Analysis of quality, production, and supply, of wood pellets for Irish domestic heating, and potential market development.

P. Dicken.

Loughborough University
Loughborough, Leics. LE11 3TU

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Abstract

This paper is a study of the recent development of the wood pellet market in Ireland with specific emphasis on local production, supply, and use in the domestic sector. This is set within the wider European, and global market developed in the last ten years. A growing domestic resource of timber is described and research highlighted indicating that indigenous production of wood pellets is likely to be constrained by the size of the available Irish timber resource, competing markets for timber, and imports. The importance of pellet quality for domestic wood pellet stoves and boilers compared with industrial use is investigated citing existing research and European initiatives. Bulk density, low ash and fines content are shown to be the key parameters. Samples of pellets on the Irish market are tested and shown to be of variable quality. The rapid growth of the domestic wood pellet market in 2006-2007, largely due to financial incentives from the Irish government is examined highlighting the problems that occurred. Future growth is considered and, with reference to the development of the domestic Swedish pellet market, thought to be reliant not only on governmental fiscal and financial support, but also on investment cost and reliability.

1 Introduction

The paper takes a snapshot of the production and supply of Irish produced wood pellets for use in domestic stoves and boilers in August 2008. It places wood pellet use in Ireland in the context of developing European and world markets, comparing prices, standards, quality and availability. The paper concludes with predictions for the future of the Irish pellet market. The development of wood pellet stove and boiler technology also forms part of this analysis.

The methodology for this paper has included two main strands. Firstly, with a review of recent research available in Europe, it collates information and experiences from government agencies, importers, manufacturers, and users in the pellet market. Secondly, it uses a recommended method of quality assessment to form the basis of a simple empirical comparison of wood pellet samples, with regards to the specific requirements of domestic wood pellet stoves and boilers.

The paper is written from the point of view of the Irish Republic, but companies in the wood pellet business operate across the whole island and often internationally. Similar government support schemes for renewable technologies operate in Northern Ireland, and to the wood pellet the border is transparent.

91% of Ireland's energy is imported; a growth of 50 % since 1990. GDP has grown 2.7 times in the same period. 54 % of this imported energy is oil. The domestic heating market, in conjunction with home construction, has grown rapidly over this period and oil heating now contributes 38% of this market [1]. There is therefore a large potential to substitute heating oil with biomass, (wood pellets or wood chips) or other renewable heat sources, and to reduce greenhouse gas emissions as required by specific EU targets.

The Irish government has recognised this and introduced grant support schemes for householders and businesses to install biomass boilers, (Greener Homes Scheme), heat pumps and solar thermal renewable technologies. In the last 2 years there has been a rapid increase in demand for these boilers and their feedstock. Starting from a very small base this has put great demands, on manufacturers, suppliers, installers, of wood pellets and wood pellet boilers.

2 The Irish Wood Resource

The Irish market for combustion of biomass has until recently been dominated by availability and low cost of peat, and indeed with the formation of Bord na Mona (Peat Board) in 1946, the

