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World Energy Council 2008

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Performance of Generating Plant

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Support Paper

The Evolution of the Electricity Sector and Renewable Sources in Italy: Opportunities and Problems for Wind Power Integration

Luigi Salvaderi, Consultant, IEEE Fellow

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1. Introduction

The solution of problems with Italian energy and correspondingly, electricity systems, needs the implementation of a balanced approach considering the security of supply, the impact on the environment and efficiency.

These issues are reflected into “20%-20%-20%” targets indicated by the EU Commission in January 2007 and agreed at the EU Spring Summit on 8-9 March 2007. By 2020 the targets are:

20% of the primary energy consumption confronting renewable energy sources (RES) in the field of electricity production, transportation, condition and refreshment;

20% of unilateral reduction of carbon dioxide emissions, regardless of the outcome of future international negotiations;

20% reduction in primary energy consumption.

The first two targets are binding and should be subdivided into “burden sharing” by Member States. The third one is left to voluntary actions by Member States.

On 14 March 2007 in a plenary session in Strasbourg MEPs debated the Summit outcome and the EU Industry Commissioner welcomed the “far reaching and ambitious goals set by the EU leaders”.

As far as the development of the RES is concerned, possible solutions are not the same for various power systems since there are different characteristics such as market evolution and percentages of renewable production.

Commitments, already taken by Italy stem from the Kyoto Protocol (Italy’s burden sharing = -6.5% of 1990 CO₂ emissions); and from the “Renewable Directive”, D 2001/77/EC (EU15 = 22.1% production with RES by 2010, corresponding to a burden sharing of 25% of the Gross Internal Consumption by Italy). These are mutually interconnected and strongly dependent on the evolution of the generation mix. They look very ambitious and adequate legislative, technical, regulatory and administrative moves are needed to overcome obstacles exist.

This paper presents an overview of the evolution in the Italian electricity system in the eight years since liberalisation started, until the full opening for demand occurred on 1st July 2007. And of the technical and regulatory situation concerning the support of the RES. Comments are made on actions that the Government, Parliament and the Industry envisage in order to find possible solutions to existing problems.

2. Features of Italian Energy and Electricity

Italy is a huge importer of primary energy needs: in 2006 almost 85% was imported. Consequently the Italian “energy ticket” is extremely high: 48 b€ in 2006, corresponding to 3.3% of the Italian GNP. The gas consumption is high: in 2006 about 84.5 GM3 10.4 from national production and 77.6 GM3 imported (with an increase of 3.6 GM3 in storage), mostly by pipe. Major suppliers are Algeria (27.6 GM3) and Russia (22.5 GM3) [1] . Only one “old” LNG plant (3.5 GM3) is in operation. Ten LNG projects have been launched: 3 - 4 are deemed necessary to add flexibility to the supply but only one (8 GM3) is expected to be in operation by 2008. Various obstacles are raised by authorisation procedures.

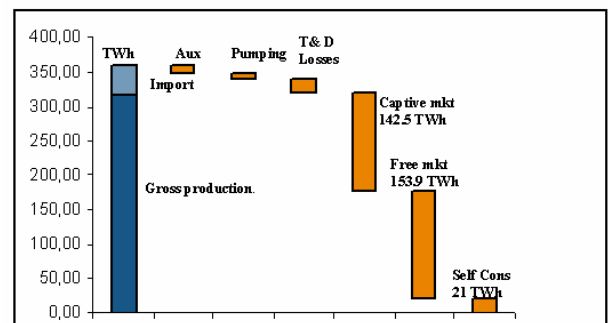
Regarding Electricity, in 2006 the Gross Electricity Consumption (GEC) was 359.7 TWh, faced with a gross national production of 315 TWh and a net import of 44 TWh. The Gross Electricity Demand, T&D losses included, was 337.8 TWh. Demand is still growing: a rate of increase between 2006 and 2010 (369.3 TWh) in a development scenario of 2.3% is forecast (Peak: 3%), greater than the GDP growth [2].

Renewable sources.

The 1997 baseline of RES was 16% of the GEC. In 2006, the gross production 52.1 TWh, a percentage of 14.5% in respect of the GEC. RES production includes significant hydro production and annual variations of inflows (from 36 TWh in 2005 to 46.8 TWh in 2001) affect the total. The installed wind capacity was about 2100 MW, with a production from wind source of 3.5 TWh, that is 7% of the total renewable production

Figure 1

Italian Electricity System Balance 2006

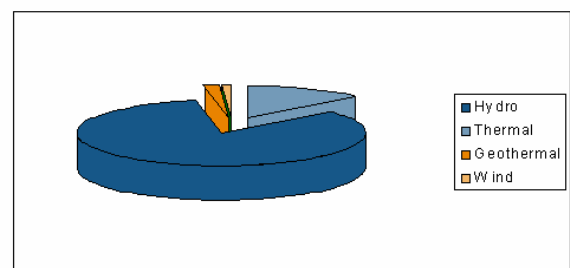


Gross Production = 315
Net Import = 44.7
GIC = 359.7 TWh

TWh Demand = 337.8 TWh
TWh T&D Losses = 20.4 TWh
Final Consumption = 317.4 TWh

Figure 2

Italian Production 2006 TWh



| | | | |
|-------------|----------|----------------------|-----------------|
| Thermal | : 263.25 | Auxiliary Services | : 13.29 |
| Hydro | : 43.02 | Total Net Production | : 301.73 |
| Geothermal | : 5.53 | Pumping | : 8.65 |
| Wind | : 3.22 | Net import | : 44.7 |
| Total Gross | : 315.02 | Demand | : 337.8 (+2.2%) |

Sources: Terna Provisional Values

3. Evolution from Liberalisation

Law 481 of 14 November 1995 established the Italian Regulatory Authority for Electricity and Gas (AEEG).

The “Bersani Decree” (Legislative Decree n. 79/99), implementing the European Directive 96/92 EC in March 1999, started market liberalisation. The former Vertically Integrated Utility ENEL was unbundled; the Generation area was fully liberalised and the Transmission and Distribution sectors came under a third party access regime and regulated tariffs. Demand was gradually opened up to competition, with a Single Buyer main trader for captive consumers; with full opening begun by July 2007.

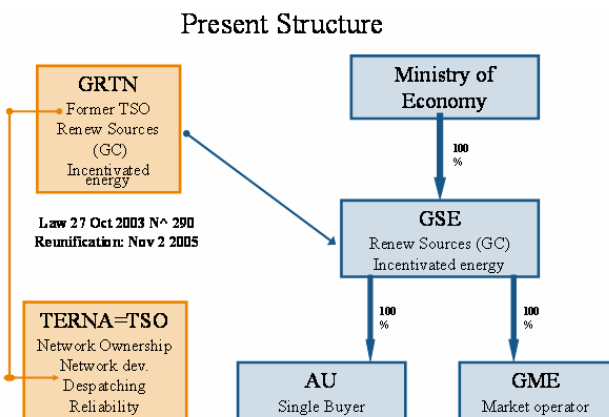
3.1 Generation

The displacement of three GenCos of the ENEL was completed by 2002:

- Elettrogen 5.4 GW, now “Endesa Italia” with 6.5 GW;
- Eurogen 7.0 GW, now “Edipower” with 8.5 GW;
- Interpower 2.6 GW, now “Tirreno Power.

Initially, foreign Producers sought alliances in Italy. There was an imbalance in demand vs supply in the free market and producers were price setters. Competition began due to huge investment: the Producers’ Association Assoelettrica [3] states: that in eight years new plants generating 14 GW have been commissioned and another 4 GW are now under construction. Furthermore, re-powering and conversion on the existing 20 GW will provide availability of an additional capacity of 3 GW. Economic investment is 24 billion €: the result expected by 2010 is an increase in the average efficiency of production by up to 50% (10% more than at the end of the century). According to data published by the Regulator [1], six major Generators are now competing. In 2006, 34.8 % of Italian production came through ENEL, 13.1 % from Edison, 9.2 % from Eni, 8.7 % from Endesa Italia, 8% from Edipower, 4.0% from Tirreno Power; another six generators produced between 1-2% each and the remaining an aggregate of around 14.8%.

Figure 3
Structure and Responsibilities



Nonetheless, ENEL Production still has a prevailing position and is a price setter in some Macro Areas of the country. In December 2006, the Antitrust Commission ruled that ENEL Production will sell “virtual plants” for 1000 MW in 2007 in order to avoid potential “pivoting” of the pool price in the Macro Area “South”. ENEL for 650 Mw base duty and 350 MW made auctions for “2 way CfDs” for peak and off peak, alternatively. A further sale of 700 MW was agreed in 2008, subject to checks on real price pivoting.

The Treasury directly owns 21.4 % of ENEL and indirectly a further 10.2% through Cassa Depositi & Prestiti (a Company owned 70 % by the Treasury and 30 % by Bank Foundations). Other ENEL shareholders are International investment funds, insurance companies, pension funds and retail businesses.

