PELLETS IN SOUTHERN EUROPE. THE STATE OF THE ART OF PELLETS UTILISATION IN SOUTHERN EUROPE. NEW PERSPECTIVES OF PELLETS FROM AGRI-RESIDUES

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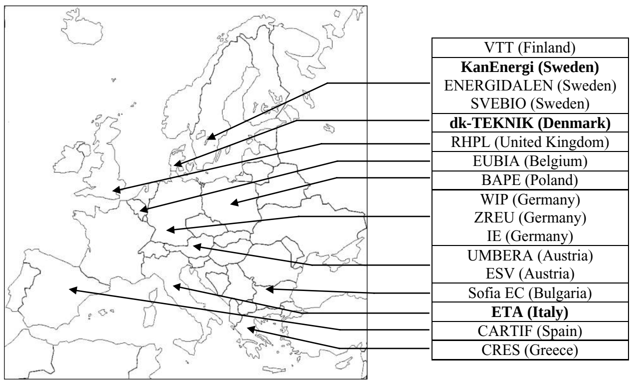
ABSTRACT – The following paper presents some of the conclusions from the *Pellets for Europe* on-going project, supported in the framework of the EC ALTENER Programme. The overall objective of this European project is to draw an accurate picture of market opportunities for wood- and agri-pellets (i.e. pellets made from agricultural residues) in Italy, Spain and Greece, while also providing a general overview on pellets market potential in the other European Countries. On the basis of the information gathered (market potential size, actors involved, usual practices), it will be possible to identify the main barriers - technical or not - and to design relevant strategies so as to overcome those critical factors and to support the development of pellet markets in Southern Europe. After presenting the general features of the project, the paper then describes the state of the art of pellet markets in Italy, Spain and Greece. Wood-pellet market seems to have taken off quite successfully in Italy and, to a lower extent in Spain, while it is still inexistant in Greece. Today, producers of the two first countries face difficulties ranging from the increased difficulty to be supplied in raw material, to the absence of political or financial supports.
As a matter of fact, the development of the solid biofuels market in Europe presents different patterns in North and in South European countries for bioclimatic, political and economic reasons. The relatively low forestry resources in south European countries (and the shortage in raw material reported above) invites to tackle the possibility of using agricultural residues as a raw material for fuel pellet production, and thus invites to think of strategies for supporting the development of the agri-pellet market. The first part of the paper shows that agri-pellet markets are almost inexistant in Italy, Spain and Greece. Yet, the agricultural residues available for energy purposes are important and could amount more than 40 million tonnes of dry biomass, i.e. more than 16 million toe. Obstacles to the agri-pellets market development are then pointed out, and it is stated that, with appropriate political and information measures, those obstacles could be overcome in the short to medium term, especially as far as large-scale combustion systems are concerned.

1. PELLETS FOR EUROPE : FRAMEWORK, OBJECTIVES AND PARTNERS

The following paper present some of the results of the *Pellets for Europe* project, which is co-funded by the European Commission, Director-General for Energy and Transport, in the Framework of the ALTENER Programme. *Pellets for Europe* results from the merging of three different projects, which prevents overlapping activities and enhances synergy effects. General objectives are:

- To stimulate new European markets for pellet stemming from wood residues;
- To stimulate a new market for pellet stemming from agricultural residues;
- To analyse the state of the art of the collecting and conversion technologies;
- Analysis of the main regulatory barriers in the European areas which have been selected;
- To support Public Administrations with programs of diffusion and support;
- To create national and regional networks for monitoring and promotion;
- To bring together key subjects in the production, distribution and application sectors of biomass.