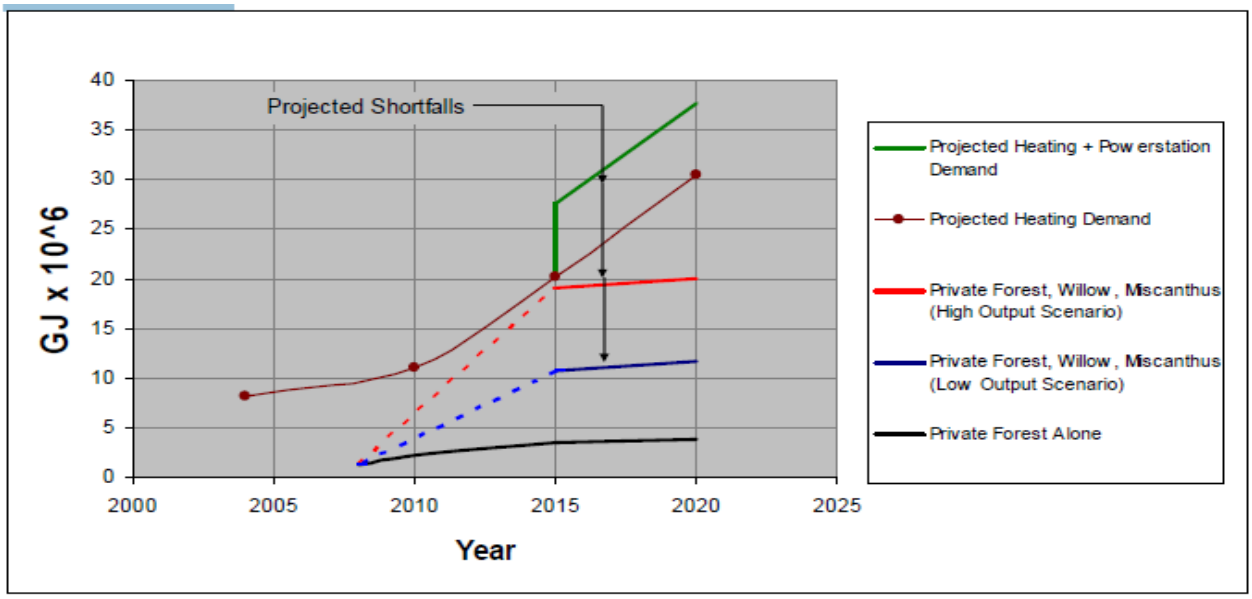

Figure 1. Projected biomass supply/demand shortfall. Source: Pearse Buckley SEI. Presentation to Bioenergy 2008, Athenry, Co Galway, June 2008.

government has sought to expand exploitation of this resource. Woody biomass predominantly forestry has had a slower development. In 1900 only 1% of Ireland was covered by forest. State involvement in the development of forestry started at this time and continues to this day with Coillte, (the state owned forestry company), today owning 70% of all Irish forests. Forests now cover over 9% of Ireland, with government grants to private land owners, and the record afforestation programs of the last twenty years, there is now a significant resource for wood energy.

The degree to which this resource is accessible is now being debated in Ireland. Presentations to the Bioenergy 2008 Conference, Athenry, Co Galway June 2008; indicated that much of the private forestry, especially in the west would be difficult to exploit due to poor terrain and infrastructure. Projections as to future demand /supply shortfall indicated problems after 2015, especially if there is increased demand for fuelling electricity generation with biomass; specifically an EU requirement to fuel peat fired power stations with 30% renewable biomass by 2015, see figure1.

3 Wood Pellets – a short history

Wood pellets were first developed for use as a fuel in Canada and the United States in the 1970s as a result of the first oil price/energy crisis. In Europe, the first developments were in Sweden in the 1980s as a result of the second oil price/energy crisis, but with declining oil prices the market did not take off in Sweden until fiscal measures were introduced in 1992, taxing fossil fuels, and making wood pellets competitive almost overnight. One of the first pellet consumers was a major energy utility, Stockholm Energy, who also invested in a pellet production plant. This was significant in the rapid growth of the market. The domestic market did not take off till 1997, but has grown at approximately 25% per annum since [2].

The wood pellet markets started to develop in Austria, Denmark, Italy, and Germany in the late 1990's, but market development has been very country specific and fragmented in the last ten years, driven by national fiscal and financial incentives to influence their own domestic market, see Figure 2.

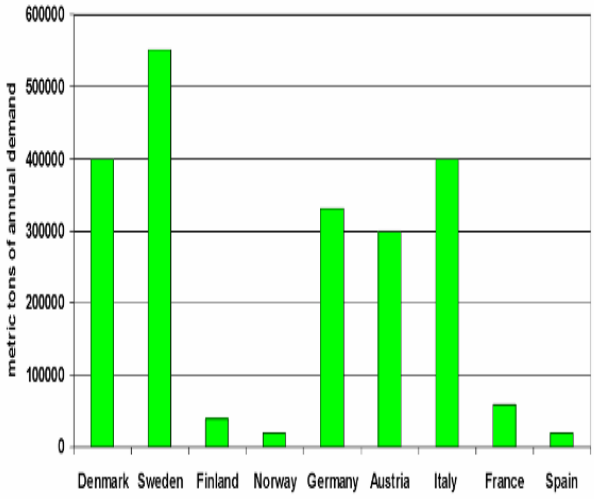

Figure 2. European markets for residential pellet heating in 2005 (source: ProPellets Austria)

In other European countries such as the Netherlands and Belgium the pellet market has

developed to co-fire in power stations using imported pellets, with little domestic heat use, figure 3.

As both production and consumption increase, trade in pellets is becoming more significant and the market for this new fuel is becoming increasingly global, with imports to Europe from as far as western Canada and China.

