Note de l'Ifri

An Overview of Italy's Energy Mix

Corrado Cammi

Mattia Assanelli

June 2012

ifri

Gouvernance européenne
et géopolitique de l'énergie

The Institut français des relations internationales (Ifri) is a research center and a forum for debate on major international political and economic issues.

Headed by Thierry de Montbrial since its founding in 1979, Ifri is a non-governmental and a non-profit organization.

As an independent think tank, Ifri sets its own research agenda, publishing its findings regularly for a global audience.

Using an interdisciplinary approach, Ifri brings together political and economic decision-makers, researchers and internationally renowned experts to animate its debate and research activities.

With offices in Paris and Brussels, Ifri stands out as one of the rare French think tanks to have positioned itself at the very heart of European debate.

The opinions expressed in this text
are the responsibility of the author alone.

ISBN: 978-2-36567-034-0

IFRI
27, RUE DE LA PROCESSION
75740 PARIS CEDEX 15 – FRANCE
Tel: +33 (0)1 40 61 60 00
Fax: +33 (0)1 40 61 60 60
Email: accueil@ifri.org

IFRI-BRUXELLES
RUE MARIE-THERESE, 21
1000 – BRUSSELS – BELGIUM
Tel: +32 (0)2 238 51 10
Fax: +32 (0)2 238 51 15
Email: info.bruxelles@ifri.org

WEBSITE: *Ifri.org*

Foreword

Italy is currently hit by an unprecedented economic, political and social crisis. This changing and uncertain environment affects more than ever the ability to define an energy strategy, which has never really benefitted from a clear vision and a solid organization. Since the 1987 referendum, which acknowledged the end of the nuclear program, the Italian energy policy has been elaborated through a juxtaposition of decrees and rules. Several laws have been approved either to comply with the European regulation or to correct former policies. These have contributed to the creation of a highly intricate regulation puzzle, only accessible to the most voluntary ones or the better equipped. The "success" of renewables subsidies has compromised the profitability of thermal power stations and increased the energy bills of retail consumers.

The Government chaired by Mario Monti tried to sketch, before the Parliament, the fundamentals of the future Italian energy strategy. This national policy would be founded on four pillars: energy efficiency, the creation of a Southern European gas hub, the development of renewables and the revival of the domestic hydrocarbon production. However, this strategy will be able to create the framework only if certain conditions are satisfied. Indeed, it is possible to identify three key features of the difficulties that the Italian energy policy faces today.

The first one is the administrative sluggishness. Since the constitutional reform of 2001, different levels of the Italian bureaucracy share energy-related decisional and law-making competences. The reform allowed for the sharing of the competences between the Parliament and the 22 regions. Therefore, companies in the energy sector suffer the consequences of a decentralized management that is generally endowed with a small budget. British Gas recently decided to abandon the LNG terminal project located in Brindisi (Puglia), extending the list of valuable projects that were discouraged by the long permit granting process. As a matter of fact, after waiting eleven years, the British company abandoned a project that could have helped Italy diversifying its LNG supplies, a milestone for the creation of a gas hub.

The second factor is the patchwork of successive laws aiming at promoting renewable energies. Besides the superimposition of several instruments, the lack of clear definitions provoked striking contradictory effects. This was the case of the so-called "renewable" thermal stations that produced "green" energy from refinery liquid waste. Or, more recently, the incentives to the development of the wind and solar sectors have inflated the energy bills, with an overall expenditure of almost 6 billion euros. This has caused a drop in the output of CCGT's who now ask for a capacity payment mechanism in order to remain profitable. Finally, transmission and distribution systems will have to be largely improved to avoid bottlenecks and to facilitate power flows. National connections reinforcement especially between the North and the South would allow for a better use of the installed capacity and could eventually spur future exports to Mediterranean southern neighbors (interconnections projects with the Southern European neighbors, like Tunisia, are currently under study).

Thirdly, it is the lack of a global energy strategy and the absence of Italy from the European energy scene that is visible through these dysfunctions.

The last decade, the reinforcement of the energy mix has been based on nuclear power as the main base load production. Italy imports on average 13% of its electricity (data by Terna, 2010), particularly during the night (25%). Among these imports, France represents the main partner, as three fourth o nf the imports come from its (nuclear) electricity. June 2011 referendum rejected this strategy, even though it can be interpreted as a wider refusal of the overall political regime.

What's more, a nation-wide debate on energy issues has never been organized. Energy and climate policies definition has been delegated either to tribunals, to enforce the laws, or to administrative bodies.

The Italian energy team has not found its coach yet and needs more than ever a clear and ambitious roadmap in order to justify the economic efforts endured by citizens. The ambiguity coming from old choices (such as the policies favoring the use of natural gas in electric power generation) and current renewable policies enhances the sector instability and prevents the creation of an investment-friendly environment. Italy's challenge is to provide itself with the means to allow for coherence between its objectives and the undertaken actions.

These aspects will emerge in the detailed overview of the Italian energy sector that follows.

L. Parmigiani

Contents

Introduction

In Italy, the issue of energy supply is always of great interest because this country depends on foreign imports for 83% of its primary energy needs. This is due to the limited availability of domestic mineral resources, combined with a strong dependence of the electricity production on fossil fuels. The present situation should be viewed in the light of the decision to freeze the nuclear program following the referendum of 1987. Italy's energy strategy subsequently turned back to the thermoelectric sector, which was updated, during the latter part of the 1990s, with several modern and efficient plants, mainly based on a combined cycle structure and fed by natural gas. In addition, the Italian government has started to fund renewables, in compliance with the European regulations, and these forms of energy have experienced a significant increase, especially in recent years.

The current energy-mix makes the Italian economy more exposed to the global geopolitical instabilities of the oil- and gas-producing countries, compared to northern European countries. Moreover, with the shift of economic activities towards the service sector, the demand of electric energy is increasing and its costs, weighted also by renewable incentives, are becoming more and more significant for Italian users and the economy in general. These issues, coupled with the constraints set by the European 20-20-20 plan, in particular in terms of polluting gas emissions and energy savings, led the Berlusconi government (2008-2011) to resort to a new nuclear program. This relied on the construction of 4 EPR power plants (at least) in order to cover 25% of Italy's entire electricity needs. But the program was stopped by another referendum in June 2011, whose result was strongly influenced by the Fukushima tragedy. However, a new national energy strategy has not yet been defined.

This paper analyses the present energy mix, with particular attention to the electricity production system, in order to identify the effects of previous strategies and to understand what kind of choices Italy should make to meet the 20-20-20 requirements and to integrate efficiently its energy market into Europe's.

Since data for 2010 were the most recent, definitive figures available when the paper has been written, almost all the analysis here refers to this year. All reported trends also ended in 2010.

Section 1 provides a snapshot of Italy's energy balance, based on 2010 data, and includes an analysis of the historical trends of primary energy and electricity consumptions, considering also the economic situation. To this end, trends in the main energy indicators are reported, including: primary energy/GDP, electricity/GDP and CO_2/GDP.

Section 2 describes the primary energy mix, highlighting Italy's strong dependence on oil and natural gas, comparing it with those of the main European countries. A description of the electricity production system is also given; more specifically, the thermoelectric and hydroelectric plant fleets are analyzed in detail, along with the development of renewable sources. Renewable power capacity has constantly increased during last years, but the corresponding regulation has not always been clear, often changing year by year, causing a tumultuous growth in this sector, which has not been supported by a fundamental enhancement of the transmission network. For these reasons, some information about the evolution of the Italian tariff system is also given. Finally, the electricity imports from nearby European countries, covering 13% of the gross demand, are reported.[1]

Sections 3 and 4 deal with the electricity and natural gas markets respectively. First of all, the current structure of the final markets, after their liberalization, and the contributions of the main operators are analyzed. Then final prices are compared with those of other European countries. Particular attention has been given to the development of the gas transmission network. This may be considered fundamental, given the strong dependence of Italy on this energy source.

Section 5 concerns with Europe's 20-20-20 plan requirements. The policy choices in the field of carbon emissions, energy savings and renewables are presented along with the results obtained.

Section 6 is about the future prospects of the Italian energy system.

[1] TERNA, Statistical Data on electricity in Italy: general data 2010, http://www.terna.it/LinkClick.aspx?fileticket=9mXvJCVFoN4%3d&tabid=670&mid=13878

Italian Energy Demand and Economic Background

Figure 1[2] and Figure 2[3] show Italian energy demand in terms of primary energy and of electricity, from the 1980s to 2010[4]. The increase in primary energy demand was basically uninterrupted till 2005, when it reached its peak. From 2005 to 2008 the primary energy needs experienced a slight decrease due, in particular, to the flattening of the needs of the industrial sector (see Figure 3). This decrease accelerated when the crisis of 2009 hit all the economic sectors. Electricity demand flattened with a little delay in 2006 and experienced the same collapse in 2009. It is worth noting that comparing the energy needs of 2010 with those of 1980, the overall increase is more dramatic for electricity than for primary energy (81% and 26% respectively). This is mainly due to the movement of the economic activities from the industrial sector towards the service sector.

Figure 3[5] shows the energy requirements of the three most energy-intensive sectors: industry, transportation and houses+services. The energy needs of these three sectors contribute almost equally to the overall energy requirements. It has to be noted that the energy needs of industrial sector started to decrease in a pre-crisis period (2005) and that the houses+services sector did not experience the effects of the crisis.

