Supporting and integrating RE-Electricity in Italy
The GSE experience
IEA DSM Task XVII
Seoul, Korea, September 2008

Giancarlo Scorsoni
Huge challenges

To cope with:

- **Global Climate Change**  
  *(facilitating Kyoto targets)*

- **Security of supply**  
  *(restraining high dependence on fuel imports)*

- **Local environmental issues relief**  
  *(waste disposal, landfill reclamation)*

in a consistent way with the European Union policy:

- **Directive 2001/77/CE targets**  
  \[
  \frac{\text{Gross RE-E generation (kWh)}}{\text{Gross domestic power consumption (kWh)}} = \frac{22\% \text{ as EU}}{(22\% \text{ as Italy})} @ 2010
  \]

- **Directive proposal COM(2008)19 targets**  
  \[
  \frac{\text{Final RE-E consumption (Mtoe)}}{\text{Final energy consumption (Mtoe)}} = \frac{20\% \text{ as EU}}{(17 \% \text{ as Italy})} @ 2020
  \]

  about 30% of RE-E  
  as Dir 2001/77/CE targets  
  for memory: 14% recorded in 2007

*when hydro declines and nuke is expected after 2020*
Integrated options for the 2020 EU RE target

Renewable share of final energy consumption
(Italy case)

Legend:

- Biofuels
- Cooling + heating from RE
- RE-E
- Efficiency gains

2005

RE-E

2020

5%

12%

17%
Country main effective policy options

- Liberalization of generation
  (everybody free to generate and buy power anywhere)

- Downsizing of the incumbents
  (lower power market)

- Implementation of a wide portfolio
  of regulatory and economic supporting schemes
  (facilitation of RE-E, CHP and energy efficiency)

- Establishment of an independent body (GSE)
  focused on promotion of RE-E and energy efficiency
  (really oriented to supporting)
Reconciliation of externalities

Fuel-fired generation costs

Renewable generation costs

Contributions to cap., interest rates, premium to generation, TGCs, ...

Incentive

produced kWh cost

supplied kWh cost

supplied kWh cost

charged kWh cost

produced kWh cost

quotas, carbon tax, ...

<G.S.>
## Most of experimented supports

<table>
<thead>
<tr>
<th>Regulatory</th>
<th>In the building phase</th>
<th>In the operational phase</th>
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<tr>
<td></td>
<td>• Grid connection obblig.</td>
<td>• Dispatching priority</td>
</tr>
<tr>
<td></td>
<td>• Simplified authorization</td>
<td>• Supply disclosure</td>
</tr>
<tr>
<td></td>
<td>• ................</td>
<td>• ................</td>
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<tr>
<td>Economic</td>
<td>• Contribution to capital costs</td>
<td>• Feed-in tariffs</td>
</tr>
<tr>
<td>Administrative</td>
<td>• Contribution to interest rates</td>
<td>• Emission taxation</td>
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<tr>
<td></td>
<td>• ..................</td>
<td>• Fuel taxation/ RE-E tax exemption</td>
</tr>
<tr>
<td>Market oriented</td>
<td>• Bidding of capacity package eligible for incentivizing tariffs</td>
<td>• Net metering</td>
</tr>
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<td></td>
<td>• ..................</td>
<td>• ................</td>
</tr>
<tr>
<td></td>
<td>• Quotas &amp; TGCs</td>
<td>• Green pricing (GOs, RECs, labels,....)</td>
</tr>
</tbody>
</table>
Support to RE-E & CHP in place

- Feed in-tariffs for RE-E (and quasi RE-E) for plants listed eligible within 1 April 1999 (coexisting with TGCs)

- Quotas & TGCs for RE-E plants commissioned after 1 April 1999 (subjected to frequent upgrading)

- Fixed premium for PV-E green value in place from end 2005

- Global tariff (green value + brown value) for RE-E plants < than 1 MW (wind farms < than 200 kW; biomasses: only local) on producer choose from 2008

- Brown value for RE-E paid by GSE on producer choose @ power market prices from 2007

- Net-metering in place for RE-E and CHP up to 200 kW size devices from 2007
# Country supports to RE-E in place

