Abstract

Italy is largely dependent on foreign energy supplies as it concerns with fossil fuels, and the contribution of renewable energy sources (including hydroelectric power) to the national energy budget amounted in 2009 to about 11%, of which 1/3 came from biomass.

The adoption of the Directive 2009/28/EC on the promotion of the use of energy from renewable sources (with targets of share 17% in final energy consumption and 10% in transport sector by 2020), represents a great opportunity for the further development of bioenergy and biofuels.

The recent adoption of new and clear incentives for electricity, heat and biofuels (including biomethane) production from biomass will probably stimulate the further implementation of new plants.

Although most of the feedstock is expected to be supplied by local farmers, it is foreseeable that part of this feedstock will also come from trade, particularly in the case of bioliquids.

Keywords

Bioenergy, Biomass, Biofuels

Introduction

Bioenergy production, that is to say the use for energy purposes of those biological raw materials generally known as biomass, has been used for a long time in Italy although presently contributing for just 3.5% of the final national energy consumption.

The main biomass end uses for energy production are domestic heating, heat for industrial processes, electric power production in centralized plants from woody biomass, agricultural and agro-industrial residues, municipal solid waste (MSW), biogas from liquid manure, organic fraction from municipal solid waste (OFMSW), dedicated crops (maize, sorghum) and, finally, liquid biofuels (biodiesel and bioethanol in a small quantity).

The amount of energy produced (6.2 Mtoe in 2009) equals to 64% of the target set for 2020 by the National Renewable Energy Action Plan (9.8 Mtoe), that is considerably smaller than the estimated potential (24 - 30 Mtoe, ITABIA, 2009), an amount that could cover 13-17% of the domestic demand.

The biomass commonly used in Italy for heat and/or electric power production are mainly waste materials, as residues and effluents from different sources, although agricultural-forestry dedicated crops (fast-growing poplars, maize and other annual crops for biogas production etc.) are also used. Nevertheless, a significant development of crops for energy production raises the issue of a possible competition with food production, requiring a detailed evaluation of each bio-energy chain.
In the biomass thermal energy sector, the most important contribution comes from the use of firewood in the households (over 50,000 TJ/y) and in industry (over 40,000 TJ/y), while it is estimated a production of 15,000 TJ/y by means of cogeneration plants; more limited the heat production by means of district heating plants (about 2,000 TJ/y).

As regards the Italian solid biomass chain for the production of electric energy, so far it represents an important reality in the sector. In fact this chain is strong of about 80 plants, with a total net installed power of nearly 1,450 MWe and a biofuel consumption estimated around 4.5 Mt/year.

The fuel is generally chipped wood of different quality, but also agro-industrial residues, as rice husk or nut shells, vinasse and olive cake, are widely utilized. It is important to underline that the biomass origin is not always national, but there are sensible lignocellulosic biomass import from abroad, mostly for the plants located in the South of the Country.

The quantification of the wood consumption for energy purposes in Italy is an extremely complex work, because it does not exist any survey that is sufficiently reliable, in particular for what it concerns the household usages. These biomass amounts are only estimable, due to the role of self-supply and the short-distance trade.

**Italian target for 2020**

The Italian Renewable Energy Action Plan has been submitted to European Commission on 30 June 2010.

In 2009 the use of biomass for energy purposes contributes for just 3.5% to the final national energy consumption (180.2 Mtoe), but with a production equal to about 6.2 Mtoe, bioenergy represent 29.5% of the whole amount of energy from renewable sources in Italy (21.1 Mtoe).

The National Renewable Energy Action Plan (nREAP) sets for bioenergy in Italy a target by 2020 equal to 9,815 ktoe, in order to cover 19% electricity, 54% heating and cooling and 87% in transport fuel on total consumption from renewable sources.

The amount of energy produced in 2009 (6,238 ktoe) was equal to 63.6% compared to the target set for 2020 by the nREAP. Such a target could seem ambitious, but is considerably smaller than the estimated potential (24 - 30 Mtoe, ITABIA, 2009) for bioenergy in Italy, able to cover up to 13-17% of the total energy demand.
Biomass potential in Italy

ENEA has recently carried out a detailed census of national biomass potential. The study took into account the availability of biomass from following sectors:

- Agriculture (both residues that energy crops);
- Forestry (both cutting and maintenance that arboriculture);
- Agro-industry (vinasse, olive cake, fruit shells, rice husk);
- Livestock (solid and liquid manure);
- Slaughtering (by-products cat.2 and cat.3, Regulation (EC) no. 1774/2002);
- OFMSW (organic fraction of municipal solid waste both from separated collection that from mixed waste).