---

[2] ISTAT, Italian Historical Statistical Repository: gross inland energy consumption, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.13.xls

[3] ISTAT, Italian Historical Statistical Repository: gross electricity production and final electricity consumption in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.14.xls

[4] Throughout the paper energy is always expressed in TWh, according to the context, when talking about primary energy it is implied that it expresses thermal energy, while when talking about electricity it is implied that it expresses electric energy.

[5] ISTAT, Italian Historical Statistical Repository: Simplified Energy Balance in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.12.xls

Figure 1 – Primary energy demand (authors' calculations based on ISTAT data)

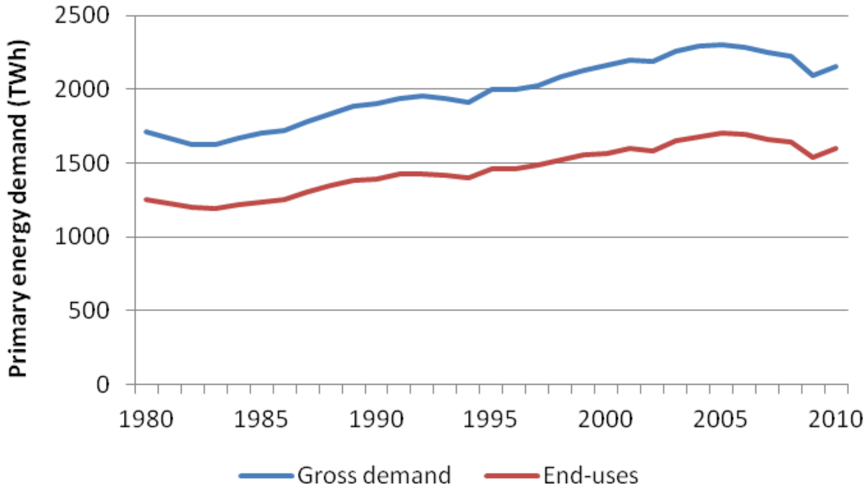


Figure 2 – Electric power demand (authors' calculations based on ISTAT data)

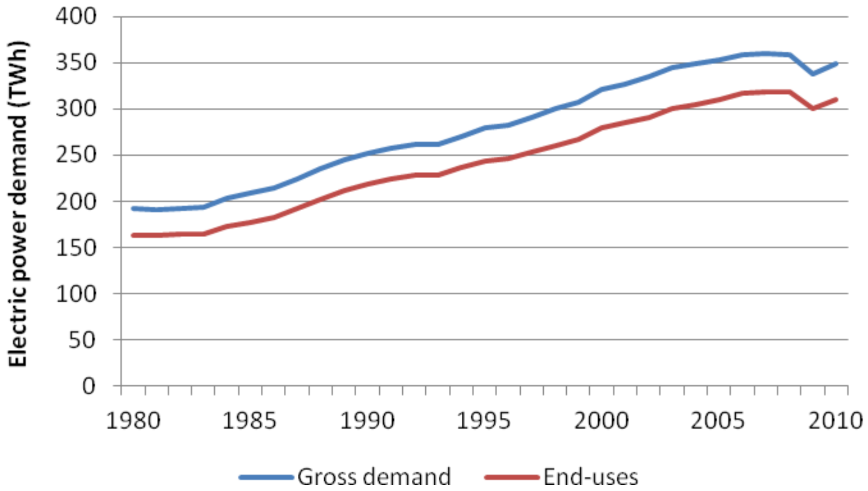
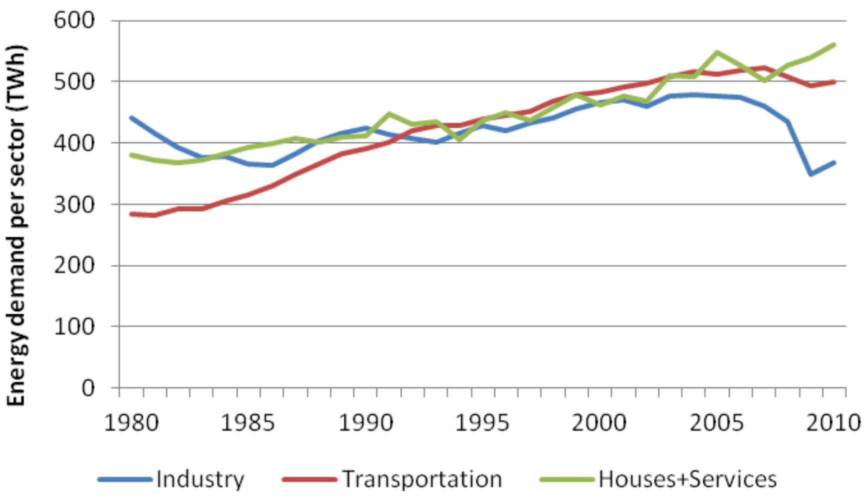


Figure 3 – Primary Energy demand per sector (authors' calculations based on ISTAT data)



The Energy Balance in 2010

From all these graphs it is evident that the economic pick-up of 2010 led to an upturn in the energy sector after the strong recession of 2009 that caused consumption to contract. Table 1 shows how this resumption affected all the energy sources and the activity sectors to different degrees.

Looking at the first row, it can be seen that the total internal primary energy production increased by 11.8% compared to 2009 thanks, in particular, to renewables (+26,4 TWh) and to a lesser extent to fossil fuel production.[6] The foreign supply of primary energy (row 2), and in particular natural gas (+58.1 TWh), increased, followed by the imports of oil (+31.5 TWh) and coal (+21.8 TWh), while electricity imports decreased (-2.7 TWh). Exports increased by 35.2 TWh due notably to refinery products. For all the sources, stock-injection outweighed withdrawals. In conclusion, as reported in row 5, the gross availability increased by 86.5 TWh, achieving the considerable value of 2183.9 TWh, significantly lower than the 2005 historical maximum of 2300 TWh.

[6] Ministry of the Economic Development, Tabella Dati Energetici 2010, http://dgerm.sviluppoeconomico.gov.it/dgerm/downloads/tabella_dati_rge_2010.xls

Table 1 – Italian energy balance (net of pumped storage) for years 2009 2010 (authors' calculations based on Ministry of Economic Development data)

(TWh)	COAL	NATURAL GAS	OIL	RENEW-ABLES[(a)]	ELECTRIC POWER[(a)]	TOTAL
Year 2009						
1) Internal Production	**3.6**	**76.3**	**52.9**	**219.6**	**0.0**	**352.5**
2) Imports	**148.0**	**659.6**	**1096.6**	**15.7**	**120.4**	**2040.4**
3) Exports	**2.8**	**1.2**	**304.6**	**1.0**	**5.4**	**315.0**
4) Stocks variations	**-3.4**	**-8.4**	**-7.5**	**-0.2**	**0.0**	**-19.4**
5) Gross availability (1+2-3-4)	**152.2**	**743.2**	**852.4**	**234.5**	**115.0**	**2097.4**
6) Losses	**2.2**	**12.7**	**68.7**	**1.1**	**469.2[(b)]**	**554.0**
7) Electricity conversion	**118.6**	**276.4**	**59.0**	**190.3**	**-644.3**	**0.0**
8) End uses (5-6-7)	**31.4**	**454.0**	**724.7**	**43.1**	**290.1**	**1543.4**
- Industry	30.2	137.8	61.5	4.6	114.3	348.4
- Transportation	0.0	7.0	464.4	12.3	10.5	494.3
- Houses + services[(c)]	0.0	301.0	55.5	23.3	159.5	539.3
- Agriculture	0.0	1.7	28.0	2.9	5.7	38.2
- Non-energy uses	1.2	6.6	76.2	0.0	0.0	84.0
- Storage	0.0	0.0	39.2	0.0	0.0	39.2
Year 2010						
1) Internal Production	**9.1**	**80.1**	**59.1**	**246.0**	**0.0**	**394.2**
2) Imports	**169.8**	**717.7**	**1128.1**	**21.3**	**117.7**	**2154.6**
3) Exports	**2.9**	**1.3**	**340.1**	**1.2**	**4.7**	**350.2**
4) Stocks variations	**2.2**	**5.0**	**7.2**	**0.3**	**0.0**	**14.7**
5) Gross availability (1+2-3-4)	**173.8**	**791.5**	**839.9**	**265.8**	**113.0**	**2183.9**
6) Losses	**3.5**	**16.8**	**71.0**	**0.1**	**480.8[(b)]**	**572.2**

(TWh)	COAL	NATURAL GAS	OIL	RENEW-ABLES[(a)]	ELECTRIC POWER[(a)]	TOTAL
7) Electricity conversion	**124.2**	**286.3**	**46.9**	**209.8**	**-667.2**	**0.0**
8) End uses (5-6-7)	**46.2**	**488.4**	**722.0**	**55.9**	**299.4**	**1611.7**
- Industry	44.9	149.1	55.7	2.5	121.7	373.9
- Transportation	0.0	8.1	459.4	15.2	10.7	493.3
- Houses + Services[(c)]	0.0	323.0	50.4	36.5	161.4	571.4
- Agriculture	0.0	1.7	26.4	1.6	5.6	35.3
- Non-energy uses	1.2	6.6	89.8	0.0	0.0	97.5
- Storage	0.0	0.0	40.3	0.0	0.0	40.3

(a) – Renewables and import-export electricity are evaluated as an equivalent primary energy input of 2.56 kWh_t/kWh_{el}
(b) – Electricity end-uses are reported in kWh_{el}; the losses entry includes the conversion losses from kWh_t to kWh_{el} (primary energy to electricity).
(c) – Includes consumptions from the domestic users. services and public administration

The electric power needs of economic recovery were satisfied by an important increase in renewables and natural gas for electricity production (+19.5 and +9.9 TWh respectively) and a smaller increase in coal (+5.6 TWh). While for the purpose of electric power conversion the input of oil reduced by 12.1 TWh. Among renewables, photovoltaic, wind-energy and biomass experienced the strongest growth (+181.7%, +39.5% and +24.9%).[7]

With regard to end-uses, natural gas showed the largest absolute increase (+34.4 TWh), mainly due to the cold winter. In relative terms the strongest growth came from coal, in particular in the industrial sector (+48.6%). The reduction of oil-needs, almost everywhere except in non-energy uses, is also remarkable.

