

## **MixBioPells: Verbesserung der Marktrelevanz alternativer Biomasse(misch-)pellets in Europa**

### **MixBioPells: Enhancing the market relevance of alternative (mixed) biomass pellets in Europe**

**T. Zeng<sup>†</sup>, C. Kristöfel<sup>‡</sup>, E. Wopienka<sup>‡</sup>, N. Weller<sup>†</sup>, V. Lenz<sup>†</sup>**

<sup>†</sup> Deutsches BiomasseForschungsZentrum (DBFZ), Torgauer Straße 116, D-04347  
Leipzig, Tel: +49-341 2434-112, Fax: +49-341 2434-133, E-mail: [info@dbfz.de](mailto:info@dbfz.de)

<sup>‡</sup> BIOENERGY 2020+ GmbH, Gewerbepark Haag 3, A-3250 Wieselburg-Land,  
Tel: +43-7416-522380, Fax: + 43-7416-52238-199,  
E-mail: [office-wieselburg@bioenergy2020.eu](mailto:office-wieselburg@bioenergy2020.eu)

#### **Abstract**

Currently, small-scale combustion units in Europe are fired almost exclusively with high quality wood fuels. However, caused by the growing demand for material and energetic use wood is getting more scarce nowadays. Consequently, alternative solid biomass, like low quality wood or straw, is experiencing growing interest as alternative fuel source. In most European countries preliminary activities in industrial as well as in public sectors have been started to integrate these alternative solid biofuels. However, the market integration of alternative biomass pellets is still hindered by various constraints. To overcome these constraints and strengthen the drivers promising market introduction concepts have to be identified to enhance the relevance of alternative pellets in Europe. Thus, legal conditions for the combustion of alternative pellets are described. Furthermore, an assessment of the costs of energy production with alternative pellets compared with energy production costs of other (fossil) heating systems will be done. The cost analysis is based on concrete scenarios and innovative concepts for the energy production chain (raw material supply – pellets production – pellets supply – combustion) in seven European regions. Thus, detailed cost analysis will be figured out and compared with the support of local industry partners. In result legal and economic constraints and barriers on EU-level will be presented to evaluate relevant raw materials in appropriate combination of pellet production and combustion systems.

#### **1. The MixBioPells project**

There are significant differences for the types of the available raw materials and the local frameworks in the European countries and even between the regions of one country. Thus, the local situations in Central Finland, East Sweden, Jutland in Denmark, Rhineland-Palatinate in Germany, Lower Austria, Lombardy in Italy and Asturias in Spain are analysed. Local bio-business activities will be supported based on a close cooperation with local key actors amongst the whole supply chain. The objective is the development and the creation of regional case studies to gather information about successful technical developments, available raw materials, basic and economic conditions and problems during the build-up of new regional bio-business activities. To ensure a transferability of the results of each region, the current situation concerning technical possibilities in production and utilisation of alternative pellets in the European partner countries are monitored and summarised. This includes national

conditions and available pelletising and combustion technologies which will be investigated by literature research and market surveys as well as interviews with key actors. Finally, the regional and national conditions are compared to identify common constraints and drivers. On this basis, recommendations on favourable legal frameworks are given and regional concepts for the market implementation of alternative pellets with regard to the existing frameworks are developed. To increase the market implementation of alternative pellets dissemination of the project as well as the project results has to be realised for defined target groups and interested public. To do so, a website including a database and forum is set up and side-workshops will be organised at local, national and international conferences. Thus, the MixBioPells project provides up-to-date market information for alternative biomass pellets and mixed biomass pellets based on a comprehensive data collection for representative European countries and regions which is available at [www.mixbiopells.eu](http://www.mixbiopells.eu). The major relevant objectives and outcomes for the actors are:

1. Improvement of the data and information transfer and support of local bio-business activities by:
  - evaluating best practice examples and case studies,
  - organising of regional workshops,
  - publishing of an initiators handbook and
  - set up of a database and communication platform.
2. Increasing the public awareness, e.g. improved communication and guidance for decision-makers by:
  - publishing brochures and
  - including political and administrative decision makers in the project.
3. Development of a labelling system for non-woody (mixed) biomass pellets / briquettes and boilers.

## 2 Legal conditions

The legal conditions for the combustion of alternative biomass pellets made of different raw materials, residues and mixtures differ significantly within the partner countries. Thus, it is crucial to point out which licensed fuels are available and what emission threshold values have to be complied with. Possible solid biofuels that can be used for combustion purposes are listed in Table 1 for seven European countries.