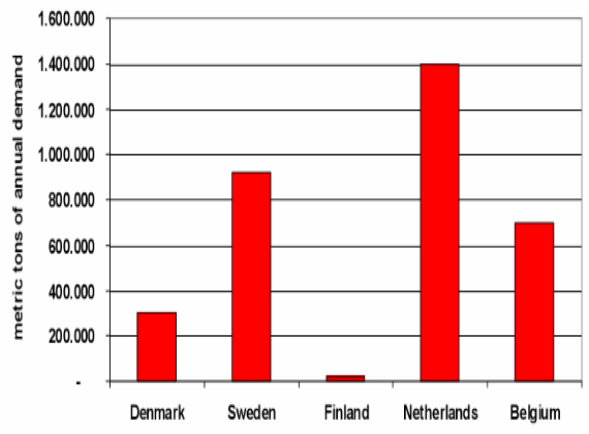

Figure 3. Pellets use in power plants in Europe 2005. (source: ProPellets Austria 2006)

Potential resources for this global market, in Russia, and Brazil for example, are as yet little exploited so providing further opportunity for global expansion.

Swedish, Austrian and German domestic markets for pellets have been established for more than ten years and continue to grow. They are often described as mature markets, but the continued rapid growth, as shown in Figure 4, and some price volatility would suggest that these markets are not yet entirely established.

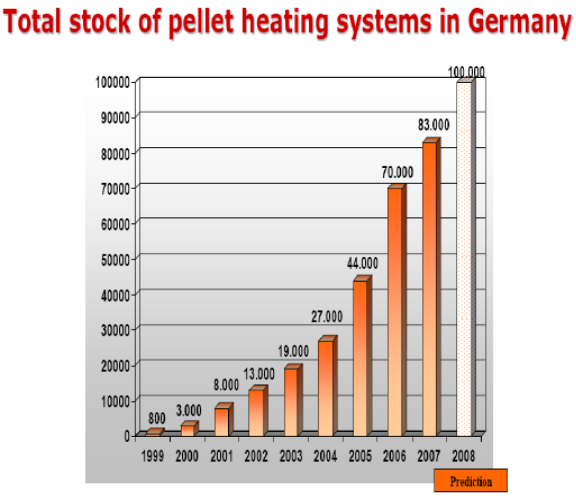

Figure 4. Source: ProPellets, Austria, 2008.

3.1 The Irish domestic market for wood pellets

Before 2006 there was no significant market for wood pellets in Ireland, and no indigenous production of wood pellets. Two significant developments promoted the market in 2006.

Firstly, Balcas, a sawmill and timber products company based in Enniskillen, Northern Ireland, built a combined heat and power plant (CHP), 10MW heat, 3MW electricity, with assistance from the UK government of £3 million. They also built alongside it a pellet production plant with a capacity of 50,000 tons per annum. This was commissioned in 2005 and initially exported pellets to UK power stations for co-firing. Other companies began importing pellets from Europe, Canada and China.

Secondly, setting up of Sustainable Energy Ireland (SEI); an agency of the Irish government in 2002 to “promote and assist the development of renewable energy”. Their brief consisted of reducing dependence on fossil fuel, reducing greenhouse gas emissions and encouraging the development of renewable energy technologies. Under the “Greener Homes Scheme”, introduced in 2006, SEI provided financial assistance to householders in the form of grants to install renewable energy systems. These systems include solar thermal, biomass, and geothermal systems. The scheme was allocated a budget of €47 million over five years. The total budget was exhausted after 16 months (for Greener Homes Scheme phase 1), as over 17,000 applications were approved. The applications were split between three technologies: biomass 26%, heat pumps 26% and solar thermal 48%. Over 2400 biomass boilers and stoves (mostly wood pellets) were installed. The scheme has since been revised twice, in October 2007 Phase II, and July 2008 Phase III, halving available grants and increasing conditions for grant approval. Alongside these grants for domestic users there are similar schemes for commercial, industrial, public and community, e.g. The Renewable Heat Deployment Programme, (ReHeat). Fifty-two biomass projects were installed, in hotels, schools, and industry, some as large as 2 MW.