Table 1 also shows an increase in energy needs of the industrial sector (+7.3%) and in houses+services sector (+5.9%). The first term is due to a partial resumption after the economic crisis of 2009 and the second one is mainly due to the cold winter. The transport sector saw a transfer of the needs from oil to natural gas and biofuels (renewables column), resulting in a stable overall consumption.

[7] GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

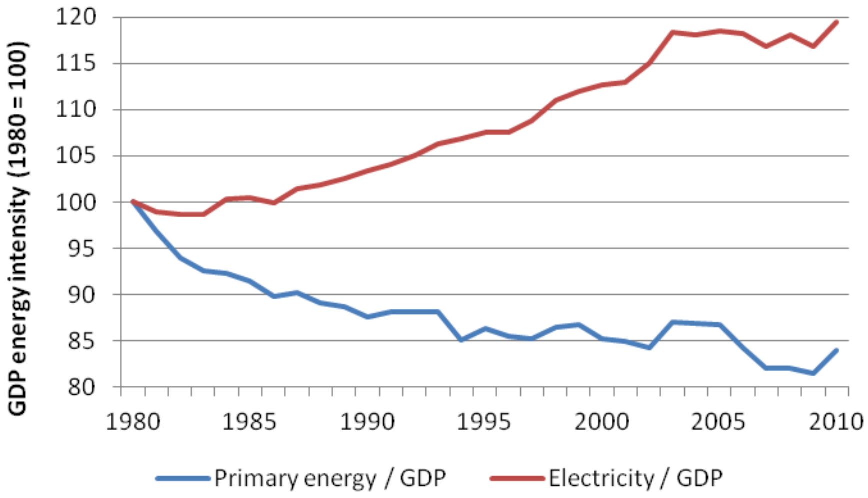
Trends in the main energy indicators

The trends in the main energy indicators for the last few years, summarized in Table 2, appear encouraging for the future security of Italian energy supply. After peaking in 2005, primary energy needs seem to have stabilized before the beginning of the economic crisis of 2008-2009 (see also Figure 1). Despite the substantial fall in the domestic production of fossil fuels, the production of primary energy is constantly increasing due to the escalation of renewable sources, while the overall imports of fossil fuels have been decreasing since 2006. The primary input for electricity generation has not grown significantly. With regard to the period of 2004-2010, the end-use energy demand, after processing and distribution, apparently started to stabilize or decrease, except for the civil sector (houses+services), whose consumption is however influenced by winter and summer climatic conditions.

Table 2 – Main Energy indicators from 2004 to 2010 (authors' calculations from ISTAT data).

	2004	2005	2006	2007	2008	2009	2010
Primary energy needs	2289.1	2300.1	2281.7	2252.6	2224.9	2097.4	2154.9
Primary energy production	360.8	342.3	334.2	324.7	345.2	352.5	385.2
Fossil fuels	203.8	194.6	178.3	166.5	155.6	132.7	142.1
Renewables	157.0	147.7	155.8	158.2	189.6	219.8	243.1
Fossil fuel imports	2232.4	2295.6	2311.2	2287.9	2230.9	2040.4	2141.0
Coal	198.9	198.2	199.5	200.2	194.7	152.0	169.8
Natural gas	773.4	827.7	810.6	808.6	808.5	743.2	717.8
Oil	1023.0	991.4	991.0	959.0	921.6	852.4	1126.9
End-uses	1674.7	1704.9	1694.0	1662.1	1641.3	1543.4	1599.2
Industry	479.5	477.5	475.7	460.2	435.1	348.4	367.6
Transportation	516.4	511.3	518.0	522.3	508.0	494.3	498.8
Houses + Services	508.9	547.3	526.8	502.2	526.3	539.3	561.3
Other	169.9	168.7	173.5	177.4	171.8	161.4	171.5
Primary input to electricity	689.7	676.9	692.0	688.5	694.3	644.3	658.3
Energy/GDP							
Primary energy	87	87	84	82	82	81	84
Electricity	118	119	118	117	118	117	119

Figure 4 – GDP energy intensity and GDP electric intensity (authors' calculations based on ISTAT data)



Primary Energy/GDP and electricity/GDP

The analysis of the indicators reported above (fossil fuel production and imports, end-uses, etc.) does not take into account the rate of operation of the economic sectors. For this reason it is more interesting to normalize the energy needs by GDP. Figure 4 reports the GDP energy intensity trends from 1980 to 2010 related to 1980.[8] The primary energy intensity has been decreasing almost constantly since 1980. This is mainly due to the increased efficiency in energy-intensive sectors (e.g. industry) and to the shift of economic activity to the service sector. The Italian economic system is thus becoming more and more efficient in converting primary energy into GDP. In contrast, the electric energy intensity increased constantly from 1980 onwards, but seems to have leveled-off since 2005. This trend expresses an increasing dependence of the economy on electric power because of the shift towards the service sector and of the progressive electrification and automation of the industrial sector.

The reduction of the dependence on imports, the increase in renewables, the reduction of the primary energy intensity of GDP in the last few years are all definitely positive results. But they have been achieved in presence of a rather low GDP growth rate

[8] ISTAT, Italian Historical Statistical Repository: Reconciliation of Gross Domestic Product (GDP) and Gross National Income (GNI), http://timeseries.istat.it/fileadmin/allegati/Conti_economici_nazionali/Tavole_in_inglese/Table_12.8.xls

compared to other European countries. If Italy had an economic growth more similar to the other European countries it would have been more interesting to evaluate the trend of the main energy indicators. Indeed, a higher growth of GDP also implies a higher replacement-rate of capital equipment and technological innovation which in turn should stimulate a further reduction of the energy intensity of GDP and, maybe, a further shift of the needs towards electricity.

CO_2 indicators

Another important feature characterizing an energy mix is the emission of carbon dioxide which represents the environmental sustainability of the energy supply system. This issue has gained further importance after the commitments deriving from the Kyoto protocol (1997), which has been acknowledged into the 20-20-20 European plan (March 2007).

With respect to the carbon intensity (CO_2/Primary energy) reported in Figure 5, it is possible to note a decreasing trend starting from the 1980s, and which experiences an abrupt acceleration from 2008 onwards.[9]

The first part of the decrease (1980-2008) is mainly due to the increasing incidence achieved by natural gas in the Italian energy mix and to the corresponding decrease of oil consumption, as shown in figure 6. In fact, the additional energy demand, compared to 1980, has been almost completely satisfied by natural gas, whose emission per energy unit is about 30% lower than oil. Concerning the recent part of the trend, the sharp decrease relates to the expansion of the renewables sector, whose contribution almost doubled in the period 2008-2010, thanks to the incentives created by the Italian government.

Finally, Figure 7 shows the carbon intensity of GDP (CO_2/GDP), which can be calculated as the product between the trend in Figure 5 and the primary energy intensity displayed in Figure 4. Since both trends show a fall to about 85% (2010) compared to the reference value in 1980, the resulting curve for the CO_2/GDP index is characterized by a more pronounced decrease starting from 2005. This brought the final value to less than 75% in 2010.

[9] ISTAT, Italian Historical Statistical Repository: Pollutant emission in atmosphere in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.20.xls

Figure 5 – CO_2 / primary energy, 1980 = 100 (authors' calculations from ISTAT data)

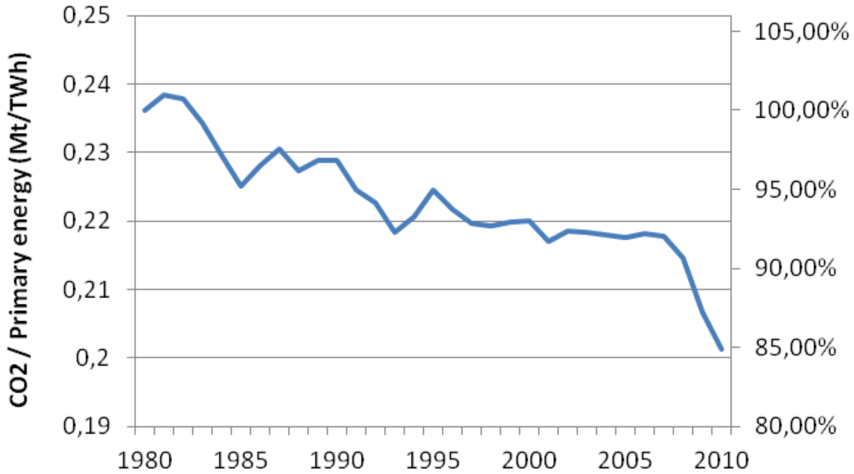


Figure 6 – Primary energy gross consumption per source (authors' calculations from ISTAT data)