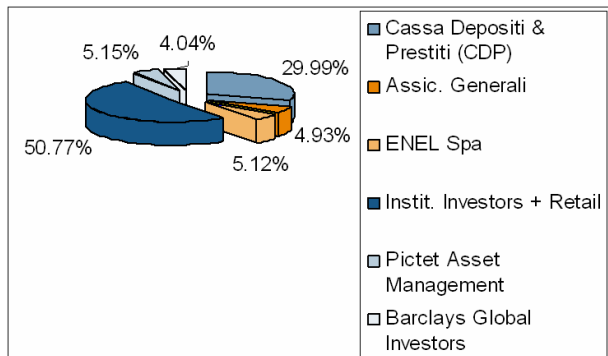
After the agreement between ENEL, Acciona and Eon in Spring 2007 for the take-over of Endesa, and the creation of a European Company of about 80 GW and a flexible mix, In June, ENEL became a 24.97 % shareholder of Endesa. A reshuffle in the Italian generation system (Endesa Italia: 75 % Eon and 25 %) of the “universe” of the MUNIS took place.

The merging of Asm Brescia with Aem Milano in June 2007 created the “super Muni” ASEM, the third utility in Italy after ENEL and Edison, 55 % public, with ownership of generation assets through Endesa Italia (20 %) and Edipower (20 %). At the time of writing (end of July 2007), other mergers of MUNIS are in discussion; fi.i Hera Bologna with Enia in the Emilia Region, Hera with Iride (resulting from the merging of the Utilities of Torino & Genova), Hera with Acea (Rome) and others. Some of these merged bodies are active both in electricity and gas and have a “traditional” important linkage with the territory.

3.2 Transmission

After an initial period during which the “wire ownership” (Terna and others) and system operation (GRTN) were separated, since November 2005 Terna has become (as per DM 11/05/04) a full TransCo. It was introduced to the market in three major steps: June 04: 50%; Early 2005: 14%; November 05: 30% to Cassa Depositi & Prestiti. Terna is fully unbundled from ENEL, which only keeps 5% of Terna [4], and allows fair competition to all producers. In his annual report to Parliament at the beginning of July 07, the Electricity & Gas Regulator pointed to different aspects in the situation for gas, in which ENI still owns two companies for the network (Snam Rete gas) and storage (Stogit), asking Parliament to foster network unbundling.

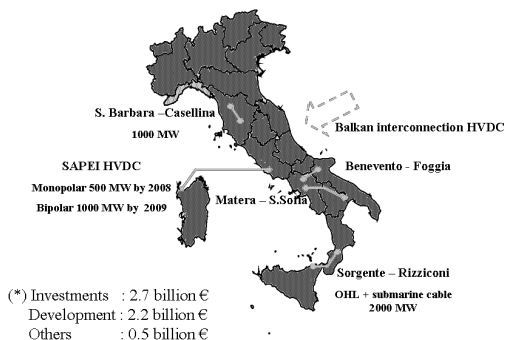
Figure 4
Terna Shareholders



Sources: Terna 2007

Figure 5
Terna Main Projects

Network main projects (strategic plan 2007-2011) *



After the purchase of transmission lines owned by Edison and AEM Milan and AEM Turin, Terna currently owns over 98.3% of the National Transmission Network. It is responsible for:

- ▶ the Planning & Development of the National Transmission Network;
- ▶ O&M;
- ▶ Despaching and Operation and
- ▶ Purchase of system services for system security.

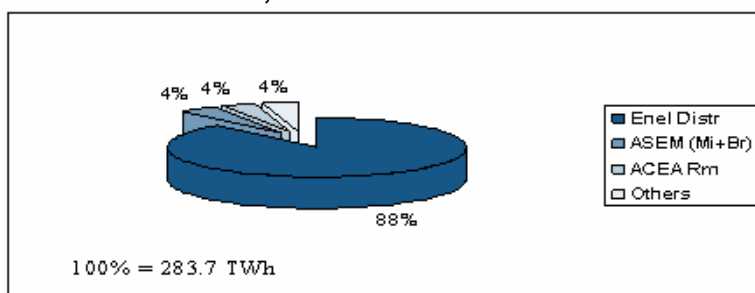
The business is regulated: each regulatory period last 4 years: 1[^] period: 1999-2003; 2[^] period 2004-2007, -3[^] period to start in 2008.

- ▶ RAB methodology: re-evaluated historical cost
- ▶ RAB revision: Annual (+ Capex-Depreciation+Inflation)
- ▶ Allowed revenues: RAB remuneration+ Opex+Depreciation

Basic parameters for the present regulatory period (204-2007):

- ▶ RAB remuneration= WACCpretax,real = 6.7 %
- ▶ New investments for network development: WACC = 8.7 %
- ▶ Opex+ Depreciation: Price cap = (RPI-X) X= 2.5 %
- ▶ Full benefit of volume growth retained
- ▶ The third regulatory review will start by January 2008

Figure 6
Sales of Distributors, 2005



Source: Italian Regulator

3.3 Distribution

The “Bersani Decree” 79/99 ruled only one concession in the Municipalities: correspondingly, rationalisation of network ownership in metropolitan areas has taken place since 2000, with mutual transfers of ENEL/MUNIS assets. The main Distributor is still ENEL Distribution: in 2005 it supplied the 88% of sales. Other players are various MUNIS in Rome, Turin and Milan, Brescia, Verona, each with a supply in the order of 2-4% of sales. As mentioned, some fusion took place and more are presently discussed.

Regulation: same methodology as per Transmission for the “wire business” Basic parameters for the present regulatory period:

- RAB remuneration= WACC pretax,real = 6.8%
- Opex+ Depreciation: Price cap = (RPI-X) X= 3.5%

As of 1st July 2007, Government and the Regulator on the occasion of complete market opening (see later) ruled important legislative and regulatory changes.

3.4 The electricity exchange

IPEX, run by the Market Operator GME, started operation on 1st April 2004. Various Macro Area prices are established and paid to the Producers, but the consumers only pay a single national price (PUN). The average national price in 2006 was 74.75 €/MWh, an increase of 16.2 €/MWh from 2005. This was due to the increase in fuel costs and to some extent, the persisting lack of competition in some areas. Regional average prices varied between a minimum in the North of 73.63 €/MWh and a maximum in Sardinia of 80.55 €/MWh.

In 2007 a considerable decrease in price was recorded: this was helped by a mild winter and lower oil prices. The average national price in June 2007 was 67.16 €/MWh, 5.12 €/MWh lower than in June 2006. The maximum price was 79.08 €/MWh in Sardinia while the minimum price was 62.62 in the North [5].

IPEX: 2006 average regional prices

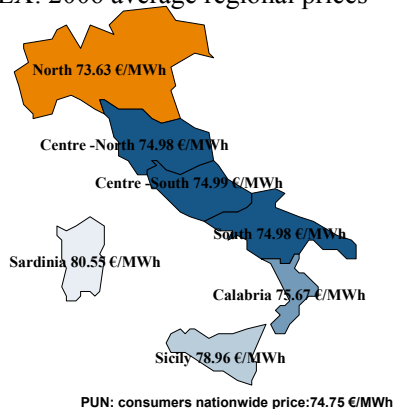


Figure 7
Average Regional Prices

IPEX: 2007 June - Day ahead regional prices

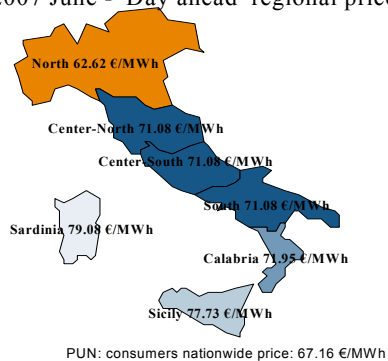


Figure 8
Day Ahead Regional Prices



Figure 9
Possible Market Trends

Sources: GME

The price difference between the peak load and off-peak hours is considerable, 50-55 €/MWh, with prices in the off-peak hours around 40 €/MWh, even lower than the marginal cash-cost. By taking into account the generating system development, the trend should be:

- in the North: high competition;
- in the Centre: still lack of generation;
- in the South: huge new generation with the possibility of bottlenecks.

The persisting price difference within Central Europe justifies the high value of imports, higher during peak hours than in off-peak, since at that time exports sometimes occur.

An indication of the expected price difference is given by the results of monthly auctions for the import capacity at various borders. The highest recorded values for peak monthly product in July 2007 have been for France (71.7 €/MWh) and Switzerland (60.1 €/MWh), while those for Austria (45.28 €/MWh) and Slovenia (45.28 €/MWh) had lower results. Every month from January to July the peak monthly prices were even considerably lower.