4 Wood Pellet Prices.

As the pellet markets have grown in Europe, pellet prices have reflected local supply and demand. Prices have been affected by shortages such as in the winter of 2006/7 which caused a sharp price hike in Austria and Germany, see Figure 5. Previously Austrian prices were quite stable at around 180 EUR per tonne. Price discrepancies between individual European countries, until

recently, were poorly documented, but the “Pellets @las project” [3], A European Community funded project, which was set up in January 2007 to run for 33 months has already given improved data. It’s aims to, disseminate information on the whole European pellet market; collect data on prices, volumes traded, and production averages; add more transparency in prices of pellets traded on and into the European market, and to avoid large price fluctuations. In Figure 5,

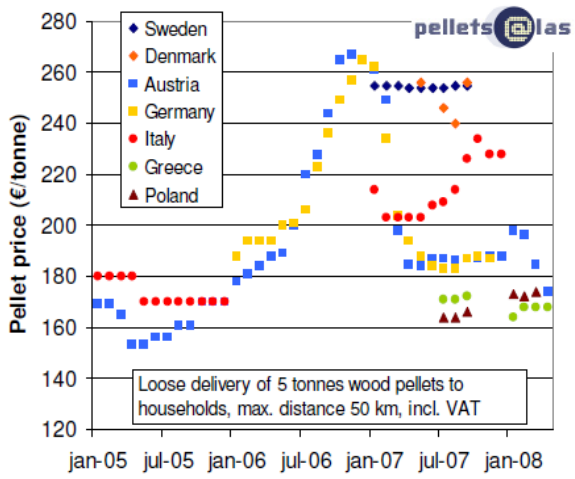

Figure 5. Pellet prices in selected European countries 2005 – 08.

5 Pellet quality issues with domestic wood pellet stoves and boilers.

One of the critical requirements for the development of European wide and global market is agreed standards for the pellets. As wood pellet markets developed nationally in America and Europe, so did the requirement for standards and quality marks.

It became apparent as the use of wood pellets in domestic boilers increased in Europe, that there were particular quality issues which were not significant in burning pellets on an industrial scale. One of these was the formation of solid slag, which fouled the automated feed systems of the boilers. Obernberger and Thek, [4] identified this and suggested two standards, one for domestic automated boilers and one for industrial users, in their extensive study.

Two papers by Ohman [5], [6], investigate slagging tendencies of wood pellet ash and measures for prevention. They identified that the critical component in the pellet with regards to slag formation was silicon, (as SiO_2), and the critical level was 20 – 25% of the fuel ash. Silicon content of the fuel correlated with the tendency to slag, and they recommended that high ash fuels, such as those containing bark, should not be used in domestic burners. Ohman et al also identified that silica contamination of the fuel can take place as part of the pelletising process and gave recommendations to minimise this.

The effect of raw material composition on wood pellets was studied by Rhen et al [7]. They also showed that combustion time and ash content increased with high bark content in the pellets.

As silica content is rarely measured, low ash content, <0.7%, and low bark content are the best indicators for pellets which burn slag free.

Excessive fines, (dust) can also cause problems in small boilers. Pellet delivery can be blocked, and fines can generate more rapid burning, increased temperatures and sintering of the ash. Fines can be minimised by high pellet quality; high bulk density, high durability, and careful delivery to the customer.

5.1 Standards and Quality marks

A common European standard, CEN/TS 14961:2005, is being developed and has been in draft form since 2005, but at present in Europe there are three national standards, with subsets:
Austria: ÖNORM M1735
Sweden: SS 187120 and SS 187121
Germany: DIN 51731 and DIN plus

The ONorm and DIN plus quality standards are the only ones that currently apply to small domestic stoves and boilers, because of their low ash tolerance, see figure 6.

Wood pellets quality norms		ÖNorm M 7135	DIN 51731	DIN plus
Diameter	mm	4 to 10 mm	4 to 10 mm	
Length	mm	5 x D[1]	< 50	5 x D[1]
Density	kg/dm³	> 1,12	1,0 < Dichte< 1,4	> 1,12
Humidity	%	< 10	< 12	< 10
Ash	%	< 0,50	< 1,50	< 0,50
Heating value	MJ/kg	> 18	17,5 < HW< 19,5	> 18
Sulphur	%	< 0,04	< 0,08	< 0,04
Nitrogen	%	< 0,3	< 0,3	< 0,3
Chlorine	%	< 0,02	< 0,03	< 0,02
Abrasion	%	< 2,3	-	< 2,3
Press aid	%	< 2	([2]	< 2

[1] no more than 20% of the pellets may be longer than 7.5 x Diametre
[2] DIN prohibits additional matter. This prohibition however, is not valid for small heating systems

Figure 6. Austrian and German Quality standards

In Canada and the US the equivalent standard is ASTM E 870, Premium grade. When the European standard is adopted the national standards will be superseded. The standard

defines how solid biofuels are classified and specified. It does not at present specify minimum quality standards. The key parameters, and typical limits, for wood pellets are given in table 1. These are a subset of the European standards, and the specifications usually quoted by pellet manufacturers, alongside ONorm and DIN plus.

