

# Chapter 85

## Technical and Economical Feasibility of Biomass Use for Power Generation in Sicily

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### ABSTRACT

*Biomass can provide a reliable support for production of biofuels while contributing to sustainable management of natural resources. Many countries, including Italy, have introduced important incentive schemes to support the use of biomass for electricity, heat and transportation. This has raised considerable interest towards the use of biomass for energy generation purposes. Nonetheless, the design and installation of biomass-fuelled power plants present several critical issues, such as choice and availability of biomass, choice of technology, power plant localization and logistics. The case study tackled in this paper evaluates the economies originated by a 1MW<sub>el</sub> Organic Rankine Cycle (ORC) turbine coupled with a biomass fuelled boiler, installed in an area close to Palermo (Italy). A Geographical Information System (GIS) was used to localize the power plant and to optimize logistics. The thermodynamics of the plant as a whole were also analyzed. Finally, two different scenarios were simulated for project financial evaluation.*

### 1. INTRODUCTION

The 2003 Common Agricultural Policy (CAP), otherwise known as “Fischler Reform”, drove wheat production to a substantial reduction in volume. In years 2004-2009, the areas destined to

wheat production decreased by about half a million hectares and wheat production amounted to about 4 million tons in 2009 (Sistema Informativo Nazionale per lo sviluppo in Agricoltura, 2009).

Over the past years a new approach to agro-energy policies has taken place, favoured by an increasing demand of energy, which induced to

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an integration between traditional cultivations and energy crops.

This approach could help using financial supports for agriculture in a more strategic way, compatible with the objectives of rural policies: individuation of new commercial ways for agricultural productions, valorization of territorial resources, implementation of integrated agreements with industry.

However, sustainability of a bio-energy project demands for several objectives to be satisfied, such as production of low-cost energy crops, with an overall positive energy balance and a low environmental impact.

In Italy, statistical data show an increase of areas destined to cultures dedicated to pure vegetable oil (sunflower, soy etc..), potentially interesting for bio-energy production.

This approach, on the other side, risks to dramatically reduce the area destined to food market.

For this reason, this study evaluates the possibility to produce energy from agricultural by-products such as wheat (straw) or tree pruning and trimmings. Small size cogeneration plants are among the most promising alternatives to produce power and heat from such residues.

Power generation from agro-waste is particularly interesting for some agricultural areas of Sicily, where this practice could significantly contribute to the local agricultural development, in line with current European agricultural policies.

The quantity of residual biomass obtainable from agriculture is evaluated by correlation of data which link soil productivity to quantities of by-products generated.

## **2. DESCRIPTION OF THE SOLUTION**

The area under study is located within Palermo province (Italy) and was chosen using GIS technology, by considering current agriculture in the area and the existing infrastructural network.

Through some 65,816 ha of cultivated wheat, a substantial amount of by-products (mainly straw) is generated yearly. This represents an important energy source, relatively easy to access both in terms of cost and collection.

Potential success of an agro-energy chain depends mainly by the logistics of a production organization and by power plant size. The latter should be dimensioned taking into account biomass availability on one side and cost/benefits of the installation on the other.

Some 3 t/ha of wheat straw dry matter are produced yearly through wheat cultivation (Pellerano, Pantaleo, Tenerelli, & Carone, 2007; Pantaleo, Pellerano, & Trovato, 2002). The farmers generally incur substantial costs to dispose of the straw. For this reason, the use of straw for energy production may represent an opportunity to create new economies throughout the wheat production value chain.

The area under analysis presents also 300 ha of forestry able to generate some 30,000 t/yr of residual wood. Using these products for energy production induces no substitution of food crops with energy crops, but only a sustainable way to dispose of by-products.

Power plant size was tailored to the area under analysis, considering biomass availability and the relative costs for collection and potential plant revenue based on the current national incentive schemes (Decreto del Ministero dello Sviluppo Economico, 2008).

GIS technology allowed delimitation of the area. The accomplished analyses suggest 1,000 kW<sub>el</sub> plant size for 8,000 hrs/yr running time. This requests some 11,000 t/yr of biomass with 14MJ/kg Low Heating Value (LHV).

For plants of this type, an Organic Rankine Cycle (ORC) generator coupled with a diathermic oil boiler (up to 300 °C temperature, Gaia, Scheidegger, Bini, & Bertuzzi, 2000) is a suitable choice.

A valid technological alternative could be the use of gasification systems coupled with alternative engines for the production of electrical energy.

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