Introduction
Large quantities of pruning residues from fruit trees, grapevine and olive cultivations are available in Italy. In the northern part of Italy, in particular, the amount of pruning residues (dry matter), mainly grapevine pruning, is estimated to about 0.7 – 0.8 Mio. t. Particularly, in the Veneto Region, about 70 - 75,000 ha are cultivated with grapevine and produce about 0.1 – 0.12 Mio. t dry matter of biomass residues each year. Thus, regional entrepreneurs involved in agricultural machinery and biomass sectors have developed equipments for harvesting of grapevine pruning and its utilization to produce energy.

Raw material
The grapevine pruning residues are usually collected between January and March. Depending on the harvesting technique, the residues can be baled or shredded; the product is afterwards dried, usually on the sides of the field, until the moisture content reaches about 20-25%. The choice of the different harvesting equipments and technologies is very important because it affects the quality (table 1) of the product and the following steps: storage, transport and processing of the biomass.

Table 1: typical fuel properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Net calorific value (MJ/kg dm)</td>
<td>17.6</td>
</tr>
<tr>
<td>Ash content (dm)</td>
<td>2.1 - 3.5</td>
</tr>
<tr>
<td>Water content (%)</td>
<td>35 - 50</td>
</tr>
<tr>
<td>Softening temperature of ash (°C)</td>
<td>&gt; 1500 °C</td>
</tr>
<tr>
<td>Nitrogen (dm)</td>
<td>0.5 – 0.7</td>
</tr>
<tr>
<td>Sulphur (dm)</td>
<td>0.01-0.02</td>
</tr>
<tr>
<td>Chlorine (dm)</td>
<td>0.04-0.06</td>
</tr>
</tbody>
</table>

dm = dry matter

Pelletising
The pelletizing process of grapevine pruning can be performed in an industrial plant (Produttori Pellet – Colognola ai Colli (VR)) or directly in the farm. In the first case, a hammer mill is used for particle size reduction and to improve the homogeneity. The mill grinds the pruning biomass passing it through a sieve of Ø 8 mm; the grind can be operated when the raw material moisture content is 15-18%; this condition is normally realized after a natural drying period of 3-6 months. After that, a belt conveyor transports the refined product to a press (220 kW – 2 t/h) with a ring die (30/6 mm). During the pelletizing process, no additives are used. Pellets are cooled by air and then stored in silos. Finally, the product is packed in one big bag or in different 15 kg bags.

Cost
A first assessment indicates a cost of 100-120 €/t for the pellet produced by mobile pellettizer. The cost for the industrial pellet is evaluated to 120 - 130 €/t. This estimation doesn't take in consideration the costs of pruning, assuming that the raw material is a residue. During the last winter season (2010), the grapevine pellet prize in the regional market reached about 150-180 €/t for the different packaging.
Combustion

The combustion of alternative pellet causes some problems when used in traditional heating systems, developed for wood pellets. The main problems are: incomplete and not uniform combustion of pellets; low energy efficiency; high quantity of ash produced in the combustion chamber and of pollutants in the flue gas.

The most suitable combustion technologies for the alternative pellets are devices with blown air burners (horizontal flame model) or with moving grate. In the first case, the burner separates the gasification phase from the pellet combustion phase and continuously removes the residual ashes. These devices, even of low power (25 kW), can also be implemented in conventional boiler systems, fueled by traditional fossil fuels. The second technology provides a mobile grate where the air distribution system ensures the correct air/fuel ratio needed.

The market development of alternative pellets is slow. However, it seems to be continuously growing. Gas emissions were monitored in some small scale boilers. The measured concentration values of CO, NO\textsubscript{x} and dust are similar to those of the wood pellet systems and they are generally below the emission thresholds established by the Decree 152/2006 and EN 303-5. However, the results also depend on the abatement systems implemented in the heating device.

Summary

In some of the cases considered in the MixBioPells project, the alternative pellet users have shown a high satisfaction. The most important reasons are:

- low cost of the fuel;
- more efficient transport and storage operations;
- better quality in comparison to the traditional solid biomass fuels;
- more efficient heating systems.

However, the operators highlight also some problems. Among them:

- high production of combustion residues (ash) to be frequently removed;
- discontinuous availability of alternative pellets;
- lack of a product quality control;
- difficulties to reduce the emissions in the exhausts of small heating plants.

Combustion system manufacturers are focusing their attention in the development of heating device technologies that are more efficient and have low pollutant emissions. The corrosion of materials, including the chimney and the internal parts of the boilers, due to the high content of chlorine and sulfur of some biomass residuals, is still a problem that needs to be solved.

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