Table 1. Key quality parameters for wood pellets.

Key parameter	**limits**
Diameter	Usually 6 or 8mm
Av length	L <5 x diam.
moisture	< 10%
Ash	<0.7%
Mechanical durability	>97.5%
fines (dust)	<1%
Net calorific value	4.6 – 5.0 kWh/Kg
Bulk density	650 kg/m^3
chlorine	< 0.03%

The final form of the 14961 standard**:** "prEN14961 – 1:2008.4 Solid biofuels – fuel specification and classes – part 1:general" is about to be published, with significant changes to the original draft. Within the standard, Table 1 classifies the properties of solid biofuels; table 2 defines traded forms, and tables 3 – 14 describe the properties of particular solid biofuels.

Drafts are expected for parts 2 to 6 before the end of 2008. These define the requirements of domestic solid fuels in quality classes. In particular, part 2 describes non-industrial wood pellets. This is most critical for the consumer as it defines the maximum values of, for instance ash and fines, which small stoves and boilers are most sensitive to.

Manufacturers market pellets under particular brand names, e.g. Brites, Firestixx, and Stovies. High quality pellets command a premium price, so to protect the brand name manufacturers add distinctive shapes or marks to their pellets ensure traceability. This also gives the consumer some assurance as to the quality of pellets purchased.

5.2 Pellet production site visits

During August 2008, the following Irish pellet manufacturers or importers were visited to get a first hand understanding of contemporary production and supply, as well as the manufacturers' view of domestic pellet market potential and challenges.

Irish Woodpellets ltd.; - A small scale operation near Tuam Co. Galway; built on a former mushroom farm. The owner, Brendan Tiernay, buys in sawdust from the local sawmills and dries it in his own dryer. The rest of the plant is bought in and he has a single pellet press. Pellets are bagged for sale at the gate or to local customers. Brendan sees his market continuing to be local and small scale.

Timber Pro;- Based near Kells, Co. Meath, are a large scale importer of wood pellets sold under the Firestixx brand. They deliver in bulk with 3 dedicated vehicles, and in bags. There are plans to build a pellet production plant in the next 9 months, producing pellets to be marketed under the Firestixx brand. They also supply wood chips, locally sourced. (There are many other companies importing or distributing wood pellets in Ireland, for example Kedco, Co Cork, and Leinster Pellets, Co Wicklow.) Timber Pro see their market continuing to grow; one third pellets, one third, wood chip, one third briquettes.

Dpellet ltd: - A larger scale pellet producer, based near Kilkenney on the site of parent company Roto Spiral. Buys in softwood logs, (thinnings), which are stacked for initial drying; debarks and chips before processing to pellets. Three pellet presses. Delivery is in bulk, and in bags. Only became fully operational this summer. See the commercial market as the mainstay of business.

Balcas Ltd, based in Enniskillen, Northern Ireland, one of the largest sawmills in the UK. Largest wood pellet plant with 3 presses and is powered by the CHP plant built alongside. The pellet plant has been in production since summer 2005. Markets wood pellets under the brand name Brites. Delivery is in bulk, and in bags. Business plan says they are committed to supporting the domestic market. Expect continued market growth, especially in 10kg bagged pellets.

5.3 Testing for pellet quality

During the production of wood pellets samples are taken at half hourly intervals (as reported by Balcas) to check for density, moisture content, and durability. Full chemical analysis is carried out only once a month. The quality of wood pellets can vary significantly and is particularly important

Table 2. Simple quality tests carried out on sample pellets.

Manufacturer	Density, kg/m^3	Visual/smell	dissolve	burn
Irish woodpellets	0.66	Dark brown /eucalyptus?	Very slow to dissolve	Burns well/ wood smoke
Timber Pro (Firestixx)	0.66	Light brown /softwood	Dissolves easily	Burns well/ wood smoke
DPellet ltd	0.52	Light brown few dark specs/ softwood	Slow to dissolve	Burns well/ wood smoke
Balcas (brites)	0.65	Light brown/ softwood	Dissolves easily	Burns well/ wood smoke

to the domestic user, where small boilers and stoves are less tolerant of poor quality pellets.