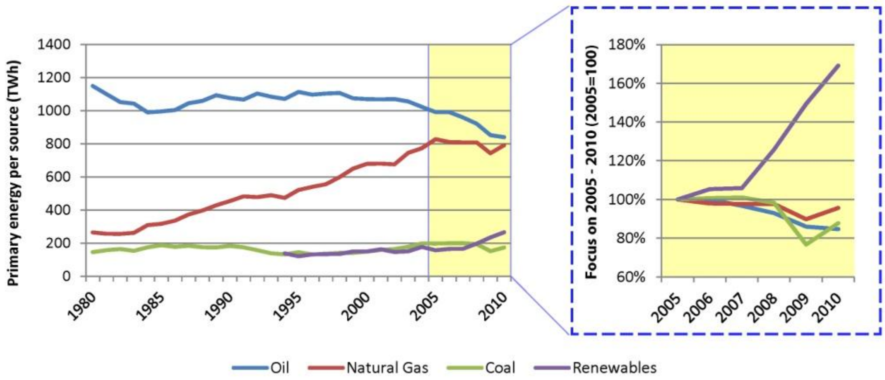
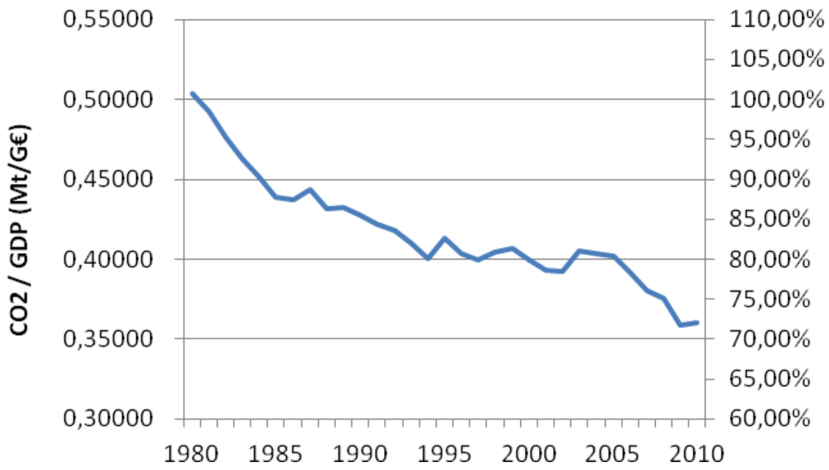


Figure 7 – CO_2 emissions / GDP, 1980 = 100 (authors' calculations from ISTAT data)



Italy’s Energy Mix

The strong dependence on fossil fuels in the primary energy mix

In 2010, Italian gross demand of primary energy amounted to 2183.9 TWh (187.79 Mtep, see Table 1). 82.7% of the requirement was satisfied by fossil fuels: more specifically, oil covered 38.5% of the total, natural gas 36.2% and coal 8%. The energy mix was completed by renewable sources (265.8 TWh, 12.2%), constituted mainly by hydroelectric power (67.6%), and by the net import of electricity (113 TWh, 5.1%).

In Italy, natural gas is widely employed in electricity production, the conversion concerns roughly a third (36%) of the primary input, causing a greater dependence from this kind of source compared to other European countries (see Figure 8). Almost all the remaining consumption occurs in the industrial sector (18.8%) and for heating of homes and commercial/service buildings (40.8%). Regarding oil, only 5.5% is converted into electric power, while 54.7% is employed by the transportation sector. Coal is mainly used to produce electricity (71.5%) and the residual part is given to the industries.

It is worth noting that 82% of the Italian primary energy supply comes from imports, resulting in a strong dependence on foreign fossil fuels. The domestic production of fossil fuels amounts to a total of 142 TWh; 56% of the domestic production consists of gas (80.1 TWh, 10.1% of the entire gross availability of natural gas) and 42% of oil (59.1 TWh, 7% of the total amount); including the increasing contribution of renewable sources (246 TWh), the total internal production constitutes 18% of the whole energy mix.

Figure 8 – Primary energy mix of different European countries in 2010 (authors' calculations from ENERDATA data)
***electricity = net imports + nuclear electricity + hydroelectricity**

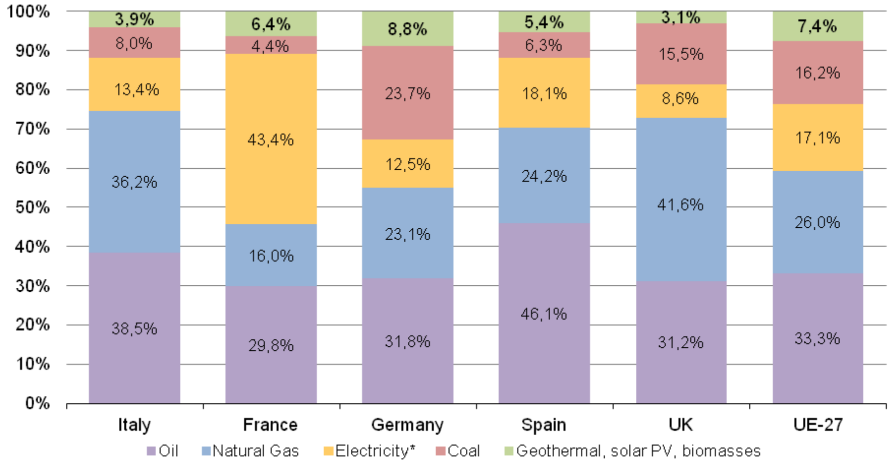


Figure 8 shows the comparative energy mixes of different European countries.[10] For instance, a considerable part of French energy supply is covered by nuclear power production, which also assures this country a weak dependence on foreign imports (about 52%). Germany also has a lower foreign dependence (61%) compared to Italy, thanks to the considerable domestic availability of coal, which covers 23.7% of its gross primary energy demand, as well as a non-negligible amount of nuclear production and a significant contribution from renewables (8%). The UK energy mix is mainly constituted by fossil fuels (88.3%), but this country shows the lowest foreign dependence (only 21.5%), thanks to large domestic sources.[11]

Electricity production: a comparison with Europe

In 2010 about 36% of the primary energy supply was converted into electricity and, as mentioned before, this share is expected to increase, along with the importance of automation and information technology in industry and in the service sector.[12] 12.9% of electricity needs are imported from neighboring countries.

---

[10] Autorità per l'energia elettrica e il gas (AEEG), Energia primaria per fonte 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/int02.xls

[11] Autorità per l'energia elettrica e il gas (AEEG), Grado della dipendenza energetica dall'estero 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/int03.xls

[12] TERNA, Statistical Data on electricity in Italy: general data 2010, http://www.terna.it/LinkClick.aspx?fileticket=9mXvJCVFoN4%3d&tabid=670&mid=13878

Figure 9 shows the weight of various primary energy sources for the internal production of electricity. It may be noted that the main source of electric power is the thermoelectric generation from fossil fuels. This source covers 221.8 TWh, corresponding to 64.7% of overall production. With 14.9%, hydroelectricity is the second source of power generation. A figure of 51.1 TWh can be computed subtracting the contribution due to pumped storage: that is energy storage carried out by pumping water to reservoirs with higher elevation. Even if from this kind of source we do not expect any increase, though it has revealed a slight positive trend of few percentage points in the last years.

The energy sources which, with their increase in recent years, are responding more effectively to the growing demand of electricity are photovoltaics, wind energy and biomasses ("Other Ren." In Figure 9), which reached 6% in 2010. Finally, an all-Italian peculiarity is the production of electricity by geothermal power: the ENEL power stations of Tuscany produce 5.1 TWh corresponding to about 1.6% of the country's needs. For more details about geo-thermoelectricity see Section 2.3.7.

Figure 10 displays a comparison between the electric energy production in various European countries. These data, taken from the Enerdata database,[13] represent gross production, before subtracting losses and pumped-storage, but do not include imports. Once again, the strong dependence of Italy on traditional thermoelectric generation (i.e. on fossil fuels) is highlighted. In contrast, French dependence on fossil fuels (11.4%) is significantly lower thanks to its large nuclear production (74.8%). It is important to stress that France and Italy are the extreme cases of the use of nuclear power in Europe: in other countries such as Germany, Spain and the UK, this energy source accounts for about 20% of final production.