Country	Licensed fuels
<b>Austria</b>	<ul style="list-style-type: none"> <li>• &gt; 400 kW: no general legislative framework – individual permission by local authorities</li> <li>• &lt; 400 kW:               <ul style="list-style-type: none"> <li>· in Lower Austria: standardized non-wood biomass up to a Cl-content of 1500 mg/kg (so far standards are available for straw, Miscanthus and energy grain)</li> <li>· Other federal states: no general legislative framework – individual permission by local authorities required</li> </ul> </li> </ul>
<b>Denmark</b>	According to the Danish Act no. 638 on biomass waste: <ul style="list-style-type: none"> <li>• raw wood, straw, kernels and seeds from fruits, fruit residues, nut and seed shells, untreated cork, grain and seeds, malt, tobacco waste</li> <li>• fuel pellets or fuel briquettes produced exclusively from these raw materials</li> </ul>
<b>Finland</b>	No general guideline: <ul style="list-style-type: none"> <li>• common solid biofuels are wood logs, wood chips and wood pellets</li> <li>• non-woody must be handled individually by the authority as a "special fuel"</li> </ul>

Table 1: non-woody raw materials for the use in combustion systems [2 – 10]

Country	Licensed fuels
<b>Germany</b>	<p>According to Federal Immission Control Regulation No. 4 (&gt; 100 kW):</p> <ul style="list-style-type: none"> <li>• Straw and other herbal raw materials (e.g. cereal whole plant, grasses, Miscanthus)</li> </ul> <p>According to Federal Immission Control Regulation No. 1 (&lt; 100 kW):</p> <ul style="list-style-type: none"> <li>• straw, whole plants (also pellets), grains (also pellets), energy grain processing residues, husks, culms residues and similar herbaceous biomass substances (like Miscanthus or hay)”</li> <li>• other renewable sources</li> </ul>
<b>Italy</b>	<p>According to the environment protection act (D.lgs 152/2006):</p> <ul style="list-style-type: none"> <li>• biomass is considered as a fuel only if it has not been submitted to any chemical treatment</li> </ul> <p>According to legislation on renewable energy promotion (implementation decree of Directive 2009/28):</p> <ul style="list-style-type: none"> <li>• any biogenic matter, regardless its origin or quality (any biomass from agriculture, forestry or agro-industry, which has been submitted only to a mechanical treatment, can be considered as a fuel)</li> </ul>
<b>Spain</b>	<p>According to the “Plan de Energías Renovables”:</p> <ul style="list-style-type: none"> <li>• biomass from forests, woody agricultural residues (pruning of olive trees, fruit trees and vineyards),</li> <li>• grass agricultural residues (mainly straw and corn maize stover),</li> <li>• residues from agricultural industries (olive stones, almond shells,...),</li> <li>• energy crops (mainly cardoon, sorghum and Ethiopian Canola)</li> </ul>
<b>Sweden</b>	<p>No general guideline:</p> <ul style="list-style-type: none"> <li>• Solid fuels are divided in groups with respect to their origin: forest fuels, peat, agricultural fuels, fuels derived from waste etc.</li> </ul>

Table 1: Alternative raw materials for the use in combustion systems [2 – 10] (continued)

Furthermore, the emission and immission legislative framework is crucial to enhance the market implementation of alternative pellets. In Figure 1 the threshold values of each country are classified according to strict, loose and no regulation of threshold values. The classification indicates whether the use of alternative biomass pellets can be problematic (“strict regulation”) or in some cases problematic (“loose regulation”). Thus, the classification can give a basic overview. However, the realisation strongly depends on available combustion and flue gas cleaning systems and the properties of the used fuel. According to Figure 1 there are significant differences of the legal conditions for different thermal ranges and different countries. Emissions of carbon monoxide, nitrogen oxides and particles are commonly limited in medium and industrial scale combustion plants. Emission threshold values for small scale combustion plants up to 100 kW mainly exist in Germany and Austria. In contrast, emission threshold values of hydrogen chloride and dioxins/furanes exist only in Germany. If there are no regulations existing, legal authorities will set the permission and the threshold values at their sole discretion. Thus, the following classification for the legal conditions can be established:

- Highly restricted legal conditions: A small range of fuels can be used due to strict emission threshold values and due to few technical possibilities to keep the threshold values, e.g. restrictions for small and medium scale combustion plants in Germany and Lower Austria.
- Low restricted legal conditions: A wide range of alternative fuels can be used for combustion purposes due to loose restricted emission threshold values, e.g. restrictions for medium and industrial scale systems in Denmark, Sweden and Finland.