There are however some simple tests the user can carry out which should minimise problems with pellets. These are explained in the COFORD document, “Simple ways to check wood pellet quality”, see Appendix 1.

Samples of pellets from the companies visited were tested as suggested in the COFORD document. Table 2 summarises the tests carried out on the sample pellets. From the tests it can be seen that the density of the dpellet sample was low, (should be 0.6 – 0.7 kg/m^3). This was indicated too in the visual examination, the pellets easily breaking. The Irish Woodpellets sample was dark and had a distinctive smell of eucalyptus, indicating the sawdust may have been, at least in part, sourced from the manufacture of hardboard or hardwood. On the basis of these tests, only the Firestixx, and Brites pellets could be recommended for domestic stoves and boilers, as the dpellets sample is not dense enough and likely to generate to much fines, and the Irish Woodpellets sample may not be entirely softwood and may cause ash problems.

5.4 Pellet delivery to the customer

Pellets are usually delivered in one of three ways:

1) In bulk via a specially designed vehicle, (or animal feed truck); minimum delivery of 3 tonnes.

2) In one tonne big bags, (dry delivery required).

3) In small plastic bags of 10Kg, 15Kg or 18Kg.

Bulk delivery requires that there is suitable storage on site, e.g. silo or dedicated bunker, and big bags require dry storage. Bulk delivery is made preferably by dedicated vehicles, or modified animal feed trucks. Care needs to be taken when delivering to the customers store to minimise damage to the pellets, and increasing fines. Small bags are more often sold through retailers and are more suitable for refuelling single room pellet stoves.

6 Pellet Stove and Boiler technology development

The development of stoves and boilers for domestic wood pellet combustion can be characterised by two distinct requirements, single stoves for room heating and boilers for central heating. These have developed in the past 15 years reflecting particular characteristics of national markets. For example, pellet stoves have become very popular in Italy and North America, whereas pellet central heating systems have been preferred in Austria and Sweden. As pellet burning technology has developed in Europe, at first, within national boundaries it has taken two distinct routes. In Sweden, simple low-cost burners were developed, often as retro fits for existing oil boilers. In Austria and Germany highly sophisticated dedicated boilers were developed with a high degree of automation. This is examined in detail by Frank Fielder [8]. He notes both the similarities and the differences in development and these characteristics are summarised in Table 3. Regulations regarding emissions and fuel quality are reported on along with some consumer environmental labelling. The consequence for the emerging Irish market is that there are a large number of wood pellet stoves and boilers available from the European market, with different burner technologies, degrees of sophistication and cost.

Emissions are a significant issue for the widespread introduction of wood pellet boilers, especially in urban areas. If the substitution of oil boilers with wood pellets boilers lead to increased air pollution, the environmental benefits might be seen to be diminished. Kjallstrand and Olsson [9], in Sweden, where oil heating has already declined in favour of wood and electricity, reported that modern pellet boilers can meet current pollution

Table 3. from F Fielder, 2004

Characteristics of typical Swedish and Austrian pellet boilers [6,31,40]

Property	Swedish boilers	Austrian boilers
Type	two unit boiler	integrated boiler
Power modulation	50%/100%	30–100%
Boiler efficiency[a]	78–85%	86–94%
Combustion air supply	blower	aspirator
Combustion control	no	no/lambda/speed controlled fan
Lighting	automatic	automatic
Air-passage cleaning	manual	automatic, optional
Cleaning burner	manual	automatic, optional
Ash removal from combustion chamber	manual	automatic, optional
Time interval ash removal from ash pan	weekly	2–8 times per year
CO emissions [mg/m^3]	260-650[b]	12–250[c]
Price	4000–6000 Euro	7000–10,000 Euro

[a] At nominal power.
[b] At nominal power with 10% O_2.
[c] At nominal power with 13% O_2.

limits, and are ten times less polluting than older wood fired boilers. They also indicated that there are considerable variations in emissions dependent on boiler design and operation. Wood pellet stoves and boilers in Ireland could therefore significantly reduce pollution, in a country where open fires and peat burning are still popular.