Pellets for Europe is being brought forward by 17 European partners:



As part of the European project *Pellets for Europe*, a market assessment is currently being performed in Italy, Spain and Greece for wood-pellets, as well as a general study on the perspectives concerning the state of the art of agri-pellets. This assessment will be the basis for the analysis of barriers and the design of market penetration strategies. This paper summarises the first results of this work.
Concerning the agri-pellets, the first step was to obtain a comprehensive overview of both wood and agri-pellet

markets in the targeted countries, which was gained by an in-depth analysis of pellet production patterns and their related socio-economic aspects by directly contacting market actors. In parallel, total raw material potential available for energy purposes was assessed. The second step consisted in analysing the critical factors concerning agri-pellets penetration. Thereby, a more detailed and subtle understanding of expectations, plans and barriers was reached. Thirdly, an overview of the legislative aspects was gained in order to identify specific legislation, standards and recommendations relevant to biofuels. This study is going underway and will be finalised by trend analysis, barriers assessments, market strategies and identification of new market opportunities, especially in Eastern Europe.

2. BRIEF OVERVIEW OF THE SOUTH EUROPEAN PELLET MARKETS

2.1 The Italian pellet market

Among the renewable energies, biomass plays an important role in Italy, contributing to almost half of the renewable energy sources (RES) in the national gross inland consumption. Actually, one of the first consequences of the Kyoto Conference has been the elaboration of the "National Program for the Renewable Energies from Biomass".

The Italian market for wood-pellets is still small but growing steadily, with a projected production of 130,000 to 150,000 tonnes in 2003, involving 41 manufacturers. Consumption is higher than national production, and pellets are imported, mainly from Austria and Spain. The acceptance of this biomass fuel is a very positive sign with respect to the future development of the market. A the moment, only one company has launched a fuel-pellet production from agricultural residues. The production of this company is still modest, as it began only in august 2003, but a production of 12,000 to 15,000 tons of agri-pellets per year is expected in 2004.

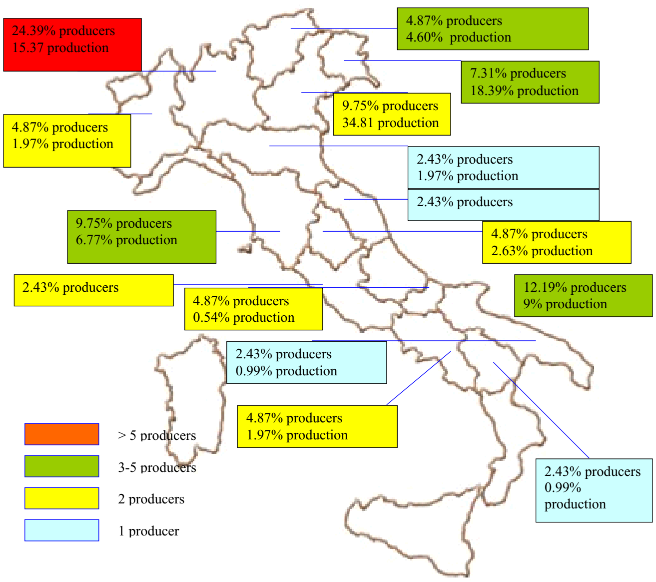


Figure 1. The wood-pellet production in Italy is mainly concentrated in the North region.

Personal interview revealed a somehow general pessimism among pellet manufacturers. Besides the high level of required investment, the lack of governmental incentives and the increasing difficulties for obtaining raw material, the low public awareness is seen as a strong limitative factor for the expansion of their activities.

The utilisation of pellets for heating uses is still in its early stages. The civil utilisation has remarkably grown in the last 3 years, as confirmed by the increasing number of retailers of pellets stoves and boilers. It must be underlined, as already mentioned above that a critical factor for the development of the market, that the great majority of citizens do not know the existence of this kind of heating equipment.

The Italian national grid operator GRTN has registered 55 plants already in activity fuelled with waste and vegetable residues, and 22 projected. This category is large, and comprises plants fuelled with biogas, as well as with wood chips or waste. In a more precise classification we find 6 plants fuelled with “cultivation and agri-industrial waste” in the year 2000, and 7 plants in 2001.