- No legal conditions: The combustion of alternative fuels is not allowed or must be individually approved by local authorities, e.g. in Spain, Finland (below 1 MW) or Austria (except for boilers below 400 kW in the province of "Lower Austria") and Italy (below 150 kW).

If the European Unions Framework Directive on Eco-Design of Energy-Using Products (Directive 2009/125/EC) is coming into force most national frameworks will be adjusted [1].

Country	Range	CO	OGC	NO <sub>x</sub>	SO <sub>2</sub>	HCl	Particles	Dioxine / Furanes
Austria <sup>1)</sup>	<100kW	strict	strict	strict	strict	strict	strict	strict
	100kW - 1MW	strict	strict	strict	strict	strict	strict	strict
Denmark	> 1MW	loose	loose	loose	loose	loose	loose	loose
	<100kW	loose	loose	loose	loose	loose	loose	loose
Finland	100kW - 1MW	loose	loose	loose	loose	loose	loose	loose
	> 1MW	loose	loose	loose	loose	loose	loose	loose
Germany	<100kW	loose	loose	loose	loose	loose	loose	loose
	100kW - 1MW	strict	strict	strict	strict	strict	strict	strict
	> 1MW	strict	strict	strict	strict	strict	strict	strict
Italy	<100kW	strict	strict	strict	strict	strict	strict	strict
	100kW - 1MW	strict	strict	strict	strict	strict	strict	strict
	> 1MW	strict	strict	strict	strict	strict	strict	strict
Sweden	<100kW <sup>1)</sup>	loose	loose	loose	loose	loose	loose	loose
	100kW - 1MW <sup>2)</sup>	loose	loose	loose	loose	loose	loose	loose
	> 1MW	loose	loose	loose	loose	loose	loose	loose
Spain	<100kW	loose	loose	loose	loose	loose	loose	loose
	100kW - 1MW	loose	loose	loose	loose	loose	loose	loose
	> 1MW	loose	loose	loose	loose	loose	loose	loose

<span style="display:inline-block; width:10px; height:10px; background-color:red;"></span>	strict	<500	<30	<300	<250	<50	<50	<0.1
<span style="display:inline-block; width:10px; height:10px; background-color:yellow;"></span>	loose	<1000	<125	<600	<400	<100	<300	<0.5
<span style="display:inline-block; width:10px; height:10px; background-color:lightgreen;"></span>	no							

- Threshold values valid up to 300 kW
- Threshold values valid from 300 kW to 1MW
- Threshold values valid for Lower Austria and combustion systems up to 400 kW

Figure 1: Classification of existing emission threshold values for the of non woody biomass up to 50 MW in different European countries (based on mg/Nm<sup>3</sup> and 13 Vol.-% O<sub>2</sub> and ng/Nm<sup>3</sup> and 13 Vol.-% O<sub>2</sub> for Dioxins / Furanes)

### 3 Cost analysis

The costs of energy production with alternative pellets compared to energy production costs of other (fossil) heating systems are another important criterion affecting the possibilities for the market implementation of alternative pellets. In order to deliver concrete results on the costs at least two case studies are considered for each region, see Table 2. For the case studies detailed cost analyses considering the local conditions were performed. The net present value method was used for calculation which is a method of classical and dynamic investment analysis. In order to compare the different heating systems the costs over service life were summed up. The rate per cent is assumed to be 5 %.

Case study	Raw material	Customers
<b>Asturias, Spain 1</b>	Olive stones from the food industry	Possible end users are private pellet stove/boiler owners as well as small district heating systems (e.g. hospitals).
<b>Asturias, Spain 2</b>	Almond shells from the food industry	Possible end users are small to medium scale heating systems (e.g. farms, industrial bread ovens restaurants and supermarkets).
<b>Central Finland, Finland 1</b>	Reed canary grass from local farmers	The customers are usually local farmers with boiler from 100 up to 500 kW.
<b>Central Finland, Finland 2</b>	Reed canary grass mixed with wood (20/80)	Main customers are farmers of the region and the local district heating plants (from 200 to 2000 kW boilers).
<b>East Sweden, Sweden 1</b>	Reed canary grass	End users can be heating plants, public buildings as well as households.
<b>East Sweden, Sweden 2</b>	Reed canary grass	End users can be heating plants, public buildings as well as households.
<b>Jutland, Denmark 1</b>	Shea waste, rape waste, potato and beet pulp, grain screenings	The pellets are co-fired in a CHP plant (electrical output: 52 MW. heat output: 112 MJ).
<b>Jutland, Denmark 2</b>	Straw, in small quantities biomass residues such as grain screenings, peanut shells and corn bobs	The pellets can be used in district heating plants or schools in the countryside and minor industries with biomass boilers. The plant size varies typical from 50 kW to 10 MW.
<b>Lombardy, Italy 1</b>	Miscanthus and poplar	The pellets are used in a heating plant with three 1 MW burner.
<b>Lombardy, Italy 2</b>	Vine pruning	The customers are mainly household heating systems.
<b>Lower Austria, Austria 1</b>	Straw from regional farmers	The customers are the farmers who are the straw suppliers; usually the boilers have a heating load of 30 up to 500 kW.
<b>Lower Austria, Austria 2</b>	Miscanthus	Customers have usually a heating load between 50 and 500 kW.
<b>Rhineland-Palatinate, Germany 1</b>	Grape marc	The pellets can be used in small scale heat plants up to medium scale plants.
<b>Rhineland-Palatinate, Germany 2</b>	Dried digestate	These pellets should be used for the combustion in a power range of 300 kW.