[13] Autorità per l'energia elettrica e il gas (AEEG), Produzione dell'energia elettrica per fonte 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/ele/int04.xls

Figure 9 – Electricity net production per energy source and imports, in 2010 (authors' calculations from Ministry of Economic Development data)

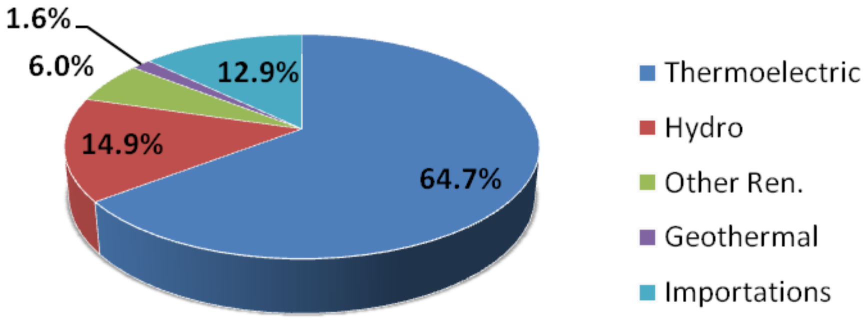
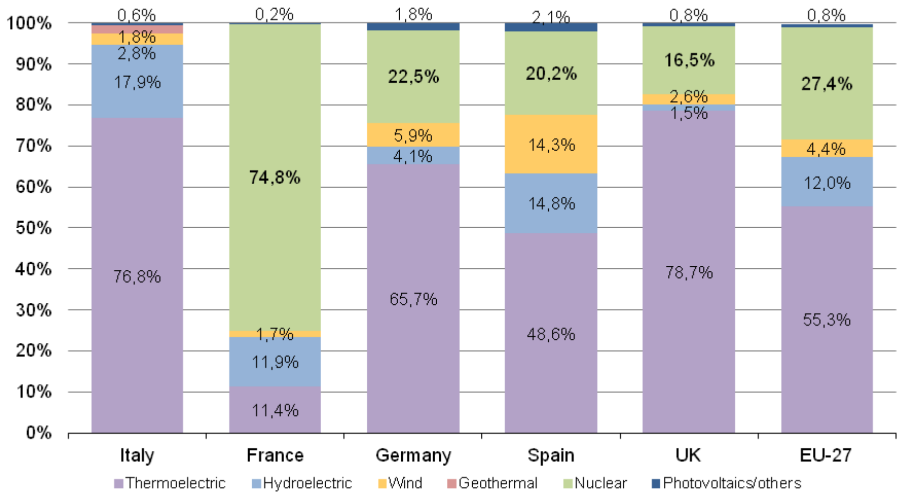


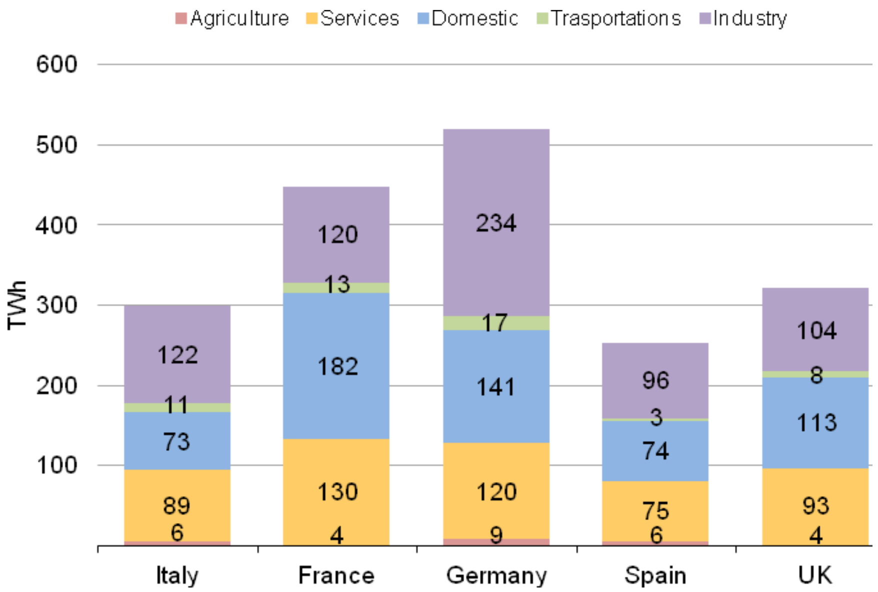
Figure 10 – Electricity production per source of different European countries in 2010 (authors' calculations from ENERDATA data): biomasses are supposed to be included in the thermoelectric percentage



The main advantages of nuclear power lie in its low cost and low carbon emissions, allowing the reduction of electricity dependence on fossil fuels which are conversely more expensive and polluting. A large amount of nuclear production does not only influence electric supply but could also have a strong impact on the primary energy mix. For example, the availability of low-cost electricity could lead users to exploit it also for the heating of buildings, instead of natural gas. From this point of view heat pumps are the best technology and thanks to their high efficiency they are also of great interest for the 20-20-20 targets.

France is a clear example of this situation. Compared to Italy this country has almost the same population but a colder climate. As shown in Figure 11[14] and Figure 12[15], comparing the domestic consumption of Italy and France, it is possible to note that French gas consumption is slightly lower while that of electricity is considerably larger. This indicates a larger use of heat pumps for household heating.[16]

Figure 11 – Electricity consumption in 2010 per sector in different European countries (authors' calculations based on ENERDATA data)



The wide availability of cheap, low carbon emission electric power in a country like France is expected to be essential also for the development the mobility of electricity. In this way also the oil contribution to primary energy could be reduced.

These considerations indicate that the French energy mix seems more ready for the 20-20-20 challenges. On the other hand, nuclear power has also some drawbacks, such as radioactive waste, decommissioning costs, health security and poor modulation of power output. All these aspects have to be taken into account to judge Italy's cuts in its nuclear program. It is also necessary to remember that

---

14 Autorità per l'energia elettrica e il gas (AEEG), Consumi finali di energia elettrica 2010(elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/ele/int06.xls

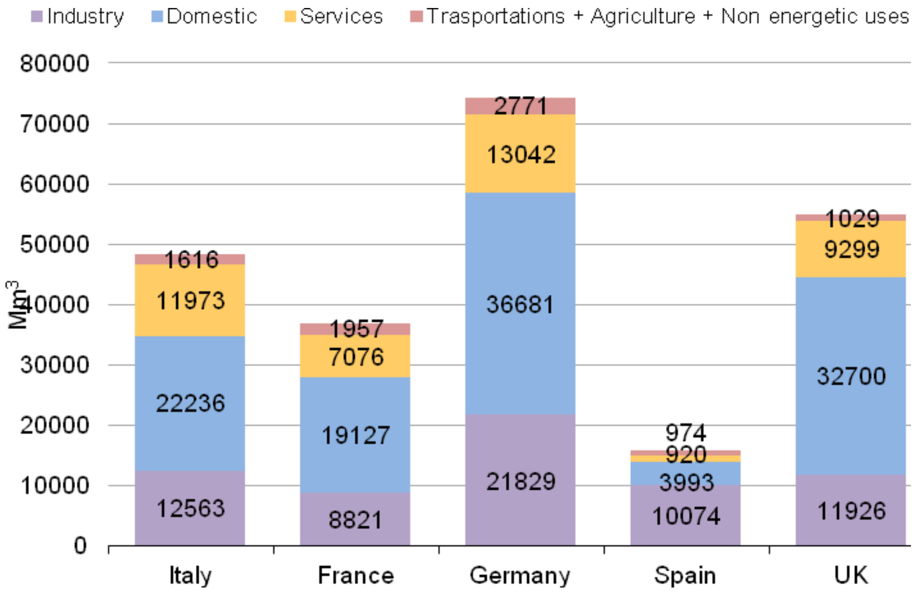
15 Autorità per l'energia elettrica e il gas (AEEG), Consumi di gas naturale negli usi finali 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/gas/int07.xls

16 European Heat Pump Association, Heat Pump Statistics 2011, http://www.ehpa.org/fileadmin/red/Heat_Pump_Statistics/Preview_2011_finished.pdf

several changes are occurring in the European scenario. For example, Germany is planning to gradually leave the nuclear program and France is evaluating the costs for new nuclear plants to replace the old ones, which have almost arrived at the end of their operating lives. Concerning this last aspect, the debate is not only influenced by the Fukushima tragedy, but also by the fact that several problems have arisen during the construction of the first two EPR plants (Flamanville in France and Olkiluoto in Finland).[17] More specifically, costs have significantly increased and their completion has been repeatedly postponed due to various technological problems.

Concerning the cost of nuclear power, there is an increasing amount of research questioning the fact that nuclear power is a cheap source of energy.[18] According to such works, there are some hidden costs not paid by end-users in the energy-bill and that are often neglected in computing the cost of nuclear-kWh. These costs, which are hanging over general taxation, include for example: financial charges, incentives for the enrichment of uranium, decommissioning and the externalities due to environmental pollution and possible accidents.

Figure 12 – Natural gas consumption in 2010 per sector in different European countries (authors' calculations based on ENERDATA data)



[17] Wikipedia, European Pressurized Reactor, http://en.wikipedia.org/wiki/European_Pressurized_Reactor#cite_note-6

[18] MIT, The future of nuclear power, 2009, http://web.mit.edu/nuclearpower/
Graig A. Severance, Business Risks and Cost of New Nuclear Power, 2009
Mark Cooper, The economics of nuclear reactors: renaissance or relapse?, June 2009

Italy said "NO" to nuclear power in the referendum of June 2011. It is necessary to emphasize that this decision was not the result of a serious assessment of the costs and benefits of nuclear power, but was greatly affected by the tragedy of Fukushima. In addition, the referendum result was also charged with political meaning: the rejection of nuclear power can indeed be interpreted as a rejection of the disastrous Berlusconi government.

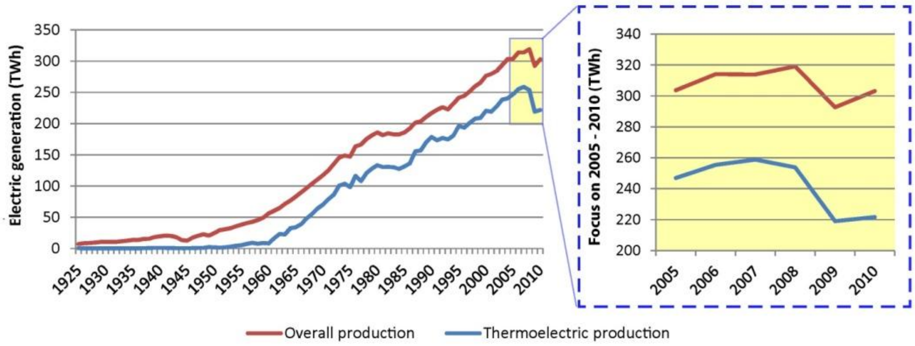
Italian power plant fleet: how is electricity produced?

