Sustainable bioenergy projects in Italy

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4BIOMASS Final Conference

Session I: The Second Transnational Forum
Bioenergy strategies in Central Europe

Berlin, 21 March 2012
Electricity production from renewable energy sources in Italy by 2010 (%)

- Hydropower: 66%
- Wind: 12%
- Solar: 3%
- Geothermal: 7%
- Bioenergy (*): 12%

(*) electricity production from solid biomass, MSW (50% biodegradable fraction) biogas and bioliquids

Electricity production from renewable energy sources in Italy by 2010 (%)

Hydropower 66%
Wind 12%
Solar 3%
Geothermal 7%
Bioenergy (*) 12%

3.3% total electricity production

(*) electricity production from solid biomass, MSW (50% biodegradable fraction) biogas and bioliquids

Total net electricity production in Italy by 2010: 286.3 TWh

**Industrial plants producing electricity from biomass in Italy (31 December 2010)**

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Plants</th>
<th>Installed power (MWe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid biomass</td>
<td>78</td>
<td>1,436.9</td>
</tr>
<tr>
<td>Bioliquids</td>
<td>149</td>
<td>617.6</td>
</tr>
<tr>
<td>Biogas</td>
<td>313</td>
<td>209.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>540</td>
<td><strong>2,263.7</strong></td>
</tr>
</tbody>
</table>

Source: GSE, 2011
Biomass power plants in Italy (31 December 2010)

Plant power (MWe)

- Solid biomass: 63.47%
- Biogas: 9.23%
- Bioliquids: 27.30%

Plant number

- Biogas: 57.96%
- Solid biomass: 14.44%
- Bioliquids: 27.59%

ENEA elaboration from GSE data, 2011
Gross RES electricity production in 2009 and forecasts to 2020

<table>
<thead>
<tr>
<th></th>
<th>Installed power RES-E</th>
<th>Gross production RES-E</th>
<th>RES production share</th>
<th>Installed power RES-E</th>
<th>Gross production RES-E</th>
<th>RES production share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>GWh</td>
<td>ktoe</td>
<td>[%]</td>
<td>MW</td>
<td>GWh</td>
</tr>
<tr>
<td><strong>2009</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydropower</td>
<td>16,458</td>
<td>42,155</td>
<td>3,625</td>
<td>67%</td>
<td>17,800</td>
<td>42,000</td>
</tr>
<tr>
<td>Geothermal</td>
<td>737</td>
<td>5,342</td>
<td>459</td>
<td>9%</td>
<td>920</td>
<td>6,750</td>
</tr>
<tr>
<td>Solar</td>
<td>1,142</td>
<td>676</td>
<td>58</td>
<td>1%</td>
<td>8,600</td>
<td>11,350</td>
</tr>
<tr>
<td>Sea</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Wind</td>
<td>4,898</td>
<td>6,830</td>
<td>587</td>
<td>11%</td>
<td>12,680</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>Biomass</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>solid</td>
<td>964</td>
<td>4,444</td>
<td>382</td>
<td>7%</td>
<td>1,640</td>
<td>7,900</td>
</tr>
<tr>
<td>biogas</td>
<td>378</td>
<td>1,740</td>
<td>150</td>
<td>3%</td>
<td>1,200</td>
<td>6,020</td>
</tr>
<tr>
<td>bioliquids</td>
<td>385</td>
<td>1,448</td>
<td>125</td>
<td>2%</td>
<td>980</td>
<td>4,860</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>24,893</td>
<td>62,634</td>
<td>5,386</td>
<td>100%</td>
<td>43,823</td>
<td>98,885</td>
</tr>
</tbody>
</table>

Source: GSE, 2010
General statement about bioenergy sustainability in a broad sense

• Economic and environmental sustainability of a bioenergy project depend both on the design, technology and size of the conversion plant as well as the logistics of biomass supply chain.

