**: The proposed limit value for mechanical durability of 97.5% is in line with the CEN standard. Similarly, a fines content of <2% is proposed.*

5. Moisture content

The Swedish standard specifies a maximum limit of 10%. Variations in moisture content can cause operating problems if the burner is not adjusted for the different fuel pellets. It is desirable to lower the limit. Also, energy is consumed in the drying process.

The moisture content of the samples varied from 5.7% to 9.2%. The Norwegian fuel pellets had a moisture content of 7.2% and the Danish of approximately 5%.

The reference group has held in depth discussions on limiting the range. There is general agreement that the range of moisture content must not vary too greatly between deliveries. There is dispute as to whether fuel pellets are sufficiently durable at moisture contents above 5%, and vice versa. Some individuals claim that combustion is sub-optimised if the fuel pellets are too dry while others contend this. Similarly, there is an opinion manufacturing dry pellets requires large amounts of energy for the presses and the addition of binding agents, and leads to greater wear. These claims are keenly contested from other camps. One conclusion is that more in-depth knowledge is required. It was also proposed to have two classes of pellets. The test method for the CEN standard is finalised: TS 14 774-1

***Conclusion:** The reference group proposes that Swan labelling should have two classes of fuel pellets: One with a moisture content of 3-8% and another with a moisture content of 6-9%.*

6. *Ash content*

The Swedish standard specifies a maximum ash content of 0.7% of the dry matter. A large proportion of non-combustible material (high ash content) would make daily attendance and cleaning of the combustion chamber necessary. Good quality wood pellets in Sweden generally have an ash content of between 0.3 and 0.5% w/w of dry matter. The ash content may in other words vary by almost 100% depending on the delivery. The Austrian standard specifies a value of 0.5% of dry weight.

The content varied between 0.3 and 0.7% in the Swedish samples that were tested. The mean value was 0.42%. Two test from imported pellets from Baltic countries contained 0.6 and 1.7% respectively. The latter content is considered extremely high and would lead to practical problems in use.

The reference group is in agreement that the range for ash content should be limited. Manufacturers of burners advocate lower limits for stoves than for boilers. A low ash content also helps keep emissions low since the fuel is a grade that allows the most complete combustion.

A CEN test method, TS 14 775, has been established. It should however be noted that the method has a margin of error of ±0.2%, which makes it difficult for manufacturers to guarantees consumers a specific ash content.

Conclusion: *The limit value for ash content should be set to <0.5% by weight of dry matter.*

7. *Ash melting behaviour*

The Swedish standard has no limit values for ash melting behaviour. The ash melting point must however be stated. The standard that used has been developed for coal and does not work satisfactorily for biofuel.
A high initial temperature (IT >1300ºC) is indicative of a good quality pellet. If the pellets have a low initial temperature (<1300ºC), there is a risk of sintering. This could lead to operating problems. A low IT is evidence of contaminants such as sand in the fuel pellets.

The results of tests show that the initial temperature varied between 1170ºC and 1550ºC.

The reference group is in agreement that a limit value is necessary, though manufacturers are somewhat uncertain as to what IT to allow. One alternative that has been discussed is that if a limit value of 1400ºC cannot be accepted, it may be reasonable to set limits for both IT and hemisphere temperature (HT), for example IT >1300ºC and HT >1400ºC.

Test method ISO 540 has been used, with ash produced at 815ºC. It has been suggested that 550ºC is a more suitable temperature. A CEN standard is currently being drafted, but this is estimated to take another year. The proposed change of method is due to the current CEN work.

Conclusion: *A limit value for initial temperature of 1,400 ℃ should be set. The test method has been adjusted so that initial temperature (IT) is tested on ash produced at 550°C.*

5.3.2 Chemical composition

1. Additives

The reference group was unanimous that **no additives** are necessary in biofuel pellets. It is therefore proposed that the criteria as a general rule prohibit the use of additives.

A possibility of exception should however exist. A manufacturer may Swan label pellets with additives so long as limit values are not exceeded, the emissions are not affected, and the manufacturer submits sufficient data for evaluation. Such data shall be submitted to an accredited laboratory in the Nordic region for assessment. The scope of such data should be outlined by the laboratory.

If the fuel pellets contain additives, these should not exceed 2% w/w, in accordance with CEN standards.

Oats are sometimes added to lubricate the presses when extremely dry matter is processed. This is not considered an additive since the oats are not mixed into the grade.

Conclusion: *A general rule prohibiting additives.*

2. Sulphur

The sulphur content of fuel pellets made from pure wood should not exceed 0.03% w/w. The sulphur content is most often 0.01-0.02% in pure stemwood. In some cases, residual products from the paper industry have or are added to the fuel pellets. This raises the sulphur content. The Swedish standard permits a higher level of sulphur than other standards.

In Denmark, fuel pellets become liable to tax if the sulphur content is >0.05%.

The CEN standard specifies a limit of 0.05%, and the Force's fuel pellets standard plans a limit value of 0.04%.

Conclusion: *A limit value of 0.04% w/w is proposed.*

3. ***Chlorine***

The customer shall be informed of the chlorine content, as in the CEN standard. The Austrian standard sets a limit of 0.02%.

Conclusion: *In accordance with the reasoning behind our proposed sulphur limit, a limit value for chlorine of 0.02% w/w is proposed.*

5.5 Sampling of fuel pellets

There is a Swedish standard for sampling but this has not worked satisfactorily. A workgroup, Solid biofuels CEN TC 335 WG 3, has been appointed within CEN. The Swedish committee goes by the name SIS TK 412 ag 2, Provtagning och Fysikaliska Testmetoder. Jan Burvall, SLU, is the Swedish delegate. A draft has been prepared for formal vote. The standard also specifies the frequency of sampling per tonne of pellets.

The standard does not specify the size of the samples. A sample volume of 10 l is however necessary for all analyses.

5.6 Self-inspection

Self-inspection comprises two parts: sampling at the manufacturer's storage facilities carried out by a third party, and daily sampling carried out by the manufacturer.

These mandatory inspections are not set by Swan labelling to assure pellet quality. This is the responsibility of the manufacturers themselves. The manufacturer may also be subject to follow-up inspections; unannounced inspections on the initiative of the ecolabelling body.

Self-inspection conducted by a third party shall cover all parameters in the specification. The cost of such analysis is estimated at less than SEK 10,000. Such inspections shall be performed once every six months; once during winter months and once during summer months.

The self-inspection performed by the manufacturer covers the following parameters: mechanical durability, fines content, dimensions and moisture content. This self-inspection shall be performed once every 8 hour shift.

Reference list:

In addition to the references given previously in this report, the following literature has been consulted.

6) "Jämförande test Norsk Pellets Vestmarka A/S", Äfab
7) "Träpellets som småskaligt biobränsle", Maria Olsson, Chalmers Institute of Technology
8) "The state of the art of small-scale pellets-based heating systems and relevant regulations in Sweden, Austria and Germany", Frank Fiedler, Dalarna University Collage.