Corresponding prices for the product “base yearly” auctions for 2007 varied between about 15.2 €/MWh for Austria and France, 11.0 €/MWh for Switzerland and 7.9 €/MWh for Slovenia [6].

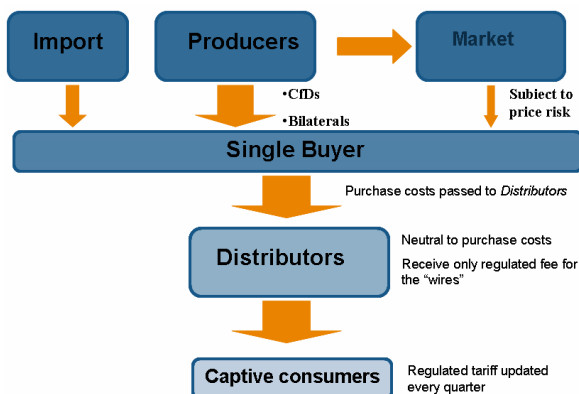
Commissioned in 2002, a new HVDC link with Greece (500 MW) and a new 380 kV line with Switzerland S. Fiorano-Robbia increased the North Bound NTC from 6.3 GW in 2003 to the present 7.1 GW. According to the EC Guidelines on Cross Border capacity allocation (EC 2006/770/CE) the Figure recalls the methods adopted for the allocation of import capacity,

3.5 Market opening

From liberalisation on, the market was gradually opened to competition from clients with > 20 GWh in 1999; then > 9 GWh; then > 0.1 GWh, in 2004 not all were domestic consumers. The share of captive consumers gradually decreased: in 2006 the demand was 337.8 TWh, T&D losses included. The corresponding final consumption was 317.4 TWh. Of these, 21 TWh are auto-producers, 153.9 TWh consumers in the free market and 142.5 TWh consumers in the captive market [7] (not every eligible consumer switched to the free market).

In order to protect the captive market and avoid possible price manipulation of vertically integrated Production-Distribution Companies it was ruled that the Distributors could not sell directly to the captive consumers. A Single wholesale Buyer (Acquirente Unico) was the buyer for the bulk of the captive market, acting as a wedge between the Distributors and Producers.

Figure 10
Main Functions of the Italian Single Buyer



The Single Buyer purchases its needs through:

- Import of residual long term contracts;
- Contracts for differences with producers;
- Some bilateral contracts;
- Utilisation of discounted renewable energy, assigned by the Ministry of Economic Development.

Under the control of the Regulator the resulting cost of the purchased mix is passed to the Distributors and in turn is passed on to the tariffs of captive consumers.

It must be underlined [1] that the weight of cost is related to Production: while in the first quarter of 2005 this was 67.4% of the total, in the first quarter of 2007 this increased to 69.4%. This testifies to the impact of a huge dependence on imported primary energy sources in Italy, with a present shift from oil to a “gas dependent” generating mix.

3.6 Full liberalisation

The EU Directive 2003/54/CE on regulations for the Electric Market ruled the separation of the Distribution activities from others and the full energy retail market opening by 1st July 2007. The Directive establishes an evolving path with four levels of unbundling:

- accounting unbundling;
- information unbundling;
- organisational and decisional independence for DSOs (functional unbundling);
- legal unbundling.

Whilst some EU markets such as the UK and Nordic countries, have been fully open for some time, a number of Member States, among them Italy, have not effectively transposed the DSO-unbundling provisions in their legislation.

On 18th June 2007 [8] the Government issued Law Decree n 73, to keep transient “protection” for domestic and other small LV consumers, intended as a transitory measure possibly lasting until the end of the year. The Decree, which is to be passed in law by Parliament within August 17, ruled:

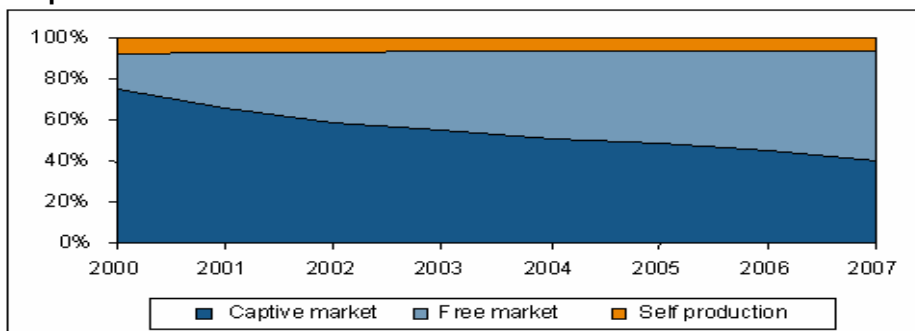
- ▶ The Distributors with more than 100.000 final clients having integrated “wires” and “supply” business, within 180 days have to unbundle the two activities, creating separate Companies exclusively dedicated to the supply business.
- ▶ The domestic clients and small Companies (less than 50 employees and yearly revenues lower than 50 M€) which will not switch to the free market are entitled to a protection service, with supply by the incumbent Distributor, through Supply Companies. The related energy will be purchased by the Single Buyer (SB), with the same procedure as previously; the related cost (commodity and dispatch) will be passed by the SB to the Supply Companies.
- ▶ For such clients, the Regulator publishes a “reference tariff”, corresponding to the “recognised costs”. The Distributors/Suppliers have the duty to include such reference tariff options in their commercial offers. In this way, the tariff component related to the cost of the commodity energy will be a transparent reference, which can be utilised for comparison.
- ▶ **For the supply of clients other than those at point ii),** that is LV Companies with more

than 50 employees, **which do not switch to the free market**, and for those who even if potentially free have not yet switched, a **safeguard service** has been introduced based on **auctions** in various macro areas. The Ministry of Economic Development (MSE) will define related characteristics *within 60 days* from the issuing of the Decree. In the *transient phase*, starting from July 1st, the Distributors or their Supply Companies, with public prices and indiscriminate behaviour, will carry out a safeguard service. Auctions should be aimed at gradually promoting the switch to a free market. Due to the possibility that clients may switch at any moment distributors are cautious in their regard of the auction mechanisms.

Due to the impossibility of organising the purchase of supply within around 15 days, the Regulator offered Distributors/Suppliers the possibility of making recourse to the SB for purchase of the energy needed for a safeguard service, with a regulated price.

- ▶ The Suppliers must include any information in their bills which relates to the fuel mix of the energy they sell.

Figure 11
Evolution of Captive and Free Markets



| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Net Demand (TWh) | 298,5 | 304,8 | 310,7 | 320,7 | 325,4 | 330,4 | 338,5 | 345,8 |
| T&D Losses | 19,2 | 19,3 | 19,8 | 20,9 | 20,9 | 20,6 | 21,1 | 22,8 |
| Final Consumptions | 279,3 | 285,5 | 290,9 | 299,8 | 304,5 | 309,8 | 317,4 | 323 |
| Captive mkt | 209,4 | 187,2 | 170,5 | 165,6 | 154,9 | 150,9 | 142 | 130,3 |
| Free mkt | 46,1 | 76 | 98,2 | 113,1 | 128,6 | 137,9 | 152,5 | 171,7 |
| Self production | 23,8 | 22,3 | 22,2 | 21,1 | 21 | 21 | 22,9 | 21 |
| Domestic | | | | | | 66,9 | 67,3 | 68,8 |

Source: AU, 2006

Summarising, with the unbundling of “wires business” (in a concession regime) from the “supply business” activity (carried out in a free market regime), access to the distribution network will be neutral, independent from the ownership and can be utilised by all suppliers with transparency and without asymmetries. At Distributor level, access to information is also essential with regard metering, privileged and priority access to consumption characteristics for an integrated network company can be a strong advantage. At the same time the new tariffs should foster a shift to the free market, not only by domestic consumers (60-65 TWh) but also LV “business” clients (other 60 TWh) which presently do not evaluate it as suitable to switch.

Initial reaction is to mention that many potential players in the domestic sector, even if active in the large consumer field, are cautious at the possibility of entering such new area. They will be “new entrants” and the cost needed to promote related commercial activity might not be covered by potential margins. From the clients point of view the total yearly discounts that could be offered to potential switchers are relatively low, since in addition to T&D components, various system charges are also regulated and there is also a high impact of taxation on the final bill.