In this section we describe in detail how primary energy is converted into electricity and the corresponding efficiency of the system. In particular, thermoelectric, hydroelectric and renewable sources will be dealt with separately.

Thermoelectricity: the primary role of natural gas

Thermoelectric conversion is the main technology that has answered to the increasing electricity needs of Italy starting with the economic boom years (1950s and 1960s) through to the contraction of the needs which has characterized the last few years. This trend is straightforward, as shown in Figure 13. As we will see in the following section, the existing gap between overall production and thermoelectric production was covered by hydroelectricity and, in recent years, increasingly by renewables. Considering this last aspect and observing Figure 13 in its last part, it is possible to note that, in recent years (2008-2010), the difference between the thermoelectric production and the overall production has increased: this is mainly due to a larger electricity production from renewable sources.[19]

Figure 13 – Gross thermoelectricity production and overall gross electricity production trends (authors' calculations from TERNA data)



[19] Autorità per l'energia elettrica e il gas (AEEG), 150 anni di energia in Italia, http://www.autorita.energia.it/allegati/dati/150anni.xls

Figure 14 – Gross thermoelectricity production per source in 2010 (authors' calculations from Ministry of Economic Development data)

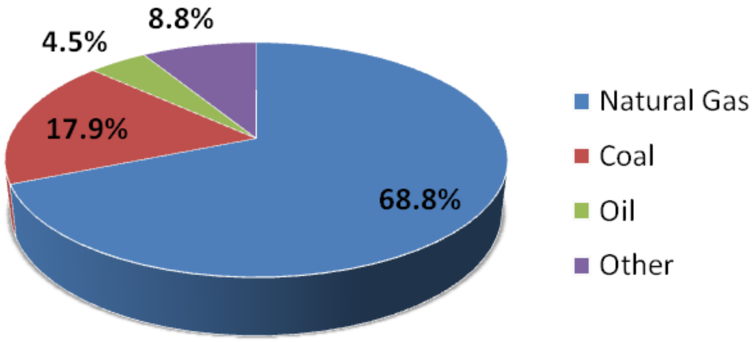


Figure 14 reports the breakdown of fossil fuels used in Italian thermoelectric plants.[20] 68.8% of the production is covered by natural gas, 17.9% by coal and only 4.5% by oil and its by-products. The residual 8.8% is covered by other fuels such as still mill or coke gases and others.

Natural gas is the most used fuel in turbogas power stations. This kind of plant is, for sure, very versatile because it can be modulated to meet the intra-day power needs of a country, but it is characterized by low efficiency (30%-35%). This lack of efficiency can be mitigated recovering the heat from the hot output gases or adding a steam cycle to create a combined cycle plant. The combined cycle plant indeed attains the high efficiency of a steam cycle with partial modulation of its turbogas section (overall efficiency ≈ 60%). In Italy, 55% of thermoelectric power stations employ the combined cycle technology and almost a half of them do not waste the low enthalpy heat, by employing it, for example, for district heating. Concerning steam cycle plants, this technology achieves quite high efficiency (40%), but it is characterized by very slow transients (10-30 hours) that make intra-day modulation of the power output difficult.

[20] Ministry of the Economic Development, Tabella Dati Energetici 2010, http://dgerm.sviluppoeconomico.gov.it/dgerm/downloads/tabella_dati_rge_2010.xls

Table 3 – Thermoelectric power plant production divided by technology in 2010 (authors' calculations from TERNA data)

	TECHNOLOGY	NET PRODUCTION BY FUEL (GWh)					NET POWER (MW)	DUTY CYCLE(a)	
		Coal	Natural Gas	Oil	Other	Total		hours	%
Plants producing only electricity	Internal combustion	-	174	265	2495	2935	859	3418	39%
	Turbogas	-	263	27	37	328	2494	131	1%
	Combined cycle	-	59655	2	1182	60838	22660	2685	31%
	Steam cycle	35819	4116	3981	3273	47189	19905	2371	27%
	Other	-	570	120	-	691	5386	128	1%
	Total	**35819**	**64778**	**4395**	**6988**	**111980**	**51304**	**2183**	**25%**
Plants with heat recover	Internal combustion	-	3921	60	1437	5418	1368	3961	45%
	Turbogas	-	3234	523	1	3758	875	4295	49%
	Combined cycle	98	79111	1710	11097	92016	18489	4977	57%
	Steam cycle	15	1850	2239	2960	7064	2940	2403	27%
	Total	**113**	**88116**	**4532**	**15496**	**108256**	**23672**	**4573**	**52%**
All plants		**35932**	**152894**	**8927**	**22483**	**220236**	**74976**	**2937**	**34%**

(a) – Duty cycle is calculated as working hours over hours per year

In Table 3,[21] Italian thermoelectric plants are sorted by technology and fuel use. Moreover two macro-groups have been identified: plants producing only electricity and plants coupled with a heat recovery system. Plants belonging to the first group, which produce about half of the total thermoelectricity, work for a limited amount of hours per year: 2183 hours on average corresponding to a duty cycle of 25%. More specifically, combined and steam cycle power stations, which generate almost all the energy referred to in this group, work for about 30% of the time. On the other hand, plants with heat recovery, which are consequently more efficient, are characterized by a larger duty cycle. In particular, the combined cycle

[21] TERNA, Dati Statistici sull'energia elettrica in Italia 2010, http://www.terna.it/LinkClick.aspx?fileticket=68ZI9snVJNA%3d&tabid=418&mid=2501

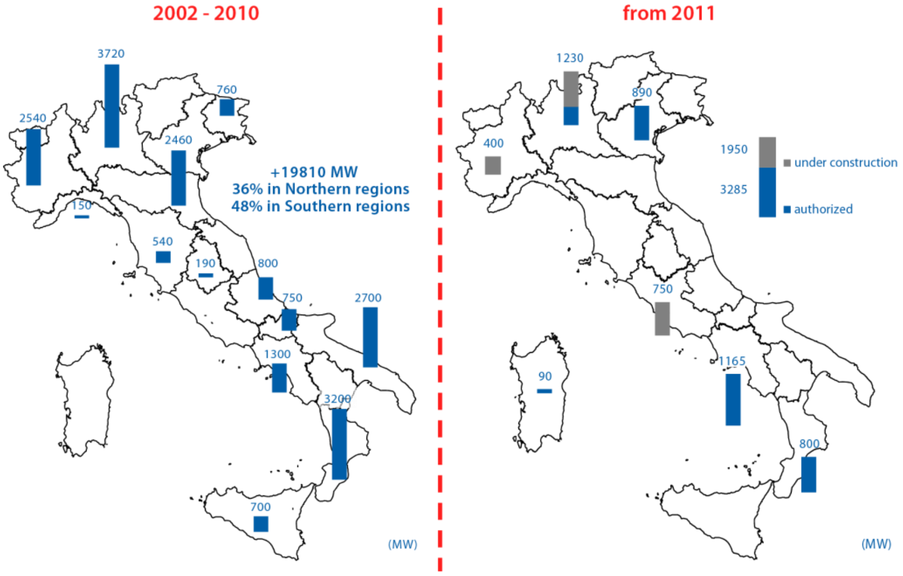
ones, which produce the vast majority of the energy, work for 57% of the available time in one year. It is worth noting that heat recovery systems can be useful with respect to the energy consumption objectives; for instance several district heating networks have been built in various Italian cities, thus reducing the incidence of the domestic sector on primary natural gas consumption.

Finally, it can be stated that 69.4% of the electric power is produced in combined cycle plants, while steam cycle plants cover 24.6% (about 66% of steam cycle power station production is fed by coal). For sure, the bias of the Italian electricity generation system towards natural gas is costly compared to coal, but, as said before, it also has the advantages of fast modulation of output power, high efficiency of the combined cycle technology and lower carbon emissions.

Italy is seriously working to improve the power generation plants, and to make them more modern and efficient. According to forecasts published by ENEL, all Italian power plants combined will reach an average efficiency of 46% in 2012.[22] This is a noteworthy result, considering that it relates to all types of power plants (coal, oil, gas, self-production, biomasses and incinerators) and that only 10 years ago it was less than 40%. The modernization of the Italian power plant fleet started a long time ago, indeed, about 60% of the power stations started working after 2000 and, as mentioned before, the vast majority of these are constituted by efficient combined cycles. Figure 15, on the left, shows the thermoelectric capacity installed starting from 2002, which amounted to 19,810 MW in the first eight years. In the same figure, on the right, new plants authorized or already under construction are displayed. All these projects will allow an additional power capacity of about 24,000 MW to be achieved

[22] ENEL, L'efficienza delle centrali italiane, http://www.enel.it/it-IT/eventi_news/news/lefficienza-delle-centrali-italiane/p/090027d981986fa4

Figure 15 – On the left, power capacity installed from 2002 to 2010; on the right, expected power of new thermoelectric plants (source: TERNA).