• Economic viability is a consequence of a profitable cost-benefit balance, taking into account O&M cost - including feedstock - and revenues from selling heath, electricity or biomethane together with available subsidies and incentives.
**Environmental sustainability is depending on several different factors as, for example:**

- Long term feedstock availability security (locally produced biomass, long-term contracts with suppliers, biomass self-production)

- Meeting local farms, households or enterprises energy needs, especially for heating (CHP)

- Re-utilisation or economic valorisation of residues and/or by-products of the supply chain and conversion process

- Integrating both from the spatial (short-distance biomass supply chain) and the production point of view biomass technology together with agriculture and other productive activities of the plant site
Inventory of relevant “Demoprojects”

WP3 – Sustainable Exploitation of Biomass

3.1.1 – Inventory

All PPs selected several example of biomass plants with a relevant demonstration value, to be considered as BAT.

This inventory contain all possible information available on each demo project identified (location, plant capacity, efficiency, biomass feedstock, technology, etc.)

Main outputs:

• 8 Country papers on demo projects
• Inventory and analysis of relevant demo projects (14 for Italy)
• Demo projects online database
<table>
<thead>
<tr>
<th>Region / Province</th>
<th>Plants &gt; 1 MWt (Villages or small towns, tipically on mountain areas)</th>
<th>Plants &lt; 1 MWt (farms, country hotels, small villages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alto Adige</td>
<td>42</td>
<td>4</td>
</tr>
<tr>
<td>Emilia Romagna</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Friuli Venezia Giulia</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Liguria</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Lombardia</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Piemonte</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Trentino</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Valle D’Aosta</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Veneto</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Marche</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Toscana</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Molise</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Umbria</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>79</strong></td>
<td><strong>70</strong></td>
</tr>
</tbody>
</table>
Biomass district heating and cogeneration plant
Tirano (SO, Lombardia Region)

The biomass combined heat and power generation (CHP) supplies the town of Tirano with district heating and electricity

- Two 6 MW biomass boiler fuelled mobile grid burner
- 8 MWth diathermic oil boiler
- 6 MWth oil stand-by boiler to cover peak load

Nominal electric power: 1.1 MWe
Overall efficiency of about 89 %
Net output of 10,08 GWh/year (2009-2010)
Thermal energy invoiced 39153 MWh/year (2009-2010)
Most of the biomass feeding the plant is supplied by local sawmills (sawdust, bark, wood chips). The biomass consumption is about 80,000 t/year (2009-2010)

The length of district heating net is about 31 km, with 715 connected users and a thermal load of about 56 MW (by 2010)

Pictures from the 4BIOMASS “Field Trip”
The Italian target of increasing separate waste collection to 60% in 2011 (Law December 27 2006, n. 296), and at the same time reducing biodegradable waste in landfill (Dlgs. 36/2003), asks for urgent strategic choices in the management of the organic fraction of municipal solid waste (OFMSW).

OFMSW management is currently oriented to the recovery of organic material through composting and soil fertilizer production.

Energy production from biogas based on anaerobic digestion of OFMSW is currently a very promising option for a sustainable management of this type of waste.

The organic fraction of municipal waste is an ideal substrate for the anaerobic digestion, which production can be significantly increased using co-digestion of different types of biomass, enabling the stabilization of the process and significantly increasing biogas production.
The Pinerolo plant is an integrated system for the treatment of organic waste from separate collection and consists of an anaerobic process followed by an aerobic process.

The plant system consists of four plants, each other physically interconnected (Ecological Integrated Pole):
- Anaerobic digester (50,000 t/y)
- Wastewater treatment plant (75,000 inhabitants equivalent)
- Composting plant (20,000 t/y)
- Landfill

**Biogas section**
- OFMSW + sewage sludge
- Anaerobic digestion (semi-dry, batch, thermophilic)
- CHP 3.1 MWe, 3.3 MWth (3 i. c. engine)
- Biogas (whole) primary energy 39.3 GWh (2010)
- Electric energy produced 14.6 GWh (2010)

**Composting section**
- Digestate sludge (dewatering)
- 90 days (slow and accelerate maturation)
- Quality Compost Mark (C.I.C)
Integrated system for biogas and compost production from OFMSW. Pinerolo (TO, Piedmont)

- Wastewater treatment plant (75,000 m³)
- Composting plant (20,000 t/y)
- Biogas plant (50,000 t/y)
- Gas holder 3,300 m³
- District heating (1.3 km)
- Landfill (3 km)
Biogas plants: “best practices” examples in the frame of the ENAMA Project

Some biogas plants in agriculture and breeding sector have been recently selected as “best practices” examples in the framework of the ENAMA Project, financed by Italian Ministry of Agricultural, Food and Forestry Policies.