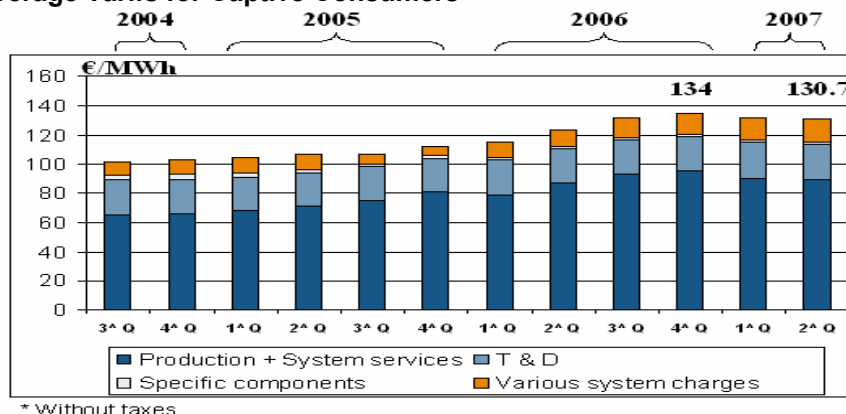
According to the Decree, the “Single Buyer” should keep the roles of:

- “protector” for the domestic clients and small companies who will not switch to the free market;
- a function similar to the past one in determining the price for the commodity energy, even if it is now “reference price” and no more a “regulated price”;
- wholesaler, availing himself of the commercial organisation of Distributors.

One problem for the SB, especially if there should be a high rate of switch to the free market, is related to the possibility of having timely measures for consumption by switchers, in order to forecast the positions in the energy market, with related impact on balancing costs.

It must also be mentioned that before 1st July tariffs paid by residential domestic consumers with contracts rated < 3kW (previous Tariff D2) were subsidised by other domestic consumers (previous tariff D3). The cross subsidy was made through the energy component of tariffs. Notwithstanding the aim, this implementation is not “social” and has been criticised for many years. In fact, subsidies are given for a certain amount of consumption, independent of the welfare state of the consumer.

Figure 11
Evolution of Average Tariffs for Captive Consumers



Source: Italian Regulator

A reform is under way: the Government must rule which characteristics are needed to keep discounts for a certain “vital” amount of consumption.

Pending this decision, due to the need for publishing the same reference price for component commodity, the Regulator made a move to change some other regulated components (T, D, and various additional system charges). This was done in order to keep roughly the same overall price as before the 1st July, at least until the end of the year.

At present the Decree is being discussed by Parliament. The Anti-trust Commission transmitted some reservations related to the “reference tariff” and the future role of the Single Buyer. The time allowed for the Decree to be passed expires on 17th August.

3.6 Kyoto and National Allocation Plan

The Italian commitment is a decrease of -6.5% from the 519.5 MtCO₂ 1990 emissions, a target of 485.7 MtCO₂. Regarding evaluations related to the National Allocation Plan (NAP1) for the first period 2005-2007, reference was made to 2004 emissions, which resulted in 580.7 MtCO₂, that is an increase of $\approx 12\%$ and a “distance” from the target of 95 MtCO₂.

The contribution to reduction by the “ET Sectors” was evaluated on the basis of the contribution to emissions by the ET Sectors, 38.3%, corresponding to a reduction of 36.4 MtCO₂. The planned “coverage” was entrusted for 22.3 MtCO₂ to the

flexible mechanisms (CDM+JI) and absorption, and for 14.1 MtCO₂ to reductions of the “ET Sectors” emissions.

The EU Commission approved, with Decision C (2005) of 25th May 2005, the Italian NAP1, which assigned, on average, to the ET Sectors 223.1MtCO₂, free.

The emissions by the ET Sectors were 225.6 MtCO₂ in 2005 against an allocation of 219.2 MtCO₂ and a related deficit of 6.4 MtCO₂; in 2006 emissions were 215.7 MtCO₂ against an allocation of 215.7 MtCO₂, with an increase in the deficit of up to 9.4 MtCO₂ [1]. The imbalance is mainly due to the thermal sector with allocations under 8.5 MtCO₂ in 2005 and 15.9 MtCO₂ in 2006.

It is known that during the first period of application of the ETS Directive an over allocation of allowances showed in many EU Member States: only 5 countries (UK, ES, I, IRL, DK) allocated fewer allowances than real emissions. The consequences were a decrease in the allowance price. According to data shown in the 2007 Report by the Italian Regulator, from April 2006 spot prices suddenly fell from 30 €/t to 15 €/t in May 2006, then progressively lower to less than 1.0 €/ton until March 2007. During the last year the futures of the first and second compliance periods have also been impacted. By assuming a shift to a “more severe” allocation for the second period, the price difference of the futures for the first and second periods of compliance was around 15€/t at March 2007 [1].

During the second compliance period 2008-2012 the Italian NPA2, presented to the EU Commission on December 2006, an assigned average of 209.0 MtCO₂ in allowances to the ET Sectors: 197.0 MtCO₂ free and 12. MtCO₂ to be paid.

116.5 MtCO₂ were assigned to the thermoelectric sector, out of which 100.66 MtCO₂ to existing plants and 15.84 MtCO₂ to “new entrants”. Out of the total, 106.2 MtCO₂ were meant to be free of charge, while 10.3 MtCO₂ were to be paid by the coal plants.

In May 2007 the EU Commission requested that the Italian Government made a cut of -6.3% in the allocations (209 MtCO₂) proposed by the Italian NAP2, corresponding to -13.2 MtCO₂: the present burden for the Italian ETS sectors is therefore 195.8 MtCO₂.

At the time of writing, it is not possible to forecast how cut will be shared among the ET sectors: it is quite probable that a large part could be made in the thermoelectric sector, with “pressure” on coal plants. Consultation among stakeholders should be launched in coming months.

Regarding the cost impact, if the deficit should be in the order of 20-25 MtCO₂ by 2008 and an allowance price in the order of 20 €/ton, the total burden on the ET sectors could amount to 400- 500 M€/year.

Just to give an idea of the size of the carbon credit market, it might be remembered that according to the World Bank, the market in carbon credits grew faster than expected in 2006, tripling to US\$30bn from US\$10bn in 2005. Almost US\$25bn came from transactions under the ET Scheme, while US\$5bn came from credits by developing countries.

4. Support Mechanism for Renewables

4.1 The “Renewable Directive”: Targets and State of the Art

The “Renewable” Directive 2001/77/CE fixed an overall target of 22% of electricity production by RES for the EU-15 by 2005, which later became 21% for the EU-25.

The situation, as reported in the EU Communication 24th November 2006 “Progress in renewable electricity”, shows that is unlikely to reach the target.

The Report subdivides the progress of EU Member States in 5 areas:

- Perfect on track : 3 Countries (DK,DE,HU);
- Good chances: 5 Countries (Fin. Ir., Lux. Sp., Ned);
- Additional efforts needed: 6 Countries (Cz. Lit. Pl. Slo. Sw. UK);
- Stronger efforts needed: 3 Countries (B.Gr.Pl.);
- Far from Commitment: 8 Countries (AT, Cy. Est. Fr. Italy. LA. Malta. SK)

The RES burden sharing by Italy, confirmed in the Italian Legislative Decree n. 387 of 29 December 2003, entails an increase in the contribution by the RES to gross electricity consumption of up to 25% by 2010.

It can be seen that the RES production is around 16% by the GEC.

Hydro and geothermal production is almost saturated, notwithstanding a leading position in Europe.

Among RES showing the greatest potential, in addition to biomass (2.7 GW and 14.8 TWh, from the present 2.1 GW and 3.2 TWh, are anticipated by 2010), wind production has a key role.

By the end of 2006, despite various administrative barriers, 2.123 GW are installed (an increase of 417 MW with respect to 2005) and a production of 3.2 TWh (an increase of 0.9 TWh).

In the 2007 Development Plan of Transmission Network of Terna [10], it was anticipated that by taking into account all connection requests with “sound” economic engagements of the proponents to the TSO and to various DSOs, a total wind capacity of 3875 MW should be installed by 2008.

At the time of writing, even if the various “moratoria” established in different Regions for the installation of new wind plants are formally over, there are still many difficulties.

The wind producer association ANEV anticipates the possibility of having some 7.5 GW installed by 2010, with a related production of about 14-15 TWh.

4.2 Short overview of the RES support mechanisms in Europe

One major driving force of RES development is the mechanism used in their support.

In Europe the major mechanisms are:

- Feed in Tariffs (FiTs) and
- Tradable Green Certificates (TGCs), or “Quota systems”.

Other less used mechanisms are:

- tenders;
- tax incentives;
- a mix of the previous.

With the FiTs mechanism a regulatory body sets a technology-related price for a period of several years, to be paid to producers of RES. The purchase of production by the TSO or Distributors is ensured. The result is the quantity of renewable energy that can be obtained by each technology. The costs are passed to consumers. The “advantages” are:

- the return on the investments is guaranteed and the possibility of fine tuning ;
- the possibility of promoting mid and long term technologies;
- the support is paid only to energy produced.