<table>
<thead>
<tr>
<th>Managed by GSE</th>
<th>Energy purchasing tariffs</th>
<th>Market oriented mandatory schemes</th>
<th>Voluntary support to green generation</th>
<th>Other economic supports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CIP6, Global tariff for small generation</td>
<td>Feed-in tariffs</td>
<td>Support to generation</td>
<td>Support to construction</td>
</tr>
<tr>
<td></td>
<td>Micro-generation (Del AEEG n. 280/07)</td>
<td></td>
<td>Premium feed-in (Conto Energia PV)</td>
<td>Monetary contribution to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market oriented mandatory schemes</td>
<td>Guarantee of origin (GO)</td>
<td>Capital Costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Renewable Energy Certificate System (RECS)</td>
<td>Interest rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fiscal rebates (depreciation, …)</td>
</tr>
<tr>
<td>Managed by GSE</td>
<td>Favored grid connection, priority dispatching, purchasing services, net-metering (&lt; 200 kW)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The GSE – a joint-stock public company

Ministry of Economic Development in concert with Ministry of Environment

Ministry of Economy

Ownership 100%

Acquirente Unico (Single Buyer)

GSE

Energy Regulator

Instructions

ACQUIRENTE UNICO (Single Buyer)

GME (Italian Power Exchange)

RE- E and CHP plant identification supporting schemes and services

Environmental exchanges for certificates (TGC – TEE – ETS)
GSE business (2007)

<table>
<thead>
<tr>
<th>Power purchasing and selling</th>
<th>2007 data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power plants</strong></td>
<td><strong>Capacity (MW)</strong></td>
</tr>
<tr>
<td>Feed-in tariffs (CIP 6/92)</td>
<td>386</td>
</tr>
<tr>
<td>Voluntary supply from generators</td>
<td>3,005</td>
</tr>
<tr>
<td><strong>tot</strong></td>
<td><strong>3,391</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Direct Supporting schemes</th>
<th>2007 data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quotas &amp; TGC issuing</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,036</td>
</tr>
<tr>
<td><strong>PV sets under premium feed-in</strong></td>
<td>6,057</td>
</tr>
<tr>
<td><strong>tot</strong></td>
<td><strong>7,093</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recognizing and certificate issuing</th>
<th>2007 data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cogeneration (2006 data)</td>
<td></td>
</tr>
<tr>
<td>RE-E import ¹</td>
<td></td>
</tr>
<tr>
<td>Guarantee of Origin</td>
<td></td>
</tr>
<tr>
<td>RECS</td>
<td></td>
</tr>
<tr>
<td><strong>tot</strong></td>
<td><strong>517</strong></td>
</tr>
</tbody>
</table>

¹ for exemption from quota obliglation
Feed-in tariff (CIP 6/92) scheme

Renewable & Quasi-Renewable (CHP, ..) power

Power Market

Market price €/kWh

GSE

Global tariff €/kWh

⇒ $\Delta < 0$

Global tariff €/kWh

⇒ Levy on consumer bills

$\text{Purchaser}\rightarrow\text{Power Market}$

$\text{Market price €/kWh}\rightarrow\text{GSE}$

$\text{GSE}\rightarrow\text{Purchaser}$

$\text{Levy on consumer bills}\rightarrow\text{Purchaser}$

Green value of kWh

Brown value of kWh

$\text{Purchaser}$

$\text{GSE}$

$\text{Levy on consumer bills}$

$\text{G.S.}$
Feed-in data (2007)

- CIP/6
- Premium for 8 years + avoided capital costs + avoided fuel costs

<table>
<thead>
<tr>
<th>Source</th>
<th>MW</th>
<th>TWh</th>
<th>Average tariff (EUR/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable energy</td>
<td>1977</td>
<td>8.2</td>
<td>180</td>
</tr>
<tr>
<td>Quasi-renewable energy</td>
<td>4572</td>
<td>38.3</td>
<td>98</td>
</tr>
<tr>
<td>Total</td>
<td>6548</td>
<td>46.5</td>
<td>113</td>
</tr>
</tbody>
</table>