2.2 The Spanish pellet market

The "Plan to Promote Renewable Energy Sources in Spain" (1999), derived from Law 54/1997 on the Electric Sector, pretends to achieve an increased use of RES, and particularly of biomass. It establishes a target consumption of 12 % of primary energy with RES in 2010. Biomass is the most important area of this Plan and should contribute to 63% of the substituted total primary energy supply by 2010. However, expected figures are not being reached and fuel pellets appear to be an alternative to overcome transport and storage costs, two factors which seem to affect largely the profitability of biomass projects.

The Spanish wood-pellet market is extremely small. Production of both briquettes and pellets would amount 50,000 to 60,000 tonnes per year. Furthermore, there is no current pellet production from agricultural residues for energy purpose. Only one company, which manufactures straw pellets for feeding purposes, sells a part of its production as a fuel in case of surplus. However, there is no information about the convenience or problems related to the combustion of this product.

At the moment, 90% of the raw material processed by pellet production plants come from wood processing industries, primary (e.g. sawmills) as well as secondary (e.g. furniture manufacturers). But those wood wastes are increasingly recycled in the very processing plants where they are produced. When it is not the case, wood wastes are also a very valuable raw material for the board manufacturing industries, so that there is a considerable competition on this raw material resource. As a consequence, some pellet production sites have gone out of business due to difficulties to have a guaranteed supply of raw material, both in quantity and quality. Therefore, the dependency on raw material sources appear to be a serious obstacle to the pellet production perennity. From that point of view, the possibility of using agricultural residues is absolutely relevant.

In the last decade, a significant increase in densified biomass fuels for domestic use has taken place and pellet consumption is still mainly oriented towards the small scale energy market (residential heating). Consumption is currently higher than production, and Spain needs to import pellets from Canada and other European countries. At the same time however, a part of the Spanish production would be exported to Italy, France and Germany: the respective pellet market prices might explain this apparent paradox.

As a conclusion, the country continues to face significant barriers to wood- and agri-pellet penetration. As far as wood-pellets are concerned, public awareness as well as institutional and financial supports are low. In addition, none of the European standards on pellets and pellet boilers are used to guaratee products characteristics, which can not contribute to creat consumer’s confidence. Concerning the agri-pellets, the whole market would be to build up. In relation with the relative shortage of wood residues, the agri-pellets option seems very interesting, but even at a higher degree than for wood-pellets, there would remain two important challenges: the production of a fuel of high quality, resistant to the transport abrasion, and the adaptation of small scale heating devices.

2.3 The Greek pellet market

Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market (L283/27.10.2001) provides in its annex for Greece an indicative target of meeting by 2010 a part of its gross national electricity consumption from RES equal to 20,1%, the contribution of the large-scale hydroelectric plants being included.

There is no current pellet production or use in Greece and therefore the market is completely undeveloped. Despite the National Development Law 2601/98, political support is also considered as a weak point for the development of a pellets market. As a consequence, Greece has a significant untapped potential not only for agri-pellets but also for wood pellets.

2.4 General success factors for market development

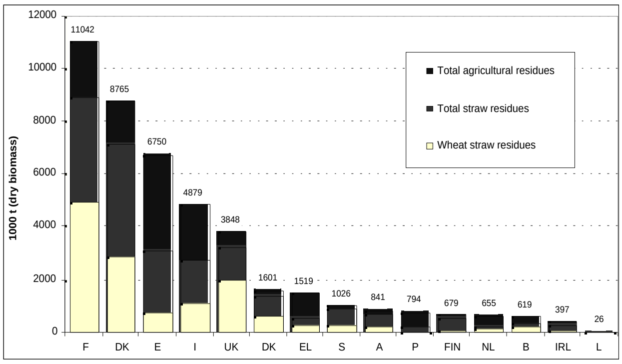
When aiming at developing a new market for pellet heating systems, both aspects of the "supply side" (pellets & equipment) and of the "demand side" (building owners) must be addressed. The challenge consists in obtaining simultaneously several positive factors: the production (or importation) of good quality pellets and combustion appliances (stoves, burners, boilers), the local distribution network for pellets (by trucks or bags), installers able to install and guarantee a convenient maintenance of the equipment. Last but not least, customers should be aware and willing to use pellet heating systems.