To reduce the dependence on natural gas without increasing carbon emissions, pilot projects of coal plants coupled to a carbon sequestration system (CCS) have also been carried out and some plants based on this technology are in the construction phase.[23]

It is clear from the duty cycles reported in the last column of Table 3 that the vast majority of the thermoelectric power plants are today under-employed. Indeed, today the above mentioned investments to modernize the power plant fleet are struggling to be repaid. This situation is expected to get worse with the increase of renewable energy that benefits from dispatching priority in the network. The effect of the renewable share on the electricity market is, indeed, becoming prominent. The price of electricity was characterized by two peaks, the first at the end of the morning (at about 11 am) and another one in the late afternoon (at about 6-8 pm). Now, thanks in particular to photovoltaics, the first peak has disappeared, while the late afternoon peak has increased strangely. It seems that this increase is caused by thermoelectric producers that are now charging users to compensate the underutilization of their plants.[24]

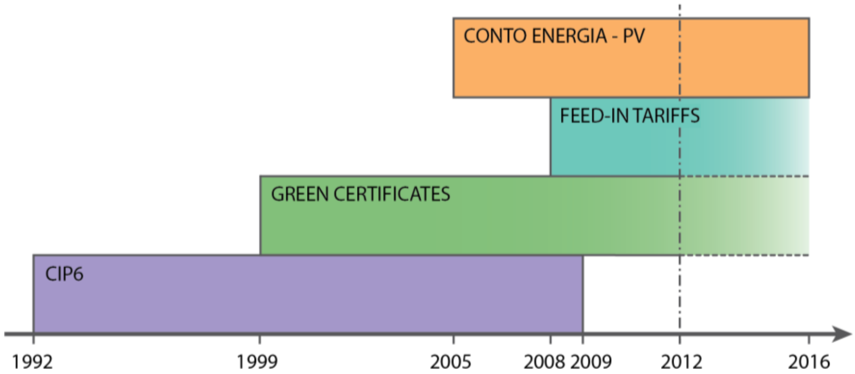
[23] ENEL, Obiettivo zero emissioni, http://www.enel.it/it-IT/eventi_news/news/obiettivo-zero-emissioni/p/090027d981930306
[24] http://www.qualenergia.it/articoli/20120329-ecco-chi-danno-fastidio-le-rinnovabili

Renewables: regulating incentives

Giving a clear explanation of the Italy's renewables incentive structure is an arduous task since the current situation is the result of different regulation frameworks introduced over years. Not only have different kinds of incentives been superimposed, but in some cases laws concerning a single type of tariff has been changed, modifying incentive values and procedures necessary to access them. The purpose of this section is to try to make order out of this bureaucratic jungle.

Figure 16 shows the history of renewable incentive policies in Italy. The so-called CIP6 program was the first kind of incentive issued in Italy, starting in 1992.[25] Green certificates should have substituted it from 1999 onwards, but for various reasons that will be better explained in the following sections, the two kinds of tariff remained active together till 2009. In addition, a specific tariff for photovoltaic plants was introduced in 2005, along with a feed-in tariff for small plants in 2009. All incentives were managed by GSE and funded by the A3 component of the energy-bill (see BOX).[26]

Figure 16 – History of renewable incentive policies in Italy



A brief description of the aforementioned tariffs is here given:

The **CIP6** program is no longer available for new plants, but several stations, built before 2009, still enjoy this incentive. The regulation CIP6/92 has promoted the construction of plants fed by

[25] The CIP6 owes its name to an interministerial committee that was devoted to the control of the prices and that introduced this first version of incentives for renewable energy.

[26] GSE is "Gestore dei Servizi Energetici", that is the authority that manages all the incentives for renewables. For useful data on renewable incentives see: GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

renewable sources or assimilated ones by the introduction of a guaranteed tariff for the energy produced. The energy is bought by the GSE and resold at a lower price in the national stock market. The difference between the purchasing and selling prices is covered by the GSE, see Table 11(Appendix, page71) for further details (for more information about this kind of incentive and in particular on the meaning of "assimilated sources" see the CIP6 box at page 31).

Green certificates ("Certificati Verdi" or CV): introduced by a legislative decree (79/99) can be issued by the GSE for certified stations fed by a renewable source, and has been in operation since April 1999. Green certificates are negotiated each year and have duration of 15 years, if the plant has become operative since December, 31st 2007. Certificates can be sold to actors able to produce the corresponding renewable energy and put it on the network: unsold certificates are retired by the GSE. The price of the green certificate does not include the energy cost that is separately remunerated (for further details, see Table 12, Appendix, page 71).

Photovoltaic systems also have a dedicated tariff (not feed-in), called **"Conto Energia"**, that will be described in detail in the BOX on page 35.

Feed-in tariff or "omni-comprehensive tariff": this kind of tariff includes both the price of the energy sold to the system and the incentive of the power stations. It can be applied to plants that have been operative since December, 31st 2007, with a nominal power capacity less than 1 MW. The feed-in tariff remains active for 15 years (see also Table 13, Appendix, page 71).

The energy produced by renewable sources is always injected into the grid thanks to the guaranteed dispatching priority.[27] If the chosen incentive does not include a remuneration for the energy (e.g. green certificate), producers have to sell it on the power stock exchange. For small plant owners, two simplified mechanisms are available:

Since 2008, producers can enter into an agreement with the GSE, called **dedicated withdrawals ("ritiro dedicato" or RID)**, which buys all the energy produced and sells it on the market. The GSE price is generally defined by the market one depending on the hour and the location of the station, while a minimum tariff is guaranteed for plants with annual nominal power capacity less than 1 MW. The minimum prices in 2010 were: €101.1/MWh for an annual production

[27] Legislative decree 387 of December, 29th 2003, in compliance with European directive 2001/77/CE

lower than 500 MWh, €85.2/MWh for 500-1000 MWh/year and €74.5 /MWh for 1000-2000 MWh/year.

Since 2009, the **on-the-spot trading** mechanism **("Scambio sul posto" or SSP)** is also available. In this case, stations with power capacity lower than 200 kWp (20 kWp if the plant became operative before December, 31st 2007) can exchange the energy produced with the network directly on its own connection point; the price of the input energy is established by the GSE through a compensation criteria based on the energy cost where the exchange happens.

In 2010, the GSE bought and re-sold on the stock market about 11 TWh of renewable energy through the RID and SSP mechanisms for €800 million (Table 14, Appendix, page 71).Finally, Table 4 gives a summary of the available incentives for different kinds of renewable sources.

Table 4 – Summary of the available tariffs for renewable power plants in Italy

Wind, bioenergy, geothermal, hydroelectric				
Period	A) Any power capacity		B) Small plants (alternative to A)[1]	
	Incentive	Energy value	Incentive	Energy value
First 15 years	Green certificates market (with different multiplication factors depending on the source)	Self consumption and Free market[2] or Dedicated Withdrawals (RID)[3] or On-the-spot trading (SSP)[4]	Feed-in-tariff, also called omni-comprehensive tariff (different depending on the source)	
After	No incentive		No incentive	Self consumption and Free market[2] or Dedicated Withdrawals (RID) or On-the-spot trading (SSP)[4]

Solar		
Period	Any power capacity	
	Incentive	Energy value
First N years[5]	Feed-in premium tariff (Conto Energia)	Self consumption and Free market[2] or Dedicated Withdrawals (RID) or On-the-spot trading (SSP)[4]
After	No incentive	

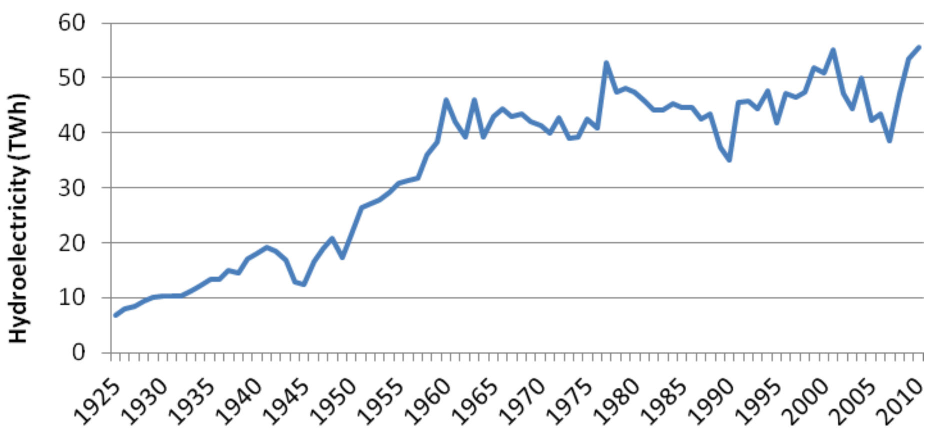
[1] Power capacity lower than 1 MW (200 KW for wind plants on shore).
[2] The energy exceeding the self-consumption needs is sold on the free market.
[3] Power capacity lower than 10 MVA or any power capacity for non-predictable source
[4] Power capacity lower than 200 KW.
[5] N=20 for photovoltaic plants; N=25 for thermodynamic solar plants sources.

Hydroelectricity: production and storage

In quantitative terms, hydroelectric power plants are the second source of the whole Italian electric production. Until 1965, hydroelectricity constituted more than 50% of the total produced power, then this percentage started to decrease due to the massive growth in the thermoelectric sector. In 2010, the power produced by hydroelectric power plants, including pumped stations, covered about 18% (54.4 TWh) of the total. More specifically, 94% (51.1 TWh) of the gross hydroelectricity is produced from natural contributions, which constitute about 67% of the total renewable production, while the remaining 6% (3.3 TWh) comes from pumped stations.