For memory: 2007 wholesale power exchange price averaged 80 EUR/MWh
Quotas & Green certificates

Non-renewable energy

Renewable energy

Power Market

- kWh price
- Purchase obligation 2 -> 6.8%

Green Certificates Market

- TGC Demand
- TGC Supply

- TGC price

Non-renewable energy
- import
- kWh
- €
- Purchase obligation 2 -> 6.8%

Renewable energy
- import
- kWh
- €

Green value of kWh
Brown value of kWh

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Premium feed-in for PV generation

PV Producer

GSE

Premium x kWhs

Green value

power

Market

Prices x kWhs
### Base tariffs for grid connection in the 2007-2010 (EUR/MWh)

<table>
<thead>
<tr>
<th>Grid connection year</th>
<th>Size</th>
<th>Built-in</th>
<th>No</th>
<th>Part.lly</th>
<th>Full</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-3 kW</td>
<td>Full</td>
<td>490</td>
<td>440</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>3-20 kW</td>
<td>No</td>
<td>380</td>
<td>420</td>
<td>460</td>
</tr>
<tr>
<td></td>
<td>&gt;20 kW</td>
<td>No</td>
<td>360</td>
<td>400</td>
<td>440</td>
</tr>
</tbody>
</table>

Constant tariffs for 20 years from grid connection

(e.g. 2008 PV device achieves 440 EUR/MWh per 20 years)

grid connection year

-2%/year

Plant connected

2007 2008 2009 2010

### Base premium tariffs for PV green value

<table>
<thead>
<tr>
<th>Grid connection year</th>
<th>Size</th>
<th>Built-in</th>
<th>No</th>
<th>Part.lly</th>
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Constant tariffs for 20 years from grid connection

(e.g. 2008 PV device achieves 440 EUR/MWh per 20 years)

grid connection year

-2%/year

Plant connected

2007 2008 2009 2010
New stimulus to small generation (2008)

2008 Budget law; Law 29/11/2007

Small RE-E plants

- Global tariff scheme

Large RE-E plants

- Quotas & TGC scheme reviewed

- Incentivation period 15 anni

- Incentives modulated by source

- Provisions for local biomasses

Global tariffs for green and brown value (omnicomprehensive)
(from 180-300 €/MWh)

TGCs cap value (€/MWh) = 180 - proxy of wholesale market price

Size of TGC to 1 MW

Yearly increase of quota percentage to 0.75 ppc
The global tariff

Law 24/12/2007 n.244 ; Law 29/11/2007 n.222

<table>
<thead>
<tr>
<th>Source</th>
<th>Global tariffs (€/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind genset up to 200 kW</td>
<td>300</td>
</tr>
<tr>
<td>Geothermal</td>
<td>200</td>
</tr>
<tr>
<td>Wave and tides</td>
<td>340</td>
</tr>
<tr>
<td>Other hydro</td>
<td>220</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>220</td>
</tr>
<tr>
<td>Local agricultural bioenergy (within 70 km)</td>
<td>300</td>
</tr>
<tr>
<td>Landfill biogas</td>
<td>180</td>
</tr>
</tbody>
</table>
# Quotas & TGCs changes

## TGCs granted by source

<table>
<thead>
<tr>
<th>Source</th>
<th>Source multipliers for granted TGCs (Basis: 1 TGC per MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind sets larger than 200 kW</td>
<td>1,00</td>
</tr>
<tr>
<td>Off-shore wind</td>
<td>1,10</td>
</tr>
<tr>
<td>Geothermal</td>
<td>0,90</td>
</tr>
<tr>
<td>Waves and tides</td>
<td>1,80</td>
</tr>
<tr>
<td>Hydro</td>
<td>1,00</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>1,10</td>
</tr>
<tr>
<td>Local agricultural bioenergy (within 70 km)</td>
<td>1,80</td>
</tr>
<tr>
<td>Landfill gas</td>
<td>0,80</td>
</tr>
</tbody>
</table>
Guarantee of origin concept