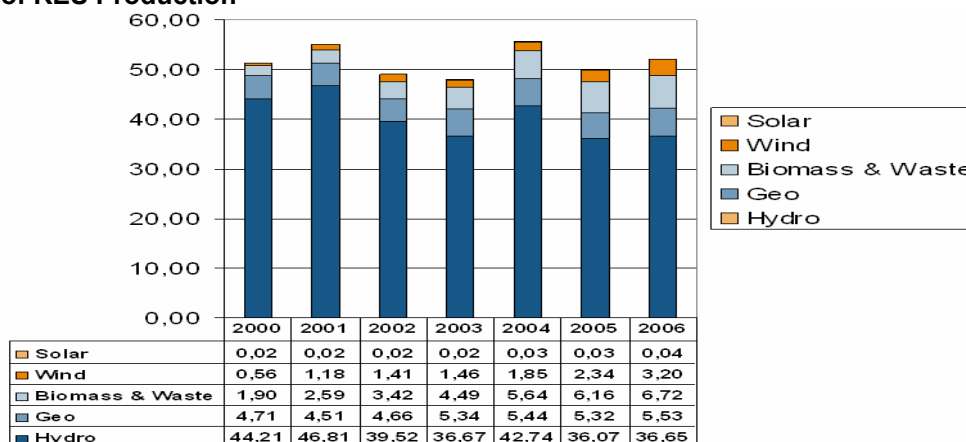
The “disadvantages” are:

- it is not a “market based” mechanism;
- there is the risk of over funding, if the learning curve for each RES technology is not built in as a decrease over time of the tariffs to follow the decrease in production costs.

So far it is the most widely used method in the EU25: 18 countries + Italy for solar PV.

Recently (May 2007) Spain “corrected” the previous mechanism, based on two options for the Producers to sell their production to the Distributors at fixed tariff or to the market with a bonus linked to Average Regulated Tariff (ART)”. Previous linkage with the ART in the “market option” was abandoned, since it was decided that it was no longer possible to “transfer” the increasing cost of the generation component of the ART (increase price of the gas) to renewable production. A “cap” and “floor” on the total price paid (market + premium) were introduced, with a premium that can be modified according to the value of the pool price. The ART is now 73,2 €/MWh. With the market option, the price received depends on the hourly market price: the maximum premium for wind production is 29.9 €/MWh; the cap and floor are respectively 84,944 €/MWh and 71.275 €/MWh. The tariff and the premium can be modified not the cap or the floor.

Figure 12
Evolution of RES Production



Source: GSE, March 2007

Under the TGCs mechanism the quantity of RES production is fixed by the regulatory body, the output of the mechanism is the price. The ratio is to split the “green” characteristic of renewable production and trade it separately from the commodity energy, which is sold at market price. In order to finance the additional cost and ensure the Renewable Obligation (RO), all the consumers/distributors (UK) or Producers/Importers (Italy) are obliged to purchase the Green Certificates in the amount ruled. Penalty payments for non-compliance are foreseen.

In principle the “advantage” is, that at least the mechanism is market based, since producers/consumers should buy the necessary certificates in a market where RES producers compete with each other. The “disadvantages” of this mechanism are:

- only lower cost technologies are developed;
- it is not well suited to support emerging high cost technologies;
- it can create uncertainties for investors, especially when quota obligations are not fixed for an extensive period;
- it presents higher administrative costs.

At the moment UK, ITALY, Sweden, Belgium and Poland use it, with different options.

Both methods have been investigated by the EU Commission Communication: “The support of

electricity for renewable energy sources” (COM 2005-final) [6], intended to see if it was possible to identify a common European mechanism. The conclusion was that, due to the different characteristics of the energy and electricity markets, a harmonised approach for regulating, supporting and integrating RES in the electricity system was at that moment a target but premature.

In the meantime various “corrections” have been examined and in some cases introduced.

Noting the EU Commission Staff Working Document [7] on the “Renewable energy roadmap” of 26th November 2006. The Commission recognised, taking into account the request by the European Parliament for a 20% energy target by 2020, that many countries made great efforts and progress regarding renewable electricity and indicated eight main areas of action on renewable electricity.

Among these, the “optimisation of the support schemes”, as defined in the COM (2005) 675 final. In 2007 the European Commission will re-examine the situation concerning the Member States’ support system for the RES. With a view to propose harmonising support schemes in the context of the EU internal electricity market, even if it is recognised that national schemes may yet have need of a transitional period.

4.3 The support mechanism in Italy: from FiTs to GCs

In the 90's, in order to support RES in a framework of fears about oil scarcity and to face the lack of capacity due to the difficulties of ENEL in siting new plants, a Feed in Tariffs (FiTs) mechanism was adopted, the so called CIP 6/92. The monopolistic Vertically Integrated Utility ENEL Spa had to purchase the energy produced by new plants of private Producers coming from a set of RES and from "assimilated sources" (mainly CCGT, having an efficiency higher than a pre-established value). The selling price was based on the "avoided cost" (capital, O&M, fuel) of ENEL plus technology-related incentives, paid for 8 years. Capital and O&M cost were indexed to the RPI, the fuel cost to the cost of gas.

According to data published by the Italian Electricity & Gas Regulator [1], out of a total 48.3 TWh of the "CIP 6/92 energy", only 9.3 TWh were related to "pure" renewable sources while the majority (39.0 TWh) came from "assimilated sources" in 2006. The prices paid were correspondingly different, namely 190.0 €/MWh for the first, 111.7 €/MWh for the second. Total cost was 6120 M€, with an average of 126.7 €/MWh.

When liberalisation began in March 1999, it was ruled that the new Independent System Operator (formerly GRTN, now Terna) should purchase "CIP 6/92 energy". This should then be resold [by allocation at administrated prices, auctioned and recently through Contract for Differences with a strike price fixed by the Ministry of Industry (64

€/MWh for the first 3 months of 2007)] to both captive and free markets. That is 35% to the captive market, 65% to free consumers in 2007.

Due to the presence of the incentives, the purchase cost of the total energy ≈ 49 TWh (including, in addition to the said 48.3 TWh, 0.7 TWh of the D 108/97 and corresponding to 16.2% of the Italian Production), is much higher than income from sales (energy + green certificates). The difference is charged on the bill of all consumers through a related supplement (A3). The total amount is huge, about 3680 M€ corresponding to some 11.6 €/MWh on the final consumption in 2006.

In 2002 the CIP6/92 mechanism was ruled out (naturally paying heed to existing 20 years conventions): Green Certificates (GCs), awarded to the new renewable plants, "qualified" (IAFR) by the TSO, were introduced. Each Producer/Importer has the obligation to inject in each year "n" a "green power", in a percentage $X\%$ n-1 of its "subjected brown" production/import E_{n-1} of the previous year "n-1". The Green Certificates Obligation (GCO) in year "n" is therefore: $GCO_n = E_{n-1} * X\%$ n-1

Green Certificates:

- are not technology-related and
- are only issued for renewable production (this in origin, some other "pretenders" appeared later).

They are coupons, originally valid for 8 years, now 12 years from commissioning, that can be traded on an Exchange run by the Market Operator or through bilateral contracting Developers- Producers/Importers. The value is added to that of the commodity energy, sold in the IPEX or through bilateral contracts. The first value of the obligation X%2002 was 2% and an increase of 0.35%/yr was ruled for the three years 2004-2006: the obligation X%2006 is 3.05%.

Over the years various criticisms have been made in the application of the GCs mechanism

A.) There are several **exemptions** to the production/import submitted to the GCO:

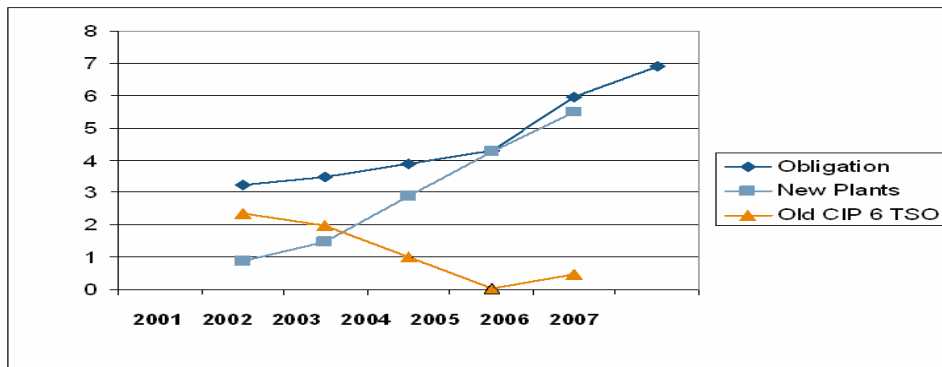
- ▶ all renewable production;
- ▶ a “qualified” CHP ;
- ▶ renewable import with a Guarantee of Origin;
- ▶ each production/ import lower than 100 GWh/yr.

B.) “Brown producers”, subject to the obligation, recover the costs of the GCs through a “bid up” on their offers on the wholesale market, influencing the system marginal price and generating a sort of windfall profit for all production. There is a corresponding increase in cost for consumers, larger than the support given to the RES.