3. AGRI-PELLETS : PRODUCTION- AND COMBUSTION-RELATED ISSUES

3.1 A considerable raw material potential

Two types of agricultural residues can be distinguished: those available from farms, and those resulting from agro-industrial processes. Only the first category has been assessed, assuming that the volumes generated by the second one are comparatively small. EUROSTAT and FAO databases provided primary data (cultivated areas and production amounts) to which different coefficient have been applied: ratio residue/cultivated, moisture content and availability. The availability coefficient is undoubtly the most difficult one to determine, as it implies to assess the alternative uses of the residues. For example, as far as cereals are concerned, most of the straw is used for animal

Figure 2. Total agricultural residues available for energy purposes in the EU-15 (medium assumption).



feeding and bedding, or ploughed back into the soil for fertility purposes. Yet, a set of medium assumptions (a 20% availability for cereal straw, and a 20 to 45% availability for other determined residues) allows

to consider that agricultural residues available for energy purposes would amount **43 million tonnes** of dry biomass in the EU-15, which correspond to 16.6 million toe (i.e. respectively 18% of the RES-share and 29% of the biomass-share in the European gross inland consumption in 2001). Other ranges of assumptions, more conservative or more optimistic, show that the estimation can vary between **23 and 64 million tonnes** of dry biomass.

Figure 2 illustrates the repartition of the 43 million tonnes of agricultural residues throughout the EU-15. One can see that straw residues represent the main part of those residues (70%), and among straw residues, wheat straw are of a relevant importance as they correspond to almost one third of the total agricultural residues. Estimations given here are very general, and before planning a local project, one should assess very thoroughly the real available amount of local residues, because for example straw yields vary greatly with variety and natural conditions (soil and climate), and also by growing season, with markedly lower production in abnormally dry years.

From these figures, a first estimation of the long term potential resources for agri-pellets can be made, and would be comprised between 40 and 50 million tonnes. If technical barriers are overcome, the medium term market for agri-pellets could be about 20 million tonnes in the EU-15. These figures show that the raw material potential is relatively important, specially when considering that the upper limit for the European wood-pellet market reaches a few million tonnes.

3.2 No major technical obstacles with respect to agri-pellets production

Straw can be pelletised without major difficulty. Straw is generally received in bales weighing up to 500 kg, and its grinding include two steps - first a scarifying process and then a fine-chopping into smaller particles – while sawdust usually only pass through one comminuting machine. In those conditions, the straw grinding require a slightly higher investment corresponding to the additional scarifyer. However, the global energy requirement for pelleting straw can generally be considered lower to the one related to wood, because straw is delivered at a low moisture content (<20%) that usually allows by-passing the drying stage, which is otherwise the most energy-consuming stage when processing wet raw material.

Generally, the same pellet mills are used for straw and wood pelleting, but from one product to another, the wear parts (steel dies and rollers) shall be changed. In relation with the lower lignin content in straw than in wood (15% against 25%), friction forces must be higher when pelleting straw so as to set free more lignin. Friction forces are increased with an increased thickness of the dies, which actually increases the compression length. Another problem is the higher abrasion power of straw because of its higher silica content. Although some manufacturers affirm that there is no obvious difference on wear, others emphasize that straw pelleting could reduce the wear parts lifetime by up to 20%. Finally, the main differences between wood and agri-pellets is the higher friability and slightly lower energy content of the latter, with a net calorific value of 15.5 MJ/kg (17 MJ/kg for wood-pellets).

3.3 Slightly higher production costs

Clearly, while evaluating the market potential for agri-pellets, price is at least as an important factor as the raw material availability or the technical manufacturing possibilities. The "theoretical" straw pellet costs was calculated from the researched figures for: raw material costs (25-50 ¤/t), pelleting running costs per tonne (20-30 ¤/t), plus per-tonne capital investment costs and overheads. The global cost was found to range 94 to 164 ¤/t. This corresponds to prices found in countries which have small straw pellets markets such as Denmark where the production cost is found to be around 135 ¤/t.