Guarantee of origin (GoO) → Certificate of origin

Feed in tariffs (Electricity + Green Value)
Supply disclosure

No Tradable
 Tradable

Premium Feed-in tariffs
(Only Green Value at fixed price)
Market Value
(Tradable Exchange)

Power exchange
Green pricing via GOs, RECS

Non-renewable energy

import

Electricity Market

kWh price

Renewable energy

Home

Abroad

Renewable energy

GOs, RECS Demand

Green Consumers
Large Industry (advertising)
Thermal Producers (to a better sale)
Traders, brokers

GOs, RECS Price

Gos, RECS price

GOs, RECS Supply

<GS>
- No monetary incentives, other than High efficiency sets listed for White Certificates

- Priority of access

- Net metering for CHP plants less than 200 kW
High efficiency CHP facilitation

Facilitation for each size:
- T-D fee rebates
- purchase of reserve or supplemental power

Small CHP
- No useful-heat metering required up to 1 MWel size
- Net-metering
- Reduced requirements for grid connection

Micro-CHP
- 50 kWel

Eligible for white certificates
Energy efficiency incentives

- White certificates *(reserved to suppliers and ESCOs)*
  - Power and gas distributors obliged to get efficiency targets
  - Obligation is fulfilled by tradable white certificates
  - Three types of certificates:
    - Electricity savings by power distributors and ESCOs \(36 \, \text{€/toe}\)
    - Gas savings by gas distributors and ESCOs \(84 \, \text{€/toe}\)
    - Primary energy savings by utilities and ESCOs \(5 \, \text{€/toe}\)

- Income tax rebates *(reserved to individuals and firms)*
  55% of installed costs returned via income tax rebates
  *(Applicable to solar heating, condensing boilers, heat pumps, building insulation, ……)*
The GSE power plants actual injected output show large unexpected variations versus the scheduled power bid on the day-ahead market, because of their characteristics.

Under the Italian Regulation, the imbalances costs from the quasi-renewable plants (CHP and heat recovery) are passed through the owners, while imbalances costs from the random generation plants (wind farms, solar devices and run of river gensets) are socialized.

The Regulator has charged GSE to keep those imbalances as low as possible, given the expected increasing penetration.
GSE as Virtual producer

GSE aggregates and sells on the market the power achieved from:

- Purchases under the CIP-6 feed-in tariff scheme
- Purchases from RE-E and CHP generators from small and micro devices under the global tariff scheme
- RE-E and CHP generators asking for selling and bidding services

In this role GSE is Responsible of Balance versus the Independent System Operator for each grid connected plant larger than 10 MVA and for the aggregated generation from the generator sets lower than 10 MVA
As virtual producer, GSE puts on the energy market yearly about 60 TWh (Italy: 300 TWh), of which 20 TWh from RE sources (Italy: 50 TWh).

The wind power short-term forecasting (PrevedoVento) implementation started in 2007. The forecasting activity for energy bidding from January 2008. At the moment, 1300 MW (40 plants) are scheduled by the GSE forecast models. Unbalances costs for 40 million Eur avoided from Jan to Jun 2008.

The short term wind power forecasting is part of a large project, aiming at forecasting the random (not programmable) RE-E (wind, solar and run of rivers). The PV solar module (PrevedoSole) is under test, in use in September.

The run of river module (PrevedoAcqua) is expected ready for use at the end of 2008.
The PrevedoVento architecture

Model Characteristics:
- Ground description (complex terrains study of the wind farm)
- Neural Network Model
- Physical Model
- WRF Meteo Model
- Historical data of the wind and production
- Plant description (turbines)
- In house development of the algorithms
The PrevedoSole architecture

Model Characteristics:
- Plant description
- Neural Network Model
- Sun radiation forecast by province
- Historical data of the sun radiation and production
- Correlation coefficients for single sun field
- Aggregated output by province and market zone
- In house development of the algorithms
PrevedoVento: a week sample

A 20 MW wind park output (14/04/2008 - 18/04/2008)

- scheduled power injection
- metered
PrevedoSole: a 24 hour prediction sample

1 MW PV device output forecast

Output forecast by market zone

light blue: forecast
yellow: metered