C.) The mechanism was subject to various modifications even after a short period. To make some mention, legislation, in a certain way contradictory, allowed the CHP produced for district heating to receive GCs. At present, under the Decree of 27th October 2006, it was ruled that the CHP for district heating will not receive GCs, but by means of the “energy-related” support mechanism aimed at increasing energy efficiency, called “White certificates”. The original duration of 8 years for GCs was extended to 12 years without a clear indication of which plants (commissioned before the law or not?) could avail themselves of the extension. This introduced uncertainties for developers.

D.) Notwithstanding the premises, the GCs price does not achieve a “market based” result. In fact, the GC model adopted by Italy, in addition to the Green Certificates GCI AFR assigned to qualified new plants, Green Certificates GCCIP6 are also assigned for renewable production (Hydro; Geothermal + wind; Photovoltaics + Urban Solid Waste + Biomass; Hydro re-powered). They are also purchased by the new Body GSE with the “old” CIP6 mechanism from “new” CIP6 plants commissioned after the 1st April 1999 (purchase cost naturally includes the technology-related incentive).

Figure 13
Evolution of GC Parametres



| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------------------|-----------|--------------|-------------|--------------|---------------|---------------|------|
| Percentage obligation | 2% | 2% | 2% | 2,35% | 2,70% | 3,05% | |
| Brown Energy [TWh] | 161,6 | 173,5 | 194,7 | 183,4 | 221,0 | 225,9 | |
| Obligation [TWh] | | 3,23 | 3,47 | 3,89 | 4,31 | 5,97 | 6,89 |
| New Plants [TWh] | | 0,89 | 1,49 | 2,89 | 4,27 | 5,50 | |
| Old CIP 6 TSO [TWh] | | 2,34 | 1,98 | 1,00 | 0,03 | 0,47 | |
| Administrated Price [€/MWh] | | 84,18 | 82,4 | 97,39 | 108,97 | 125,28 | |

Up until 2004 energy related to the GCI/AFR stemming from a new IAFR plant was not sufficient to cover the GCO. The missing offer was therefore covered by the GCCIP6 and sold by the TSO at an administratively fixed price. As a result, the Italian TSO was a price setter in the Green Certificates market.

The administratively fixed price of Gestore System Elettrico (the body in charge of handling the Renewable sources) GSE is evaluated as the difference between:

- ▶ weighted cost (€/MWh) of the purchased renewable energy of the **new CIP6/92** plants commissioned after 1st April 1999;
- ▶ the average revenue (€/MWh) stemming from selling **all** of the CIP6/92 energy purchased by the GSE.

Producers, who are likely to align to it, have always seen the administrated value as a “top reference price”. All bilateral deals are based on such a “reference price”; the mechanism therefore introduces a market distortion creating an artificial link between the new theoretically market-based model and the “old” CIP6.

E.) The result is that, notwithstanding improvement in technologies, the price of the green certificates is increased.

In 2004 the “administrated” price was 97.4 €/MWh, then 108,97 €/MWh in 2005 and for

2006 was further increased to 125,28 €/MWh. The reason for these increases is twofold:

the increase of the gas cost in 2006 due to the component in the “avoided cost”;

the percentage of “new CIP 6 plants” having higher incentives (biomass, waste) have increasing importance (about 52% of the total) and correspondingly raise the purchase cost of the CIP6 new plant by GSE.

F.) The mechanism was particularly criticised with reference to wind production; it was claimed that “wind gains too much” particularly in comparison with FiTs paid in other countries. As a matter of fact, the GCs reference price plus the underlying commodity price was high enough to attract investors.

Wind developers object that in reality the cost of a wind farm in Italy is extremely variable, since it depends on specific features of the site and the number of wind turbines installed. There is also the point that the unit costs for new large Wind Turbines (2 MW size) are higher than in the past, in the range of 1300-1600 €/kW.

The best sites have been exploited; while on average, productivity is 1800-2000 MWh/MW, the range between Wind Farms is very large, from 1200 up to 3000 MWh/MW. In addition, the yearly variation in a site is in the order of ± 15%.

Another very important impact on the real costs faced by developers is the protracted and difficult authorisation process, although laws have ruled fixed terms and a fixed path. "Shadow costs" in the range up to 0.4 M€/MW are indicated and related to full authorisation process. In conclusion, the production costs vary correspondingly over a wide range and produce relatively low post taxes return overall. Uncertainties are due; the amount of money actually received by developers depends on how project financing is structured, particularly if it is geared to low equity.

G.) Although further Ministerial decrees should increase obligation percentages over the three years periods 2007-2009 and 2010-2012, so far they have not been executed. On one hand this makes it very difficult to forecast the administrated price for the future and on the other makes the projects less bankable, increasing the financial cost to investors.

According to the Directive the burden shared by RES in Italy should be 25% by 2010 (90-95 TWh). Present production by RES is about 16% (50-55 TWh according to various hydro inflows) which means that a considerable increase in percentage obligation of X% in the remaining years before 2010-2012, and above all a long term commitment, is needed. Naturally, corresponding increases in the bills should be adequately justified to consumers.

H.) Although a vast amount of money was used for the incentive mechanism there was not a driving effect in creating national technologies. These, such as wind (only one subsidiary of Vestas is acting in the South of Italy) and solar PV, could be effective forces in reducing technology costs and triggering a corresponding effect on employment.

I.) A clearer framework is needed, with greater co-ordination of energy and environment policies and by avoiding potential overlaps of various support mechanisms in the two sectors (Green Certificates, White Certificates, Energy account for solar, Allowances for ET).

4.4 The possible evolution of the support mechanism in Italy

The Industry has debated for more than a year whether the present mechanism of Green Certificates should be:

- maintained;
- "reshaped" introducing some flexibility for the less developed technologies or;
- substituted by a return to a new Feed in Tariff mechanism.

The GCs mechanism gave a suitable return for technologies such as hydro and wind, higher than

that of the CIP6/92 incentives, but being a GC not technology-related, the developers of alternative sources request other measures. A move in this direction was made recently by the Government, introducing a new FiT for Solar PV.

The Government and Parliament faced the issue of an incentive mechanism for renewable sources, in the framework of achieving the above-mentioned 25% “renewable burden sharing” by 2010, or at least by 2012. Apparently in the opinion of Parliament the feed in tariff should be utilised for “infant” technologies (as already made for Solar PV) or for alternatives where development could be of real strategical importance. Naturally it is necessary to test the real potential and trigger industrial development.

Presently in the Parliament there are two draft laws (“Energy Bersani Decree” AS 691 and Draft law “Ronchi” AS 786) under discussion to create a more uniform framework. At the end of May 2007 an attempt was made to implement the first, which at that moment was assumed to have followed a more advanced Parliamentary path, and some proposals of the second. In particular some Senators requested the introduction of:

- a new duration for GCs, up to 15 years;
- variable “value” of the green kWh produced, according the nature of renewable sources, through a weighting coefficient ($f= 1$ for wind source; $f= 1.8$ for biomass, $f=0.9$ geo.....);

- capping of the administrated price: [160 Euro-revenues from the sale of the CIP 6 energy of GCs sold by GSE];
- increase in the percentage of the “green” obligation of 0.5 % from 2007 to 2012, with a final value of 6.05 %

By the end July 2007 the debate in the Senate still continued. The text that should be issued by the Senate has to be sent to the Lower Chamber: the final law is not expected to be in force before the Autumn.

It must be underlined that National targets are to be allocated among Regions, depending on their resources. Regions in charge of evaluating wind projects in terms of environmental impact and other aspects before authorising building have been involved in determining wind energy contribution to their regional energy plans. Unfortunately, few Regions have approved their energy plans. Since ruling “guidelines” for the installation of plants have not yet been issued, each Region and Municipality adopts an individual rather than national uniform criteria with the result that a “common culture” on exploitation of wind source has not been developed.

This entails further delays, uncertainties for investors and the increase in price/tariffs “requested” by developers. Higher incentives, stemming at least in part from the above description, could be reduced if a better cultural and legislative framework for the development of RES was created. Naturally this could have a positive impact on the final bill paid by consumers.

5. Connection to Wind Farm Transmission Network

After liberalisation, the TSO was almost “submerged” by photocopy requests of connection for wind plants, a large number of them without a real industrial plan. To deal with the matter, the TSO and Regulator began with provisional connection rules. After a long delay from a first Rule (dated 2002) and a Consultation document, on 22nd Dec 2005 the Regulator issued a long awaited new ruling 281/05 on connection.

In Italy it is common proposal by TSO to various applicant producers that any new switching station in close proximity to a 150 kV line should upload the wind energy produced in Mt to the National Network. The most debated clause of the new rule D 281/05 [13] stated that the first applicant for connection to the National Transmission Network should pay the full cost of construction of this 150/MV switching station.

What is naturally valid in the case is that connection is made to a switching station specifically required/used by the applicants and not for substations included in the “network reinforcement /development plan” issued by the TSO which are considered to be “deep network costs”. In this case the full costs of a new substation are passed to consumers by means of the transmission tariff and the applicant only pays the costs related to a new connection bay.