In Italy there is a huge amount of agricultural residues, both from herbaceous as well as woody crops, but only a little percentage of this potential can be actually converted into energy. In fact it seems quite difficult to collect the whole amount of such a biomass because it comes from a high number of little farms and often it is not easily reachable (slope of land, low road accessibility). Moreover, usually part of that biomass is utilized for others purposes (animal feed, fertilizer, household combustion).

The residues from agro-industrial sectors are often utilized for energy production in the same sites where they are produced.

The highest potential from forestry sector came from Northern Italian Regions (Toscana, Piemonte) and in some other Italian Region (Calabria, Campania) with large forestry areas, while the arboriculture is totally concentrated in Lombardia and Emilia Romagna.

Italy has a huge energy potential that could derive from the anaerobic digestion of the fermentable residues such as organic fraction of municipal waste (OFMSW), cattle and pig manure, agroindustrial residues. The energy potential from OFMSW was about 1,330 millions Nm³ biogas in 2006, considering not only the humid fraction of municipal waste from separate waste collection, but also the residual fraction from the undifferentiated waste, to be potentially recovered or otherwise sent to the landfill. The potential from cattle and pig manure, taking into account also small breedings, is about 1,827 millions Nm³ biogas.

<table>
<thead>
<tr>
<th>Biomass source</th>
<th>Potential (kt/year d.m.)</th>
<th>Installable Power (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straws</td>
<td>15,710.9</td>
<td>2,461.3</td>
</tr>
<tr>
<td>Pruning</td>
<td>4,906.4</td>
<td>850.5</td>
</tr>
<tr>
<td>Forestry</td>
<td>2,180.6</td>
<td>377.9</td>
</tr>
<tr>
<td>Vinasse</td>
<td>627.9</td>
<td>108.8</td>
</tr>
<tr>
<td>Olive cake</td>
<td>692.0</td>
<td>120.0</td>
</tr>
<tr>
<td>Fruit shells</td>
<td>116.6</td>
<td>20.2</td>
</tr>
<tr>
<td>Rice husk</td>
<td>349.9</td>
<td>60.6</td>
</tr>
<tr>
<td>Cattle manure*</td>
<td>1,481.5</td>
<td>322.5</td>
</tr>
<tr>
<td>Pig manure*</td>
<td>345.8</td>
<td>75.2</td>
</tr>
<tr>
<td>Slaughtering*</td>
<td>43.1</td>
<td>9.4</td>
</tr>
<tr>
<td>OFMSW*</td>
<td>1,330.1</td>
<td>289.4</td>
</tr>
</tbody>
</table>

Source: ENEA Biomass Atlas
Biomass plants operating and in project in Italy

In the following tables there are data on plants connected with the national power grid, taken from the data bank of the Italian Electric Service Agency, GSE.

Figure 2 - Biomass power plants in Italy (31 December 2010)

The operating solid biomass plants were 78 by 2010 with a total installed power around 1,440 MWe, but further 122 plants are today in project or under construction, with a total installed power around 785 MWe. The mean power installed per plant is around 11 MWe and 70% of these plants are located in the Northern Italy Regions. The total installed power from bioliquid plants, including those in project, is around 2,560 MWe, few more then from solid biomass, but with an installed power per plant around 5.5 MWe.

The biogas plants connected with power grid, excluding plants fuelled by landfill gas, were 78 by 2009, with a total installed power around 79 MWe. On 31 December 2010 these numbers rose to 313 plants, with a total installed power 209 MW (GSE, 2011). The mean installed power per plant is 720 kW.

<table>
<thead>
<tr>
<th>Plants number</th>
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<tbody>
<tr>
<td>Solid biomass</td>
<td>14%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>58%</td>
<td></td>
<td></td>
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<tr>
<td>Liquid biofuels</td>
<td>28%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid biomass</td>
<td>64%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: GSE, 2011

<table>
<thead>
<tr>
<th>Table 2 - Biomass plants operating and in project in Italy</th>
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<tbody>
<tr>
<td><strong>Biomass plants</strong></td>
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<tr>
<td></td>
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<tr>
<td>Plants fuelled with solid biomass</td>
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<tr>
<td>Plants fuelled with biogas</td>
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<tr>
<td>Plants fuelled with bioliquids</td>
</tr>
</tbody>
</table>

Source: GSE, 31 December 2010

Installed pellets / other solid capacities, import and export

Currently, in Italy there are 85 pellet manufacturers that are manly of small to medium size [www.pelletsatlas.info]. Most of them use their own sawmill residues (sawdust, shavings etc.) as raw material and sell the pellets inside their region where the plants are located.
The annual pellet consumption has grown from 150,000 in 2001, to approximately 850,000 tons in 2008, such as the production has grown from 160,000 tons in 2001 to approximately 650,000 tons in 2008.