Table 2: Case studies of the MixBioPells project [11]

Exemplarily, the two cost analysis described below depict the situation in Austria. In the first case study, farmers being members of an agricultural co-operation want to sell their Miscanthus as briquettes:

- 22 farmers cultivate an area of 20 ha within a radius of 6 km.
- Miscanthus is harvested annually in April. Usually a corn chopper is used for the harvest.
- The delivery is done with a specially designed conveyor belt wagon, so that the loading can be done without a fan or without major construction efforts.
- The chairman of the cooperation has already bought a mechanical briquetting machine, so he is responsible for the briquetting of Miscanthus. The machine has a production capacity of 1,000 t/a. Currently, about 200 t/a are produced.

The second case study is about pelletising of straw:

- The area-specific straw harvest is subject to strong weather-related variations.

- The Lower Austrian average area-specific straw harvest is about 30.4 t/ha. The bulk density ranges from 100 to 250 kg/m<sup>3</sup> depending on the kind of harvest machinery.
- The harvest and logistic technologies are well established. Usually the harvested straw will be compressed to bales.
- A pelletising company, which originally produced only bedding pellets for horses, is responsible for the pelletising of the straw. Only straw with water content below 15 % will be accepted for pelletising. Due to the low water content a drying of the raw material is not necessary.
- The straw suppliers are mostly farmers of the region (radius < 50 km) providing about 80 % of the required amount. The remaining 20 % of the straw is obtained from two straw dealers.
- The actual potential production capacity of straw pellets for heating purposes is about 2,000 t/a. The installed capacity is 6.000 t/a.
- The fuel is gathered by the farmers themselves, so the farmers are both the straw suppliers and the pellets customers. For combustion, the farmers have to purchase a suitable boiler. Possible boiler sizes vary from 30 kW to 500 kW.

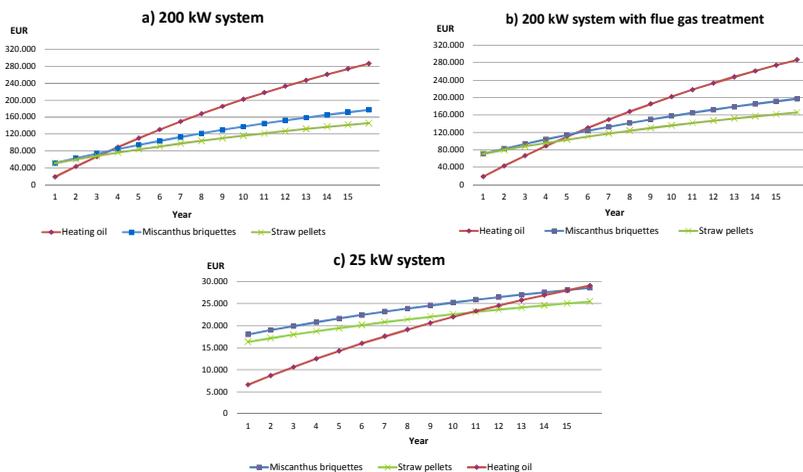


Figure 2: Heat supply costs for Austrian case studies [11]

Figures 2 (a) – (c) illustrate costs of Austrian heating systems (200 kW and 25 kW) on the basis of different fuel types i.e. heating oil, Miscanthus and straw. The investment costs of medium scale heating systems for alternative biomass are twice as much as the one for the oil boiler. However, due to high fuel costs for heating oil (average 0.8 €/l in 2010) the heating systems operated with Miscanthus briquettes as well as with straw pellets are getting pay off after three resp. three and a half years. Due to the immission control act flue gas treatment systems for alternative biomass heating systems are more commonly used recently. As a result the investment costs increased. However, lower prices for agricultural pellets still result in break even after four respectively five years for alternative heating systems. Utilising