Table 1. Compared production costs for wood- and straw-pellets

Production costs (¤/t)		Minimum	Maximum
Wood pellets (1)	Dry raw material	52	81
	Wet raw material	79	101
Straw pellets (2)		94	164

Source: (1) Thek and Obernberger, 2002; (2) Pellets for Europe

To recap, the European agri-pellet market present a medium term potential of 20 million tonnes and the agri-pellets price would stand in regular fuel cost range. Therefore, the first steps of this analysis tend to show that this market is neither restricted by raw material quantity nor price. The major obstacles to the extension of the agri-pellets market rather appear in the area of the product combustion.

3.4 Technical obstacles related with agri-pellets combustion

Agri-pellets combustion triggers several major obstacles regarding deposit formation (slagging, fouling), emissions (dust, gas and aerosols) and corrosion. Another problem is related to the further disposal of ashes which are produced in high quantities. All those problems depend not only on the fuel characteristics, but also on the design of the combustion equipment and the way it is operated.

Typical features of agricultural residues in comparison with wood residues are a high ash content (5% against 0.5%) and high nitrogen (N), sulphur (S), chlorine (Cl) and potassium (K), increased by the use of fertilisers, pesticides and herbicides in agriculture. Those characteristics make straw pellets combustion very problematic, firstly because of complications within the combustion equipment, and secondly because of noxious and corrosive emissions.

Table 2. Comparison of fuel content and emissions between wood and straw for determined elements

	Wood	Straw
Fuel content of (in mg/kg):		
Nitrogen (N)	670	1750
Sulphur (S)	40	470
Chlorine (Cl)	44	1400
Emissions of (mg/Nm^3):		
NOx	140	260
SOx	10	100
HCl	0.6	36

Source: bayerisches landesamt für umweltschut; http://www.bayern.de/lfu/luft/emicontrol/emicontrol1.htm;

The first practical problem occurs in the furnace: the high K content of straw pellets lowers the ash softening temperature of an increased ahs volume, which results in increased slagging and fouling in the boiler. If, at first sight, little can be done to reduce straw pellets ash content, one has to remember that concentrations of inorganic elements are influenced by different fertilising habits, and above all, a natural rain-leaching of straw in field can considerably reduce the K and Cl contents (respectively 6 and 10 fold). Research teams currently investigate the technical and economical feasibility of removing the inorganic elements in dedicated treatment plants.

Improvements could also be operated at the fuel preparation stage, adding some specific anti-slagging agents (e.g. kaolin) or mixing straw with sawdust so as to present final characteristic more convenient with regard to combustion and ash issues. In any case, national or European standards should always be met, and they currently authorize only a limited number of additives. The slagging problem also reduces the range of possible combustion devices, and the most appropriated technologies appear to be the moving grates (for medium energy production) and the fluidised bed combustors (FBC - for large-scale energy production). In the first case, the moving grates rapidly push away the ash which has little time to sinter. In the FBC case, the lower operative temperatures decrease the risk of slagging and inhibit the formation of nitrogen oxides (NO_x). Those systems also permit the removal of sulphur dioxide (SO_2) by addition of sulphur absorbents such as limestone or dolomite in the bed.

3.5 Emission related issues

High N-, S-, Cl- and K-content leads to relatively high levels of NOx, SOx, and HCl emissions compared to wood pellets. K influences both particulates emission. Finally, a high Cl-content results both in corrosion problem on boiler's surfaces and in formation of dioxins. Those problems can be overcome by a set of techniques, including combustion equipment design (air- or fuel-staging), combustion controls (e.g. lambda control) or flue gas cleaning (for SO_x: addition of lime; for NO_x: selective catalytic (or non-catalytic) reduction; for dust: multi-cyclone, ESP, baghouse filters). However, most of these techniques are expensive and require professional knowledge, and hence are only applicable cost-effectively in large scale combustion plants. As a consequence, all straw-based energy production takes place on a medium to large scale for example, in public buildings or district heating. Co-combustion of agricultural residues with fossil fuels is also a very interesting alternative, technically and economically. SO_2 and NO_x emissions reduced by use of biomass fuels, while sulphur or aluminium silicates in coal (or peat) prevent corrosion as well as bed agglomeration in FBC. However, in all those cases, straw in bales is preferred because its transportation costs are lower than the fuel densification costs. Pellets become an interesting option for large scale plants when their fuel demand can not be cost-effectively supplied by bulky loose biomass.

