

“The production of wood pellets from short rotation coppice material, poplar (and willow), in context with new European quality requirements according to DIN EN 14961-2”

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Project Summary

Wood pellets have recently taken off as a renewable heating source and are increasingly being produced and traded within Europe. As a result of the industry's expansion and high demand for conventional raw material, new sources for the pellet feedstock have been sought. Short rotation coppices or energy plantations of genera such as willow and poplar have traditionally been harvested for woodchips for heating purposes but are now being considered and trialled for the wood pellet industry. However the economic feasibility of this potential feedstock is uncertain due to high quality requirements of wood pellets, meaning the end product may be deemed as only low value combustion material. In 2010, the European Norm EN 14961-2 came into effect acting to unify the various national standards and placing greater requirements on the quality of wood pellets. The certification system ENplus was released along with the EN 14961-2 standard to provide quality control. This study looked at coppice material of *Populus* (clone Max 4) as potential feedstock material for EN 14961-2 complying wood pellets. Pellets were produced with a mix of short rotation coppice material with premium grade sawdust and each of the EN 14961-2 criteria were investigated to assess their suitability. Based on physical qualities (bulk density and mechanical durability), the SRC poplar (Max 4) pellets, both pure and mixed, could not meet EN 14961-2 requirements for either EN-A1, EN-A2 or EN-B pellets. This is likely to be a result of technical issues with the pelletizing process. Reasons include the pellet press die ratio of 1:5 which influences the pellet density and temperature of the pelletized material. Another reason may be the particle size distribution of the poplar feedstock material being coarser than recommended. The chemical parameters tested resulted in exceedingly high ash content and nitrogen concentration for the poplar raw material, meaning that only by mixing this material with high grade pellet feedstock such as industrial sawdust can EN 14961-2 complying pellets be produced.

1. Background

The European Union (EU) set the target of reducing greenhouse gas emissions by 20 % of 1990 levels by 2020. As part of this goal, 20 % of EU energy consumption is set to come from renewable resources by 2020. Biomass is to play a key role in helping to achieve this goal, foreseen to provide 78 % of the renewable heating and cooling output in the EU by 2020.

One of the emerging markets in the renewable energy sector for biomass heating is the wood pellet industry, where wood material is compressed to create highly energetic pellets mainly for

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combustion heating. The basic advantages of pellets over other biomass combustion technologies are that they are more biologically stable, i.e. the energetic value can be held over a longer period – at least 2 years when correctly stored; they are free flowing and therefore transportable and can be easily fed into storage or heating systems e.g. by pneumatic blowing or conveyance systems; they are compressed and therefore require less storage space; and they have lower emission levels and ash content when burnt. Furthermore, the combustion efficiency of pellet oven systems is generally greater than that of other biomass combustion systems, with up to 85-90 % for an automatically fed pellet oven.

The conventional raw material for pellet production in middle Europe is chemically untreated, debarked timber off-cuts derived from sawmills, or by-products from wood processing in the form of wood shavings, chips and sawdust from industry. New raw material for pellets may include forestry off-cuts or poor quality stem wood, industrial woodchips, industrial round wood and most recently the cultivation and utilisation of material from short rotation coppices. However, for these new materials to be economically viable from a pellet manufacturing perspective, the extra steps of production must be considered. These may include harvesting, intermediate storage, debarking, wood-chipping, natural or technical drying, and separating of impurities. The focus of this study was on the material aspects of short rotation coppices for wood pellet production in relation to quality requirements.

2. Short Rotation Coppices (SRC)

Short rotation coppices (SRC), known in Germany as “Kurzumtriebplantagen” (KUP) can be defined as the long-term culturing of fast growing (often regenerative) tree stands on mainly agricultural, fallow or grassland, with short harvest intervals. Stands of these trees can be cultivated and harvested over a period of 20-30 years with a rotation cycle of 2-10 years. SRC woodchips can be utilized for energy production, heating and cooling, and as raw material for pellet and briquette production. Short rotation coppices particularly include poplar and willow but also alder, robinia and birch trees.

The fraction of bark in SRC wood is higher than normal round wood, resulting in a respectively high net calorific value (up to 19.5 MJ/kg) due to the high carbon content. However, the inner bark contains the growth layer of the tree which has high contents of nitrogen, sulphur and ash forming minerals. SRC material also has potentially higher levels of heavy metals. The ash content of SRC wood has been shown to be too high to conform to DIN or ÖNorm standards.