Unfortunately, the rule introduced a concept which could be described as “first come, worst served”, since the first applicant would have paid almost the full cost of a 200 MVA substation, while (potential) followers should only pay for their bays. The rule left private contracts between various producers

with the re-distribution, where possible, of expenses. This is not easy since the priorities of various producers in an area may vary.

Because new standard substations used by the Italian TSO are “rated” 200 MVA with costs of about 2.5 M€, the above mechanism is results great distress for wind developers. In fact the average size of a wind farm applying for connection to the National Transmission Network is in the range of 20-40 MW.

Wind energy producers strongly objected to the proposed mechanism, which was not at all favourable to renewable sources and might hinder the economic return for their initiative, against the rationale of the European Directive on the Renewable Sources (D2001/77/CE).

A major Producer presented an application to the Administrative Court of Milan against the said Regulator’s Rule; in November 2006 the Producer won the lawsuit and the clause was removed by the Court. The Regulator did not appeal.

At the time of writing related articles in the rule are suspended. Terna, which investigates pragmatic solutions case by case, is awaiting directives from the Regulator to deal with the matter.

Other rules are followed for connection with a dedicated bay to the busbars of primary Distribution substations: in this case Producers normally pay the related cost of substation enlargement to the Distributor.

6. Wind Source Integration into Power System

In EU-25, out of the total capacity (40.5 GW) and wind production (69.4 TWh) at the end of 2005, Germany contributed 18.4 GW and 27.2 TWh; Spain 10 GW and 21 TWh (11.7 GW and 22.9 TWh by 2006). Both countries have plans for further development by 2010, Germany up to 24.6 GW and Spain up to 18.3 GW.

The present situation and planned expansion of wind power generation particularly in some EU Member States has significant repercussions for the European electricity system as a whole. The association of the European Transmission system Operators, ETSO focused on “the measures needed to be taken by legislators, regulators, grid operators and grid users, aiming at establishing a harmonised set of rules for the integration of wind power” [14], and made a very extensive and complete Europe-wide system study. They have as a target the year 2008, in which the total installed wind capacity is expected to increase to 66.4 GW. Germany contributes with 25.6 GW, Spain with 14 GW, UK with 5 GW and, among the others, Italy with 2.6 GW.

The study on wind comprises two situations with major impact on the operation and security of the European transmission network:

- Wind Situation UCTE North, with maximum wind production by Northern Countries and an overall wind production of 28,600 MW;
- Wind Situation UCTE South, with maximum wind power production of 25,300 MW, compared with an installed capacity of 56,500 MW in the UCTE area.

- ▶ Summarising, the findings of the ETSO study are:
- ▶ The expansion of variable wind power has a significant effect on Europe as a whole: high wind power concentrated in Northern Germany results in temporary large load flows through neighbouring transmission systems. The unscheduled flows could reduce system stability and affect trading;
- ▶ Massive investment is needed in new grid infrastructure, exclusively or at least mainly driven by the new RES generation;
- ▶ High wind power generation, combined with production by conventional plants in the North of Germany results in large North-South power flows through Germany and the neighbouring systems of the Netherlands, Belgium, Poland and the Czech Republic. Bottlenecks on internal and cross border lines in Northern Europe may be detected;
- ▶ The disconnection of wind farms, even in the event of minor transient voltage dips could present a danger to system security: “fault ride through capability” may be necessary;
- ▶ In order to balance the difference between day to day forecast and actual generation, increased balancing power is needed. TSOs contract the power balance and pass the cost as uplift to consumers. With this mechanism, wind farms have no incentive to reduce such a cost of integration
- ▶ Increasing grid losses and reactive compensation, due to high siting of wind

power generators remotely from demand centres;

- ▶ With existing priority rules for connection, the dispatch of RES electricity will increasingly affect power generation all over Europe, and a large proportion of cost effective power generation could be pushed out of the market by RES.

As far as the Italian system is concerned, in examining the results of the study, it seems that the Italian electric system is only partially affected by the two scenarios.

It is mentioned that *“in the UCTE Scenario North the surplus of power production in Northern Germany due to the high wind power production is transmitted to southern Germany, further to Switzerland and Austria and further to Italy reducing the exchange from France to Italy via Germany and Switzerland”*.

- ETSO also laid down a set of main recommendations as follows:
- Harmonisation of the European support scheme of RES
- Acceleration of approval procedures for new grid infrastructures

- Adjustment of market rules for imbalance management
- Ruling of fault-ride through capability or voltage support
- Re-examination of priority rules for RES electricity

As mentioned, wind production in Italy is a major possibility offered by RES development and the developers' targets for 2010 are 7.5 GW and around 14-15 TWh. Therefore, present development and anticipated targets of wind source in Italy are much lower than in Germany and Spain; another point is that network meshing/interconnection is different from that of relatively small systems with weak interconnection (e.g. Ireland).

In addition to the need for new T & D line infrastructure, the issues, which in Italy are mostly debated on wind production integration, are:

- the impact on system adequacy and the evaluation of “Cost on Intermittence “ (CI);
- the need to reduce balancing cost;
- the fault ride-through capability;
- the opportunity/need for remote “cluster management” by TSOs of various wind farms,
- the possibility that wind farms could/should join some system services as “conventional units”.

In general, the solution to all the above questions presents not only technical problems but also entails agreement between various stakeholders to *reconcile* interests that are sometimes divergent.

In principle, the solutions cannot be the same for all systems in Europe, since wind source penetration is different as are the transmission/distribution systems and their meshing and interconnection.

In general, these concepts are dealt with on a mainly qualitative basis. Following is an attempt to show better definitions for some, with quantitative figures made, where possible.

System adequacy. In a deregulated environment the *static reserve margin* is an outcome of private investment decisions, even if contesting regulation aims to verify that markets were able to deliver a “reliable” supply. There are capacity markets in various systems that are only targeted at quantifying the value of capacity needed to set a margin ensuring an adequacy index (whatever it can be) that is acceptable to society.

A related concept is the **Capacity Credit (CC)**: any MW_{IG} of Intermittent Generation (IG) has, with regard to the adequacy offered, “less value” than a thermal MW that delivers the same energy output. The value of the **CC** is equal to the **fixed cost of the thermal capacity** which, *at equal system adequacy, can be displaced* when installing MW_{IG} .

The *Capacity Credit* (CC) is **not** to be confused with the more familiar “Capacity Factor” (CF), related to annual production, which represents annual utilisation of installed capacity.

In fact, fundamental to the CC is *the time correlation between the production* of the Intermittent Generation (IG) and the *system peak hours*. CC can also be much lower than the CF. To clarify the concept, in the case of solar production and system peak during evening hours, the value of system adequacy for CC is equal to zero.

Quantitative evaluation of major costs due to intermittent wind production is quite difficult; in international literature there are various approaches for evaluating system adequacy indices (LOLP, EENF...) and system operation costs. One advanced, but time consuming method, recurses to computing tools capable of simulating the generation system behaviour on an hourly basis. This is in order to obtain the following results: “total cost” investment, operation (fuel); “risk cost”(by expressing in money the risk indices adopted to quantify the system adequacy) of two system compositions, with and without wind, substituted by a thermal “reference” plant. The comparison is to be made for equal energy supplied to the load, and equal adequacy.

The thermal plant used in comparisons with the wind is usually of the last generation (efficiency $\eta=56\%$) Combined Cycle (CCGT), meant to work at full capacity (5000-6000 hours/annum).

In the literature, confusion is sometimes made with the phrase “system reserve”, meant here as a static reserve margin to maintain *system adequacy* and not the system balancing cost of wind production. In Italy there is no clear indication of which adequacy indices are “ruled”, and a market for the capacity

does not exist. The concept of the Cost of Intermittence (CI) is often mentioned but no numerical evaluation is available in the Italian case.

The UK Energy Research Center (UKERC) [15] has extensively discussed and identified the following formula for the Cost due to wind production Intermittence (CI):

Cost of Intermittence = CI = [Fixed cost of the **energy** equivalent CCGT, that is equivalent to the wind as annual production – avoided fixed cost of CCGT displaced by **the capacity credit** (CC) of the wind at equal system adequacy].

In order to determine the value of CI it is primarily the identification of various Capacity Credits (CCs) of wind production, which depends on the variance of the system load and generation system, on the generation mix, on wind energy penetration levels and on the wind capacity factor. In this regard also, indices used to express system adequacy and the tools used for CI evaluation are of primary importance.

The UKERC presents the results [15] from various sources for a UK system with 400 TWh of demand. Summarising, for various wind energy penetrations:

- 5 % : CC in a range between 17 % and 35 %
- 10 % : CC in a range between 15 % and 30 %
- 20 % : CC in a range between 11 % and 20 %
- Each range has various outlines.