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Used system</th>
<th>Start Up</th>
<th>Electric power</th>
<th>Thermal power</th>
<th>Feedstock / raw materials</th>
<th>Biomass source (origin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pieve Ecoenergia s.c.a. (CR) - Lombardia</td>
<td>CHP - District heating</td>
<td>2009</td>
<td>999 kWe</td>
<td>1000 kWth</td>
<td>Maize silage (70%) Cattle manure (30%)</td>
<td>Farm land (99%) Farm livestock (100%)</td>
</tr>
<tr>
<td>Soc. Agricola Agri Floor (VI) - Veneto</td>
<td>Mini Biogas Plant - Mini District heating (210 m)</td>
<td>2010</td>
<td>50 kWe</td>
<td>-</td>
<td>Sweet sorghum silage (60%) Cattle manure (40%)</td>
<td>Farm land (100%) Farm livestock (100%)</td>
</tr>
<tr>
<td>Azienda Agricola Mengoli Rino, Mauro e Gianni S.S. (BO) - Emilia Romagna</td>
<td>CHP</td>
<td>2005</td>
<td>350 kWe</td>
<td>50 kWth</td>
<td>Livestock manure (1/3) Maize, sorghum, triticale silage (1/3) Agricultural byproducts (1/3)</td>
<td>Farm land (75%) Radius of 15 km (15%)</td>
</tr>
<tr>
<td>Azienda Agricola Pascotto Rina S.S. (VE) - Veneto</td>
<td>CHP</td>
<td>2008</td>
<td>990 kWe</td>
<td>1104 kWth</td>
<td>Poultry manure Maize silage</td>
<td>Farm livestock (100%) Farm land (100%)</td>
</tr>
</tbody>
</table>
Biogas CHP plant at a dairy cattle farm (Azienda Bruni, Sutri - VT)

**CHP plant**
- Electric power: 500 kWe (two stationary 250 kWe Scania co-generators)
- Utilised thermal power: 250 kW
- Running hours per year: 8,000 h for electricity production, 2,000 h for heat recovery
- Mean yearly electricity production: 4,000 MWh
- Mean yearly heat recovery: 500 MWh (farm buildings heating and digester heat regulation)

**Anaerobic digestion plant**
- Two reactors 1.100 m³ volume each, biomass mixing by screw stirrers
- Mechanical feeding (loading shovel) for solid materials, hydraulic with pumping systems for liquid and semi-liquid ones
- Mesophilic fermentation (40 °C), hydraulic retention time about 50 days
The biomass supply: an example of “short supply chain”

The CHP biogas plant at Azienda Bruni is fuelled by a mix of raw materials produced up to 70% on the farm, while the remaining 30% comes from other local produces (within a 70 km radius):

- Cattle sewage (16,200 t/year)
- Cattle manure (3,600 t/year)
- Ensiled crops (1,500 t/year)
- Vegetable wastes and wastewaters from olive oil production (1,000 t/year)
- Agro-industrial residues (700 t/anno)

Farm and breeding management
- 200 ha used for producing corn, sorghum and rye-grass suitable as cattle feed and partially ensiled for biogas production
- About 700 dairy cows
- Total digestate recycling on the farm soil
- Supply chain agreements with local vegetable producers and olive oil mills
Biomass CHP power plant at Calenzano (PO) owned by Biogenera s.r.l.

**Thermal cycle**
- 5.9 MW biomass fuelled mobile grid burner
- 4.5 MWt diathermic oil boiler
- Further heat recovery from the diathermic oil loop

**Electricity production**
- 790 kWe power ORC turbogenerator
The biomass supply: an example of “short supply chain”

The CHP biomass plant at Calenzano uses only locally produced biomass fuel (13,000 t/year on average) as wood chips:

• Pruning from vineyards and olive groves (about 2,000 t/year)
• Biomass arising from the maintenance activities of river banks and flood beds (about 1,500 t/year)
• Biomass arising from forest management and thinning out (about 8,000 t/year)
• Residues from local wood factories (about 1,500 t/year)

Biomass delivering and storage
• Storage area for medium-large woody biomass chunks
• Covered area for chips storage
• Wood chips silo with dump rakes for plant fuelling
Thanks for your attention

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