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3. Context of the European pellet standards and certification systems

Wood pellets can be burnt in specially designed wood pellet heaters, or hybrid woodchip / pellet heaters. However, the combustion efficiency varies according to pellet quality and oven layout and functionality. For most household wood burning ovens, the pellet quality is required to meet certain criteria in order to optimize the combustion and maintenance of the oven. Superficially, these criteria include the pellet dimensions, fines fraction, rigidity and durability which in turn affect combustion performance and economic value of the product. The pellet chemical constituents and moisture content influence the combustion performance, oven system maintenance requirements and lifespan, and environmental emission levels.

The different European standards have served to provide quality standards on national levels. Complementing these norms have arisen quality certification systems to ensure requirements are met. The range of different national standards and certification systems across Europe each with their own criteria limits have led to insecurity particularly for end-users, where ovens are often only provided with guarantees for the usage of specific fuel quality.

At the beginning of 2010, superseding the various national standards, the EU-Norm EN 14961 (part 1 and 2) was introduced to provide a united set of standards across the entire Europe, giving greater market security for traders and end users and creating environmental accountability. It categorizes wood pellets into classes EN-A1, EN-A2 for premium pellets and EN-B for industrial purposes.

Alongside the EN 14961-2 norm is the ENplus certification system which serves to regulate the entire pellet process chain. The ENplus certification system aspires for slightly stricter quality requirements and classifies pellets into ENplus-A1, ENplus-A2 for private use and EN-B pellets for industrial (> 100 kW) pellet systems.

4. Objectives

This study aimed to empirically determine the suitability of a short rotation coppice – poplar (*Populus* clone Max 4) – for the production of pellets. The study focused on the physical and chemical attributes of pellets produced from the poplar coppice in context with EN 14961-2. This entails the criteria of pellet dimensions, bulk density, calorific value, moisture content, fines fraction, mechanical durability, ash content and ash melting behaviour, along with concentrations of important elements. Based on the results, information was provided on the extent this SRC species can be utilized to supplement the conventional pellet raw material.

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5. Discussion

The SRC pellets met most of the criteria set by the EN 14961-2 standard – pellet dimensions, calorific value, moisture content, ash melting behaviour, along with the concentrations of most important elements. Below is a short description of those parameters not satisfied and possible reasons.

- i. Bulk density was not satisfied by the 50 % poplar : 50 % sawdust pellets. It is likely due to technical issues with the pellet press and conditions of operation during their production which resulted in a less dense product. Another possible reason for the poor bulk density of the mixed pellets is the heterogeneous particle distribution of the feedstock material, with the poplar material much coarser than the sawdust material.
- ii. Each pellet type failed the mechanical durability test, being below the 97.5 % limit. The best result was 100 % SRC poplar with 91.7 %. Given that premium EN-A1 pellets are normally produced with sawdust and satisfy EN 14961-2, the fact that the pellets produced were made from the same material indicates that optimal pelletizing conditions were not met to provide the desired durability. One explanation for the weakness of the pellets is the pellet press ratio used. The Münch GmbH pellet press die used had a press die ratio of 1:5 (6 mm diameter x 30 mm press canal) and reached a temperature of ca. 100 °C which would be inadequate for the lignin in the wood to melt or plasticize and act in binding the pellets together when re-hardened.
- iii. The net calorific value for the pellets produced can satisfy the EN-14961-2 requirement if moisture contents can be kept low.
- iv. Ash content was too high for the poplar pellets as expected due to the high bark fraction, meeting only the industrial pellet EN-B standard (< 0.3 %). The mixed pellets satisfied the EN-A2 pellet classification of being below 1.5 %.
- v. The too high nitrogen concentration of the poplar raw material may be a result of high levels of fertilization given to the SRC land. However the value measured, 0.334 % (by wt.), is consistent with typical values for short rotation coppice poplar of 0.2 to 0.6 % (by wt.) according to EN 14961-1 (2010) meaning that in general poplar may not satisfy the EN-A1 classification. The typically high concentrations of nitrogen in SRC material is generally due to the high bark fraction which contains high nitrogen levels relative to the inner tree.