All the pellet produced in Italy is sold entirely into the national borders, especially in the Northern regions, main concentration area for pellet production and consumption. It is to be underlined that there is no pellets export, while the import level resulted in 2008 over 200,000 tons.

Due to shortage of raw material the Italian producers are forced to get the raw material from foreign countries, especially the Balkans, Romania and Bulgaria, or pellets from Austria, Germany and Slovenia.

Italy is one of the first Countries importing wood biomass. Import growth was parallel to the progressive entry into operation of thermal power plants fired with wood biomass in the years around 1990 and 2000.

A significant amount of the solid lingo-cellulosic biomass demand is filled by imports from foreign Countries, often very far away by ship.

Installed biofuels capacities, biofuels consumption, import and export

In 2009 total biofuels consumption in Italy was equal to 3.47% (as energy equivalent) of the total energy used in the transport sector.

In the same year there were in Italy 19 biodiesel plants with a total production capacity of 2,457,194 tons. In 2008 the total production of biodiesel in Italy was 670,449 t, of which 108,426 t were exported and 562,023 t were distributed into the national market together with an amount imported of 239,887. In 2009, 694,000 t were produced, 90,000 t were exported and 465,000 were imported [Assocostieri (Italian association of biodiesel producers)].

In 2009 the production capacity was estimated in 2,457,194 t, so the Italian biodiesel industry is underexploited.

The raw materials for biodiesel production are mainly imported as oil (rapeseed oil for 70 percent of the total and soybean oil for the 20 percent). Most of the rapeseed oil is imported from other EU countries, while soybean oil is either imported from the EU or produced in Italy from imported grains.

Italy imports mainly from USA, Netherland, Germany and France, whereas exports primarily towards France and in much smaller amounts towards Austria and Spain.

It happens that large volumes of rapeseed and soybean oil are imported from other EU countries, processed in Italy into biodiesel and frequently re-exported to the same countries from where the raw material came.

In Italy there are more than 70 ethanol distilleries, but only two plants (Alcolplus and IMA) are able to produce fuel grade ethanol.

The main used feedstocks are wine industry byproducts, wine (derived from mandatory distillation as imposed by the EU regulations), cereals, fruits and molasses.

Undenaturated ethanol is mainly imported from EU Country such as France, Netherlands and Germany, but a considerable amount comes also from non EU countries such as Egypt and Pakistan. Exports of undenaturated ethanol from Italy are mainly directed towards Sweden and France.

The main markets for the ethanol produced and traded in Italy are that of food and beverages (28%) and distillates (18%). Industrial usage is another important market, around 28%, (10% of which is represented by cleansing products. Cosmetic products represent around 5% of the market.
In 2005, bioethanol for transport represented only 5% of the whole ethanol market and was distributed uniquely as an additive (ETBE), but not as substitution fuel, in gasoline blends.

In 2006 and 2007 not a single litre of bioethanol was used as transport fuel and, according to Assodistil (the Italian distilleries association), in 2007 the production of fuel grade ethanol (60,000,000 litres) was entirely exported to Sweden.

Conclusions
The adoption of the Directive 2009/28/EC on the promotion of the use of energy from renewable sources (with targets of share 17% in final energy consumption and 10% in transport sector by 2020), represents an opportunity for the development of bioenergy and biofuels in Italy.

In the last years, the main barrier to the development of bioenergy and biofuel production in Italy has been the lack of a stable and clear regulatory framework. The recent adoption of new and clear incentives for bioelectricity will probably stimulate the further implementation of new plants.

Although most of the feedstock is expected to be supplied by local farmers, it is foreseeable that part of those products will also come from trade, particularly in the case of bioliquids.

Expansion of biomass markets and the related flow of raw materials, also over long distance, may reach the point to compromising the overall environmental sustainability of the production of energy from biomass renewables. A big effort will has to be performed to promoting local production with careful eye for where new plants will be located and how large it should be. At the same time, economic viability of the resources must be watched carefully since they are often widely dispersed or difficult to access.

References
1. F. Di Mario, G. Bracio, V. Pignatelli, N. Colonna, F. Zimbardi, Quaderno Biomasse e Bioenergia, ENEA, July 2011
2. V. Alfano, V. Pignatelli, Identification of Need for Demo Projects in Italy, European project “4BIOMASS”, 2011
4. V. Alfano, V. Pignatelli, Study on Biomass Trade in Italy, European project “4BIOMASS”, 2010