Miscanthus briquettes respectively straw pellets in a small scale heating system is less economic. Pay off of the high specific investment costs for small scale heating systems won't be reached before 11<sup>th</sup> respectively 14<sup>th</sup> year. Thus, the straw pellets and Miscanthus briquettes are more suitable for district heating systems. Furthermore, a sensitivity analysis was accomplished on the basis of the Austrian 200 kW heating systems. Figure 3 shows different price scenarios for heating oil in Austria. Currently, the oil price amounts to 0.9 €/l and the alternative biomass heating systems pay off after three and a half years. If the oil price doubles, the alternative biomass systems would already get cost-effective after one and a half years.

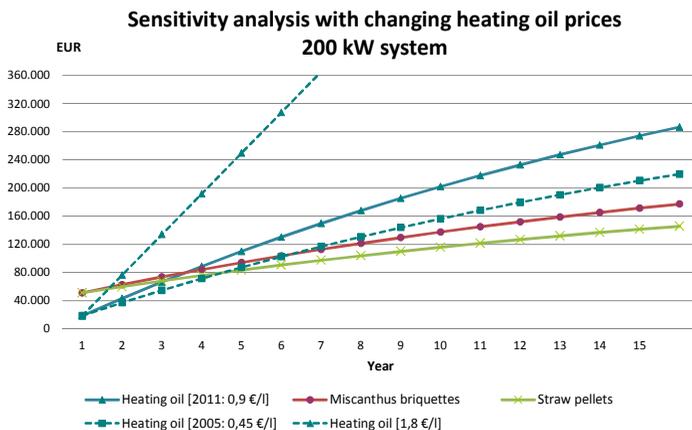


Figure 3: Sensitivity analysis with changing heating oil prices (200 kW heating system) [11]

## 4 Summary

Legal conditions, e. g. the existing emission thresholds and licensing of the fuels are main drivers and constraints which significantly influence the relevance of alternative pellets. The utilisation concepts of pelletised fuels differ significantly depending on the legal and economical frameworks. In Austria and Germany mainly heat generation is done on local level while the utilisation of alternative biomass pellets in large CHP plants is common in Denmark. Finally economic aspects, e.g. the costs of alternative fuels and additional investments for technical systems like precipitators and combustion technologies are crucial for the establishment of mixed biomass pellet production and their use in combustion appliances.

## 5 References

- [1] Directive 2009/125/EC of the European parliament and council on establishing a framework for the setting of ecodesign requirements for energy-related products, (2009)
- [2] Erste Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes, Verordnung über kleine und mittlere Feuerungsanlagen - 1. BImSchV, (2010)
- [3] Vierte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes, Verordnung über genehmigungsbedürftige Anlagen - 4. BImSchV, (2010)

- [4] Erste Allgemeine Verwaltungsvorschrift zum Bundes–Immissionsschutzgesetz, Technische Anleitung zur Reinhaltung der Luft – TA Luft, (2002)
- [5] Ministerio de Industria, Turismo y Comercio (ed.), Plan de Acción Nacional de Energías Renovables (PANER), (2010)
- [6] Decreto Legislativo n. 152, Norme in materia ambientale, (2006)
- [7] Directive 2009/28/EC of the European parliament and the council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, (2009)
- [8] Miljø- og Energiministeriet (ed.), Bekendtgørelse om biomasseaffald Nr. 638, (1997)
- [9] Vorlage der Länderexpertenkonferenz bezüglich der Vereinbarung gemäß Art 15a B-VG über das Inverkehrbringen von Kleinfeuerungen und die Überprüfung von Feuerungsanlagen und Blockheizkraftwerken, (2009)
- [10] Feuerungsanlagen-Verordnung – FAV, (1997)
- [11] C. Kristöfel, E. Wopienka, MixBioPells: Cost analysis Report (preliminary version), (2011)

## **6 Acknowledgements**

This project was financed by the Intelligent Energy Europe programme. The authors would like to acknowledge the support and input of the project partners: Technical Research Institute of Sweden (SP), Technical Research Centre of Finland (VTT), Danish Technological Institute (DTI), Comitato Termotecnico Italiano (CTI) and Energia y Medio Ambiente S.L. (Protecma). All data presented and opinions expressed remain the responsibility of the authors.

Further information is available on the project website: [www.mixbiopells.eu](http://www.mixbiopells.eu).