Gerkros is the only Irish manufacturer of wood pellet boilers; an established oil boiler manufacturer, who has started manufacturing wood pellet boilers, similar to Swedish models, and now claim to have 50% of the market

Wood pellet boilers are expensive; a typical domestic installation costing approximately 10,000EUR. This is about three times the cost of an equivalent oil or gas boiler.

7 Discussion

To quote one wood pellet boiler installer, “We seem to have learnt nothing from Europe” Many of the birth pains of the Irish wood pellet market have already been experienced in Europe. Studying patterns of deployment of wood pellet technology in countries such as Sweden and Austria may indicate a model for how the Irish market might develop. Most of this information is anecdotal, but a study by Mahapatra and Gustavsson [10], gives a good insight into the motivations of homeowners when considering buying wood pellet boilers in Sweden. The surveys from 2004 and 2007 of over 1500 randomly selected home owners, gave some clear indicators:

The most important factors when considering a new heating system were annual heating cost, investment cost, and functional reliability.

80% of respondents did not intend to install new heating systems.

Government subsidy was important for conversion from electric heating but not oil.

Installers and interpersonal sources were the most important channels for information on heating systems.

The surveys indicated the long time required for the diffusion of new energy technologies. It also concluded that government grants could be better targeted at those householders most likely to adopt particular renewable technologies.

The rapid expansion of the Irish domestic wood pellet market in 2006 had consequences for the market today. Although sufficient pellets were being produced, and imported, the infrastructure for supplying them was not in place. Balcas had 80 new customers for bulk deliveries in one week in October 2006, and with only 2 delivery vehicles, delivery lead times extended to many weeks. The distribution of bagged pellets were had only just been started, but in some areas there was a shortage. This has led to the continuing misconception today that pellet supply is unreliable. All the main suppliers now have sufficient vehicles and stocks and most guarantee delivery within 14 days.

Pellet prices are sensitive to delivery costs; bulk delivery, (>3 tonnes at 50km) currently around 225EUR a tonne, (source Pellet @las). 10kg bags can retail up to 50% more, and so are only really suitable for single room stoves. Some companies have been advertising pellets at half the cost of oil, leading to the accusation that they are offering unrealistic savings. This is valid a point, even with the current high price of oil, pellets sold in bulk are 60% of the cost of oil. Bagged pellets are not likely to be significantly cheaper than oil in the near future.

The initial grant of 4200EUR under the “SEI Greener Homes Scheme” in 2006 tempted many into the market. The rapid growth also lead to large numbers of different boiler systems being purchased and installed, some with no knowledge or support for the technology, with serious failures due to poor installation, faulty components, and lack of user training. Gerkros and KWB (an Austrian pellet boiler manufacturer), have now installer training schemes, in both the north and south of Ireland.

All boiler installations require dry storage for the wood pellets. This was one of the issues that was not fully appreciated by SEI in the initial funding, or by many of the potential customers. An energy

equivalent quantity of pellets takes up 4 times as much space as oil, and to store the minimum delivery load of 3 tonnes requires at least 8 cubic metres of storage space. Home made stores were often inadequate, which led to many of the leading pellet suppliers marketing their own storage solutions.

Pellet quality is critical to reliable performance of wood pellet stoves and boilers, especially the smallest domestic ones which are particularly intolerant of high fine and ash content. Substandard pellets have been sold on the Irish market and pellets can also easily be damaged in delivery, excess pressure in bulk delivery giving increased fines to the boiler.

These problems and the reduction of grant support from the government in phase II and III, of the Greener Homes Scheme, (almost halved from 4200EUR to 2500EUR and more restrictions), have slowed wood pellet boiler installations. As of July 22,000 grants have been approved of which 13,000 have been installed and paid for. 25 % of these are for biomass installations, approximately 4300.

8 Conclusion

The wood pellet market in Ireland is in its infancy, (two heating seasons). There is much to learn; legislators with regards to policy support; producers in quality control and delivery; manufacturers, retailers, and installers, in education of users in the pellet burning technology.

For further growth in the domestic market government support needs to be consistently targeted at the most likely adopters, and at a level at which make the technology competitive.

Further growth in the domestic sector may be restricted by the space required for pellet storage, in which case pellet stoves may become more popular.

Market growth will continue to be led, at least in the near future, by commercial users of pellets.

Pellet producers need to demonstrate they can deliver pellets of high quality consistently at a stable price.

Installers need to continue to educate and support their customers in the new technology.

