INTRODUCTION

Sicily is the biggest region of Italy and the biggest island of Mediterranean with 5 million people. Beside the main island, there are several small islands, most of them living on tourism and local agriculture with very valued typical products. Some islands (Eolie) have been declared Human Heritage by UNESCO and on most islands there are several integral natural reserves. Under the renewable energy point of view, there are lot of natural resources such as wind, sun and also significant sea currents.

POWER PRODUCTION IN SICILY AND ITALY

Power net production in Italy is below the country consumption (Fig. 1). Hence power is purchased from other countries. To the opposite, the power production in Sicily, 24,097,7 GWh in 2007, is historically higher than that needed from the region (Fig. 2) due to several extremely developed refinery districts. Hence a quota, which in 2007 year has been of roughly 6,5%, is exported to the mainland through the link between Sicily and Calabria (Fig. 3).

In Sicily, power is mainly produced by conventional thermal power plants. There are eight power plants which provide energy to the grid and five conventional power plants which provide energy for self-production in industrial sites (Fig. 4). At present status most of them (71%) are older than 30 years and the efficiency is as low as 22%. Renewable energy is produced mainly from hydro power plants and wind farms (see Table 1). Electric network is actually not efficient and it needs improvement. In particular, there is only one complete ring, around the island and a minor one in the western part, which ensure some supply security in case of some interruption. No 380 kV ring exists yet, so any issue on the 380 kV brings to a complete disconnection of the remaining part. Hence it is crucial to complete the ring (380 kV) around all the island as well as double the connection between Sicily and mainland. This latter, as explained hereafter, is very important for the increase of renewable energy production on the island (Fig. 5).

RENEWABLE ENERGY SOURCES IN SICILY

The renewable energy produced in Sicily rely mainly on hydro and wind power plants (Fig. 6), with minor presence of photovoltaic. Up to June 2008 the hydro power accounted for 732 MW and wind power plants had a capacity of 724 MW. Photovoltaic accounted only for 7 MW. It is expected in
the next few years that wind power will increase of an additional 2000 MW with the latest authorisations. The growth of wind power in Sicily has been quite fast in recent years (Table 2). The uncontrolled development of the early wind power plants has caused some social conflicts in the island, mainly due to localisation of these power plants close to, or even inside, beautiful landscapes or wildlife protected areas. Some issues have been raised whether landscape modification could damage tourism, environment or wildlife, which in Sicily has an important stage for migrating species, some even endangered of extinction.

For superior environment preservation, there have been identified three area typologies for the setting of wind power plants: (1) areas where wind farms are not accepted; (2) areas where restrictions apply after a severe evaluation; (3) areas without particular restrictions. Beside these environmental issues, it must be focused on which are the true benefits for the region coming from renewable energy power plants. Due to free energy market regulations and the excess power produced on the island, the energy produced from renewable power plants, and specifically wind and photovoltaic, is produced in addition to that produced from conventional power plants, without any environmental or economic benefit for the island. Probably true benefit, in terms of environment, sustainability and economy improvement, could come from decentralised renewable power plants, such as in isolated communities or small islands which are actually running on diesel small power plants. In some cases the cost of energy from renewable sources is already competitive and their application should be even unavoidable where environment preservation is taken into account. Nevertheless, any further increase in the amount of energy produced from renewable energy sources is strongly limited by the limited transport capacity of the actual grid on the island, as well as its weak structure. Moreover it is needed to double the capacity of the connection to the mainland to transport the excess energy produced from renewable energy sources. Energy storage is applied during off-peak with pumped hydro power plant but it is not possible to increase the storage capacity due to landscape issues.

SOCIAL ACCEPTANCE OF RENEWABLE ENERGY SOURCES

The main issues on renewable energy sources is connected to environment protection, especially close to wildlife restricted areas. Often the most economically convenient locations for wind farms are very close to wildlife reserves and usually into wild landscapes. Although generally there is a strong support to renewable energy, there is a even stronger concern whether wind farms might damage landscape or endanger fauna, especially migrating species which finds in Sicily an important stage. Local administrator are divided as well, with some supporting RES for their economic and environmental benefits, other frightened that landscape damage could take tourism away. Actually this issue is still unsolved.

The key actions for Regione Siciliana, the Sicilian regional government, is to drive a change in energy consumption by supporting best practices in energy saving (application of 2002/91/CE Directive), energy efficiency and a more efficient power grid. It also supports the diffusion of new energy technologies, collaborating with the stakeholders, establishing partnerships and funding the most meaningful projects. Under the island perspective, Regione Siciliana has funded (period 2000-2006) the “PIT isole Minori”, a funding program to support local economy in small Sicilian islands.