At the moment, there is only one known large-scale use of straw pellets, at the Amager plant, in Denmark. This old coal-fired power plant of 136 MW has been converted to be fired with straw pellets exclusively, produced in the Køge pellet plant. Currently, the Amager plant is still in the optimisation phase so that oil still counts for the largest energy input. But a normalised operation should be reached this year, and 130,000 tons of straw pellets are expected to be burnt yearly.

3.6 Recycling of ash

In order to produce a ideal sustainable biomass fuel system, nutrient cycles should be closed, and from that perspective, the recycling or storage of agri-pellets ash deserves a special attention, especially because of the much higher ash content in agri-pellets. Straw ash fractions include bottom ash (80-90%) and fly ash (10-20%). Both must be stored or recycled. Fly ashes have typically a high heavy-metal content, and they are therefore treated separately and generally oriented towards land filling, whereas the rest of the bottom could be recycled according legislation.

As a conclusion, environmental impact as well as current state-of-the-art of combustion technologies indicate that pellets made from agricultural residues (and in general way other ash-, N-, K- and Cl-rich fuels) should be used primarily in large scale combustion plants equipped with sophisticated combustion control systems and flue gas cleaning systems, whereas wood pellets should be preferred for small scale combustion unit (mainly residential heating). At a higher degree than for wood pellets, the main technical challenges regarding agri-pellets are the production of a high quality fuel, and technological improvement for small-scale combustion devices. Assuming that economic aspects concerning the agri-pellets energy option are favourable, the agri-pellet market for small-scale use will develop only if equipment manufacturers are encouraged to develop novel, safe and affordable combustion solutions.

4. EUROPEAN LEGISLATION AND OTHER VOLUNTARY NORMS

The main drivers for a dynamic market development have proved to be fiscal incentives (energy taxes in Sweden and Denmark, or subsidies in Austria), technology development (small scale heating devices) and of course public awareness. Yet, to create a positive public awareness, standards guaranteeing optimal fuel quality and optimal appliances performances are of a special importance.

Only three European countries have standards specifically for densified biomass fuels: Sweden (SS 187120 for pellets, SS 187121 for briquettes, P-marking which is a testing procedure for pellet stoves,burners and boilers under 15 kW); Austria (ÖNORM M 7135 sets quality standards for briquettes and pellets from natural wood and natural bark), Germany (DIN 51731 and DINplus for briquettes and pellets). In some other countries, quality charts can be voluntarily subscribed by market actors (e.g. France, UK). The CEN (European Committee for Standardization) and national standardisation institutes are co-operating to prepare a European set of standards concerning biomass fuels.

5. CONCLUSION

The *Pellets for Europe* has started only a few months ago and no definitive conclusions can be drawn at the moment. However, general observations can be made: while wood pellet market has emerged and is progressively growing in Italy, it remains reduced in Spain and absent in Greece. In the first two markets, raw material supply seems to be a critical factor, which is a reason why thinking of the exploitation of agricultural residues as a promising resource. Indeed, the available raw material from this sector appear to be promising, and the production costs, even if they are slightly higher than for wood, remain acceptable. Barriers appear rather at a technical level: straw pellets trigger problematic slagging and emission problems which can be solved cost effectively almost only in large scale energy plants. Research and technological development must be encouraged by financial incentives or by dedicated Laws, in order to extend performant large-scale plants, and also to favour the development of safe and affordable small-scale combustion devices. In any case, information dissemination must contribute to increase public awareness about the potential of pellets solutions. The analysis performed in the framework of this project underlines the need for a coherent European and national strategy supporting the growth of this market.

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