The increasing differential between wood pellet prices and oil prices may also help the market. As of July 2008, pellets at 225EUR a tonne (for bulk delivery), is about 60 % the equivalent heating oil price. Historically in Europe, pellet prices have been more stable than oil, providing demand could be met.

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Appendix 1

COFORD document: Processing /Products No. 11

[1] *Danish Forestry Extension, Senior Consultant Wood for Energy, Skovvej 25, 7182 Bredsten, Denmark. Email: woodenergy@gmail.com.*
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Simple ways to check wood pellet quality

Pieter D. Kofman[1]

The quality of wood pellets can vary greatly. When buying wood pellets one should preferably seek a fuel that conforms to one of the classes outlined in the recent IS CEN/Technical Specification 14961:2005 *Solid biofuels - Fuel specifications and classes (Table 5).* Consumers should examine the following pellet characteristics:

- **Size**: most pellets produced as fuel are either 6 or 8 mm in diameter and about 3-4 times the diameter in length.
- **Moisture content:** should be between 8-10%.
- **Ash content**: good quality wood pellets have a very low ash content, below 0.7%.
- **Mechanical durability**: this is a measure of how well the pellets can stand handling. Every time pellets are handled, some of them break and all of them show some wear, which will increase the amount of fines. A durability of 97.5 should be required.
- **Amount of fines**: fines hinder pellets from tumbling down to the in-feed auger, thus disturbing fuel feed to the boiler. Boilers are adjusted to burn wood pellets, but if fines arrive in the burning chamber, the flame may get too hot as fines particles burn faster than pellets. In the worst case the ash might sinter, which means that the burner must be cleaned after it has cooled down. The amount of fines should preferably be declared for each bulk delivery, and is measured at the final point in the factory production chain. Fines should preferably be less than 1% by weight. Pellets are usually screened before leaving the production facility. Pellets in bags tend to have less fines than those delivered in bulk. Pellets stored in silos can have an increased amount of fines on delivery.
- **Binding agents**: if the proper feedstock, such as conifer sawdust, is used it should not be necessary to use a binding agent to make wood pellets. However a binding agent is often used where broadleaved species are the material. If an agent has been used, the kind and amount should be declared.
- **Bulk density**: this measures the weight of a certain volume of loose wood pellets and should be in the order of 650 kg/m^3 loose volume. If the weight is too low, the pellets have not been compressed enough which might result in increased amounts of fines.

By using smell and visual appearance, and the simple tests outlined here, wood pellet quality can be quickly determined.

- Put a few handfuls of pellets into a plastic bag and smell the odour from the pellets. They should smell of freshly cut softwood. If they smell of anything else, beware.
- Look carefully at a handful of pellets. They should be light brown in colour, if they are made from clean conifer

sawdust. Dark brown particles are a sign of bark and thus an increased amount of ash. Pellets might have a darker outer layer, which is due to friction in the pressing dyes. This is not a problem as long as the pellets are a light colour inside – check by breaking them.

- Take one long pellet and light it at the tip. The smoke should smell of burning wood. If it smells of anything else, it is not of good quality.
- Place a small handful of pellets in a glass of water. The pellets should dissolve into sawdust within minutes. If not, a binding agent might have been used or improper feedstock. Once the pellets have been dissolved, swirl the glass and see what settles in the middle of the bottom of the glass. The heaviest particles will settle there. If there is a large amount, it might be possible that dust from a sanding machine has been added to the pellets. This increases the amount of ash and the risk of sintering.
- Take a vessel larger than 1 litre and weigh it on a kitchen scales. Note the empty weight. Fill the container to the brim with wood pellets and weigh again. Note the weight. Fill the container with water and weigh again. Deduct the weight of the container from both other measurements. Then divide the weight of the pellets by the weight of the water. The result should be between 0.6 and 0.7 kg/litre and preferably around 0.65 kg/litre*. This indicates that the pellets have been pressed at the right pressure. If the pellets have a density below 0.6 kg/litre then they are too soft and break easily, forming fines as a consequence.

Conclusion

These simple tests will prevent most problems with wood pellets. As a general rule, if wood pellets are cheap they are of poor quality and should be avoided. Good quality pellets may be more expensive but are a much better investment as they burn more slowly and efficiently, prolong boiler life, and release fewer emissions.

** 1 kg of water occupies 1 litre of space at room temperature.*

For information and a free on-line advisory service on the wood energy supply chain, the quality of wood fuels and internal handling visit ***www.woodenergy.ie***