Starting with these figures and assumptions on the annual cost of an equivalent CCGT, by utilising the CI formula the UKERC [15] arrives to identifying the following values of CI for UK systems, all related to the kWh produced by wind and with a change rate £/€ of 1.472:

- for wind energy penetration of 10% = 40 TWh, a CI range between 2.4 and 4.74 €/MWh
- for wind energy penetration of 20% = 80 TWh, a CI range between 3.3 and 4.80 €/MWh

The highest values for wind capacity credit are related to the lowest, which in turn decreases with the increase of wind energy penetration in the system.

The UKERC also reports that for systems with a high level of wind energy penetration, the energy cost have increased variability and the balancing costs are around 4.42 €/MWh.

In conclusion, where systems have levels of wind energy in the range of 15-20 % of demand, the UKERC Report estimates a total cost to provide adequacy and balance of 9.6 €/MWh to 10.9 €/MWh.

Without considering the benefits of wind on the CO2 emission reduction, the above mentioned costs must be compared with credits stemming from the displacement of CCGT production. In case of CCGT having efficiency $\eta = 56\%$ and gas price of 0,25 €/m³, this credit is in the order of around 46.4 €/Mwhwind.

The issue of fault-ride through capability in various wind codes triggered the adoption of advanced wind turbines in which the electronic components devoted to active/reactive power control have been redesigned in order to allow the wind turbine:

- to stay connected to the network also in case of short circuits causing voltage dips at the connection point of 80-100 %, over transient periods in which the fault is eliminated by network protection,
- to increase the injection of reactive power to support voltage;
- to return to normal service in times varying from 1 to 5 seconds.

Since wind turbines are of different types (Synchronous generators at variable speed or asynchronous Double Fed Injection Generators), technical solutions made by various Manufacturers are different and imply an “over cost” to wind developers. Many stakeholders share the opinion that this corresponds to a new “service” given to the system, which should be “recognised” by regulators and passed into purchase tariffs. The treatment of existing wind turbines (retro-fitting or not?) is also a matter of regulatory decisions.

To study requirements for new Wind Turbines at the request of the Italian TSO, the Italian Electro-technical Committee (CEI) created a Working Group (WG) by mid 2005, which was composed of the TSO, the DSOs, manufacturers, developers, association of Producers and for some aspects, the Regulator.

Out of a total installed wind capacity of 1717 MW in 2005, 1368 MW were installed in three areas of Italy: Centre South (738 MW), Sardinia (320 MW) and Sicily (310 MW). According to the 2006-2008 triennial Transmission Development Plan of the ISO Terna, economically “sound” projections by 2008 were 1516 MW in the Centre South (Calabria, Puglia, Campania, and Basilicata), 593 MW in Sicily and 533 MW in Sardinia.

The CEI WG launched a system study made by CESI Ricerca Spa in February 2006, targeted at the year 2008 for these three areas of the Country. The aim was to assess the value and extension of voltage dips in the 380 kV, 220 kV, 150 kV of these areas, with the presence of transient short circuits, normally cleared by protections (80-100 sec’s in the first step, 300-500 msec in the second).

In short, the result of the study was that from a security point of view, only in Sardinia were WTs of new design a necessity. In the other two areas, the new design of WTs naturally gives major operation flexibility but a specific “security need” was not revealed. Only a transient decrease of the spinning reserve was singled out in various simulations, due to the fact that the Italian continental network is sufficiently meshed and is moreover part of the UCTE system.

Following the work by the WG, on 1st December 2006 a new Technical Rule devoted to the connection of wind plants to the network was published by the CEI [16].

New characteristics required by wind plants are:

- Low Voltage Ride Through Capability, until a voltage drop to 0.2 V rated;
- adjustable power factor for 0.95 leading to 0.95 lagging at the generator terminal;
- static characteristic of primary frequency control, *only for over frequency* from 50.3 Hz to 51.5 Hz with drop adjustable from 2 %-5 %;
- limitation on power output gradient during start up conditions (lower than 20 %/min);
- active power control on request or by remote control signal from the TSO.

The "Preface" of the Rule underlines that it was fair if various regulatory/economical issues were solved before mandatory enforcement. At present, the mentioned CEI Rule for the Wind plants is not yet formally part of the grid code of the Italian TSO Terna.

Dispatching priority Presently the wind source, as with other RES, has a dispatching priority and imbalances are paid at the market price of the next day. On 5th June 2007 the Regulator published a "Consultation document" (n.23/07) on new "Possibilities for priority despatch of the RES, in the presence of system critical situations".

The document states that Terna wanted the possibility of reducing the injection of RES, particularly of wind production, in some areas of the country (Sardinia, Sicily) where the system is presently affected by "despatch inflexibility". The measures would indicate a maximum limit for injection of the wind production, and would be temporary until planned reinforcement of interconnections of these areas with the Mainland was in place.

The consultation document aims to define a new regulatory compact, dealing with:

- the enforcement of system services examined by the above mentioned CEI Rule;
- the enforcement of reductions in the wind injections ordered by Terna;
- the potential payment for the related system services;
- the introduction in the transmission tariff system of suitable price signals, as needed to foster the network developments targeted at utilisation of the RES, -
- the possibility that new rules, with new indices, could be adopted for payment of imbalances created by the forecast of wind injections of the producers .

Answers from stakeholders are awaited by 22nd September 2007.

7. Final Comments

The liberalisation of the electricity market in Italy made some important strides, others are yet to be taken.

In the generating area, due to huge investment for new CCGT, the generating mix changed and overall efficiency increased by up to 50% (10% more than at the end of the century). New generating companies are now competing. Nevertheless, greater competition is required in order to lower the market price, particularly in the Islands and in the South. A reshuffle of the main generators, national and foreign, is under way. Production is increasingly based on gas and the related supplies rely mostly on pipes. Realisation of LNG re-gasification plants is essential for greater supply flexibility, both technical and political.

The Transmission network is fully unbundled from the former monopolistic Utility ENEL and allows fair competition for Producers. The Regulator suggests the unbundling model be used in the gas sector.

In the Distribution sector, a merging of Municipal Utilities (MUNIS) of various Regions took place and is still underway: the mergers have assets in electricity, gas, and sometimes water. The unbundling of the “wire business” from the “supply business” of Distributors, corresponding to full market opening on 1st July 2007, should be completed within the year.

According to a Decree, still to be converted in law, the Single Buyer should retain the roles of *wholesaler*, and “*protector*” for domestic clients and small companies who will not switch to the free market.

The electricity exchange, IPEX, started operation on 1st April 2004. Various Macro Area prices are established and paid to the Producers, but consumers pay a single national price (PUN). Prices for energy commodity are still much higher than in Central Europe: this justifies the high value of imports, higher in peak hours than in off peak, since exports sometimes occur during that period.

Greater competition is in the North where prices are lowest, but lower in the island, which has higher prices. Taking into account the generating system development, the trend should be:

- in the North: high competition;
- in the Centre: still lack of generation;
- in the South: huge new generation with the possibility of bottlenecks

It is improbable that the 25 % burden sharing for Italy of Renewable Sources (RES) by 2010 will be achieved. Among the most promising technologies is wind power production, with an anticipated target of 14-15 TWh by 2010.

Prerequisites for reaching the wind target and for general development of RES, are a more flexible and less costly administrative process, timely realisation of the network infrastructure and an adequate regulatory compact to make investments reasonably profitable. Even if existing “moratoria”, established in various regions for the installation of new wind plants, are formally over, there are still many difficulties to overcome.

With industry liberalisation Italy shifted from the FiT mechanisms (old CIP 6/92) to the (potentially) market-based Green Certificates (GCs) in order to support the development of RES. The results are not as expected: in particular a market for GCs did not arise and the price is still based on a “reference price” administratively determined and seen as “top reference price” by Producers, who are inclined to align to it. Such mechanisms introduce a market distortion through an artificial link between the new (theoretically) market-based model and the “old” CIP6. The administrated price increased year by year, in contrast with the premises.

Parliament has begun discussion on two draft laws aimed at a better tailoring of the mechanism. Nevertheless, the results do not appear to be licensed by the two Chambers before autumn.

Even if wind development in Italy is not expected to reach, in the medium term, the levels of Germany and Spain, the TSO paid attention to some of the issue rulings in these countries in order to protect system security. A new Technical Rule covering many of the issues under international discussion was issued last December. The Regulator has issued a consultation document on various connected problems (priority of dispatch, remote control of wind farms that supply some system services). Stakeholders are required to send their comments by next September. In general, the solution to all the above questions presents not only technical problems but also entails economic agreements among the various stakeholders. It is hoped that it will be possible to rapidly reconcile occasional divergent interests.

Appendix A

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World Energy Council

Regency House 1-4 Warwick Street
London W1B 5LT United Kingdom

T (+44) 20 7734 5996

F (+44) 20 7734 5926

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