In 2007, beside other initiatives (feasibility study, pilot and demonstration projects) in the field of biomass and hydrogen technologies, it has contributed (2,2 Meuro) to the realisation of the new “Centre for Energy Technology Innovation and Transfer” of the CNR-ITAE, in partnership with the CNR (National Research Council, 2,6 Meuro), the Ministry of Environment (2,4 Meuro) and the Naval District (2,6 Meuro). The main activities of the centre will be the testing and benchmarking
of the most promising and next-to-market energy technologies. It will act also as consulting and scientific partner for industry involved in advanced energy technology as well as training for highly specialised personnel employed in such fields. The centre is actually under construction.

Regardless of such obstacles, a strong economy based on RES has risen on the island. Moncada Energy Group Srl has established its headquarters on the island and has invested in a manufacture plant to build wind power plants. At present state, they are running 105,3 MW wind farms, a further 40 MW under realisation (2009) and 40 MW under authorisation. The realisation of an off-shore wind farm is expected to be started by 2010, with a global installed power of 345 MW. At the end the total power run by this group will be of roughly 985 MW. It has also invested on a new company, Sun Fab, to manufacture latest technology thin-film photovoltaic modules. It has also 200 MW PV power plants awaiting for authorisation. Other energy groups are investing on renewables in Sicily, such as the Italian branch of swiss company EGL (200 GWh from wind farms, 10 GWh from biomass and 1 GWh from photovoltaic power) and Italian utility company ENEL (200 MW from wind, 14 wind farms and 2 PV power plants on Eolian islands).

CONCLUSIONS

Despite the great opportunities offered in Sicily by natural resources as renewable energy power source (sun, wind, etc.), the big issue of the power grid remain yet unsolved. Unless the grid completion (380 kV, 220 kV and double the connection to the mainland) will be completed, the increase of the renewable energy quota into the island grid represents more a problem than a solution, due to increased instability of the network and its inner weakness. More environment and fauna protection acceptance criteria of wind power plants will foster social acceptance of renewable energy, which remains a key issue to be solved together with stakeholders. Meanwhile, a strong economy based on renewable energy sources has risen in the last years on the island. Innovative technologies and companies are fostering the island’s economy, such as power from sea currents in the Strait of Messina (ENERMAR project, Ponte di Archimede SpA), on-shore and off-shore wind farms (Moncada Energy group, ENEL) and new investments on wind power industry and thin-film PV technologies (Moncada Energy Group and other partners). Beside with the actions taken by Regione Siciliana, the strong knowledge on innovative energy technologies, such as hydrogen and fuel cells, coming from internationally acknowledged research centres such as CNR-ITAE and other Institutions will help to complete the scenario of sustainable and environment friendly growth for Sicily.
Figures and Tables

Fig. 1: historical trend of total energy consumption (thick line) and total energy production (thin line) in Italy in the period 1973 – 2007. The coloured area indicate the energy deficit of the country (source: Terna – figures in GWh)

Fig. 2: historical trend of total energy consumption (thick line) and production (thin line) in Sicily in the period 1973 – 2007. The coloured area indicate the energy surplus of the region (source: Terna – figures in GWh)
Fig. 3: external and internal energy exchange (arrows) and consumption (circles) for Northern, Central, Southern, Sicily and Sardinia zones in Italy in 2007 (figures are in GWh).

Fig. 4: power plant sites in Sicily. Red filled squares indicate conventional power plants which provide power to the grid; the red squared squares indicate power plants for self production, used by industry. Blu squares indicates the hydroelectric power plants.
Table 1: share of energy produced in Sicily by technology in 2007. The total renewable energy accounts for 7% of total (figures in GWh).

<table>
<thead>
<tr>
<th>Technology</th>
<th>Share (GWh)</th>
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<tbody>
<tr>
<td>Hydro</td>
<td>708</td>
</tr>
<tr>
<td>Conventional thermal</td>
<td>22538.9</td>
</tr>
<tr>
<td>Wind</td>
<td>854.2</td>
</tr>
<tr>
<td>Photovoltaic</td>
<td>15</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>24,097.7</strong></td>
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Table 2: growth of installed wind power in Sicily up to June 2008.

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008 (June)</th>
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<tbody>
<tr>
<td>MW</td>
<td>62</td>
<td>183</td>
<td>294</td>
<td>355</td>
<td>653</td>
<td>724</td>
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Fig 5: actual grid (solid line) and expected grid improvement (dotted line). Red lines indicate 220 kV grid, which is not sufficiently developed. The green lines indicate 380 kW grid, which connects Sicily to the mainland through the Strait of Messina. It is still incomplete and no ring has been established to ensure supply security on the island. The main improvements expected on the grid are as follows (from top left and clockwise): (1) Partinico-Fulgatore 220kV powerline, still under evaluation. (2) Sorgente-Ciminna 380 kW powerline, under evaluation; (3) Sorgente-Rizziconi 380 kV, authorisation phase; (4) Paternò-Priolo 380 kV powerline, under evaluation; (5) Chiaramonte Gulfi-Ciminna 380 kW powerline, under evaluation.
Fig. 6: wind power plants installed in Sicily