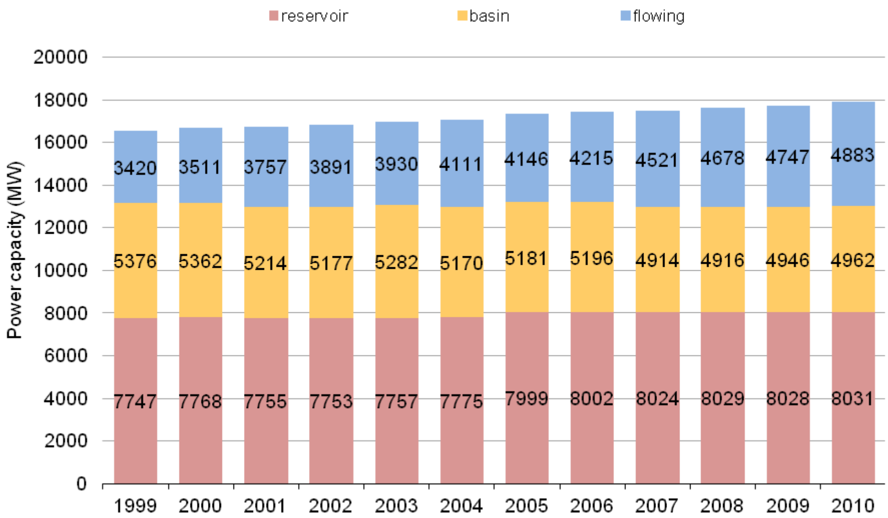
Figure 17 shows the total hydroelectricity produced starting in 1925.[28] It is possible to note that the trend becomes substantially constant from 1965 with several oscillations determined by different climate conditions, which strongly affect the production from this kind of source. The flattening of the average trend can be explained considering that the majority of the production is given by big plants (power > 10 MW), which cover 78% of the total. It is worth noting that all available sites for this kind of power station have already been exploited, consequently a significant increase of the hydroelectric base load is no longer possible.

Figure 17 – Gross hydroelectricity production including pumped storage (authors' calculations based on TERNA data)



[28] Autorità per l'energia elettrica e il gas (AEEG), 150 anni di energia in Italia, http://www.autorita.energia.it/allegati/dati/150anni.xls

Figure 18 – Hydroelectricity production, not including pumped storage, per type of plant (authors' calculations from GSE data)



On the other hand, a slight increasing trend can be observed in Figure 18,[29] mainly given by flowing water plants of small size that have been built in recent years, with an average annual increase equal to 3.3% (see Figure 20), thanks also to the incentives issued by the government.

In fact, hydroelectricity producers can access different kinds of tariffs (see Table). In 2010, about 494 GWh (see Table 13, Appendix, page 71) were remunerated by a feed-in tariff, whose actual value is €0.22/KWh. The majority of the producers have otherwise chosen the green certificate system, which has covered about 18 TWh (seeTable 12, Appendix, page 71). Due to an excess of green certificates (CV) on the market, the price of the single CV in 2010 was almost equal to the one paid by the GSE to withdraw it (€88.91, significantly lower than the reference value of €112.82). The CIP6 mechanism has collected only 178 GWh, with a cost for the GSE roughly equal to €14 million (see Table 11, Appendix, page 71). Concerning the price of the energy sold to the network, for non feed-in tariffs, the RID method (see Table 4) is available for plants with power capacity smaller than 10 MVA (reservoirs and basins) or for flowing water stations of any capacity.

As said before, about 6% of the total Italian hydroelectricity is produced through the pumped-hydro mechanism; this kind of energy cannot be considered part of renewable production, as stated in the

[29] GSE, Rapporto statistico 2009: Idroelettrico, http://approfondimenti.gse.it/approfondimenti/Simeri/fer/DocumentLibraryStatisticheFER/idroelettrico_2009.pdf

28/2009/CE regulation, since it is mainly obtained using thermoelectricity produced at night to re-pump upwards water that falls during day. In Italy, there are 22 plants equipped with a pumped-hydro system and the most part of them are of mixed type, in the sense that the reservoir is also fed by a natural source. Only 4 plants are fully pumped, but they are characterized by a large power capacity (each one > 1000 MW).

Pumped plants can be considered an as important strategic resource since they allow electricity to be stored and are characterized by low cost production (during night), with high efficiency (70-75%), while electricity is released when costs become significantly higher (during day), helping the energy production system to follow its load curve. In some cases, pumped-hydroelectricity is also used to help the switch-on of steam cycle plants, whose production was previously reduced during night, at the beginning of the day in order to reduce the time needed to reach the full capacity condition.

Moreover, pumped-hydro systems are becoming more and more important, considering the increasing production of electricity from renewable sources, in particular wind and photovoltaics, which are inherently discontinuous and not controllable during day. It is known that an efficient storage system is fundamental to regulate the power available on the transmission network and to realize the so-called "smart grids".

Concerning this aspect, the Italian legislative decree implementing the third energy packet directive (June 2011) states that TERNA, the TSO of the Italian electrical network, can build pumped hydro plants, but cannot manage them. As a result, TERNA will be forced to sell the hydro stations after having built them. In contrast, TERNA is allowed to build and control storage systems based on batteries.[30]

BOX: The CIP6 affair

The CIP6 mechanism was introduced in 1992 to make easier the liberalization of the energy market, which was monopolized by Enel group.[31] The idea was to encourage new investments in the renewable sector by providing incentives on the electricity produced, directly financed by users through a specific entry (A3) in the electricity bill. No limitations were introduced on the electricity produced that was bought by Enel at a price given by two components: the "avoided costs" (given by the cost not experienced by Enel to produce the corresponding amount of energy) and the incentive component. The first component was guaranteed for 15 years,

[30] Energia 24, Parte il terzo pacchetto energia: Terna non potrà più produrre, http://energia24club.it/articoli/0,1254,51_ART_142335,00.html

[31] www.nextville.it, La risoluzione anticipata delle convenzioni, http://www.nextville.it/index/332

while the second for 8 years. After January, 1st 2001, the CIP6 management was handed over to the GSE.

At first, the system provided good results and attracted several resources into the renewable area, in particular wind and bioenergy power. On the other hand, the CIP6 regulation presents two main drawbacks: first of all energy obtained both by organic and inorganic garbage was considered renewable, secondly the so-called "assimilated sources" could also benefit of an incentive (with a smaller value); this category included cogeneration power stations employing non-renewable sources such as fossil fuels, refinery waste products such as bitumen or exhaust smoke, etc. As can be seen in Table 5, displaying the CIP6 electricity collected by the GSE from 2001, this possibility gives rise to a distortion in the CIP6 tariff system, since the majority of the collected energy was produced by assimilated sources, often highly polluting, in spite of the renewable ones.

Table 1 – CIP6 electricity collected by the GSE from 2001 to 2010 (source: AEEG)

GWh	2001	2002	2003	2004	2005
CIP6	47153	49765	50361	52399	50296
- assimilated	38789	41183	40723	42268	40463
- renewables	8365	8583	9638	10131	9833
Mini hydro (deliberation n. 62/02)	2769	2897	2411	3064	-
Surplus (deliberation n. 108/97)	3603	1347	1140	1218	966
Total collected by GSE	**53525**	**54009**	**53912**	**56681**	**51262**

CIP6	48340	46462	41653	36194	37707
- assimilated	39068	38268	34224	29364	31558
- renewables	9272	8194	7429	6830	6149
Mini hydro (deliberation n. 62/02)	-	-	-	-	-
Surplus (deliberation n. 108/97)	689	115	54	-	-
Total collected by GSE	**49029**	**46577**	**41707**	**36194**	**37707**

Moreover, the CIP6 regulation contrasted completely with the 2001/77/CE European directive, which forbade the use of incentives for the production of energy from non-biodegradable garbage and assimilated sources. For this reason, Italy received four infringement proceedings (2004/43/46, 2005/50/61, 2005/40/51 and 2005/23/29) and a letter of formal notice from the CE. Nevertheless, the deadline for the authorization of new plants under construction, but also for planned power stations, continued to be postponed and the cost for Italian electricity users continued to increase over the years.

The Finance Act of 2008 should have definitely stopped new CIP6 authorizations (on March 2008), but a new exception till the end of 2009 was introduced, due to the "garbage crises" in Southern Italy, in order to encourage the construction of new incinerators (DL 172/2008). In this case, both biodegradable and non-biodegradable garbage continued to be remunerated as renewable sources. For plants not located next to the emergency area, the deadline was set to December 2008. The same decree acts on green certificates, which can be considered as the successors of the CIP6 mechanism: in order to identify the biodegradable component (considered renewable) burnt into waste-to-energy plants, a lump sum percentage equal to 51% was estimated for previous years, while the task was assigned to the GSE and to competent ministries for the following years.

Finally, the last decree referred to CIP6 (99/2009) gives the opportunity to owners of plants fed by fossil fuels or waste products to exit the program before the end of the period with guaranteed incentives. In this case, the amount of residual incentives is paid immediately with a discount rate equal to 6%, thus slightly reducing the total cost. Nothing about the resolution of contracts regarding waste-to-energy plants (incinerators) has been decided yet. Anyway, it seems that the CIP6 energy production has become too relevant to find a simple way to completely stop the program. More specifically the problem is not the amount of energy produced, since the Italian generation system is oversized with respect to power capacity, but the economic and occupational issue since a lot of plants are actually financed through this mechanism and it is not clear if, after the end of the CIP6 program, they will continue to produce or will close down.

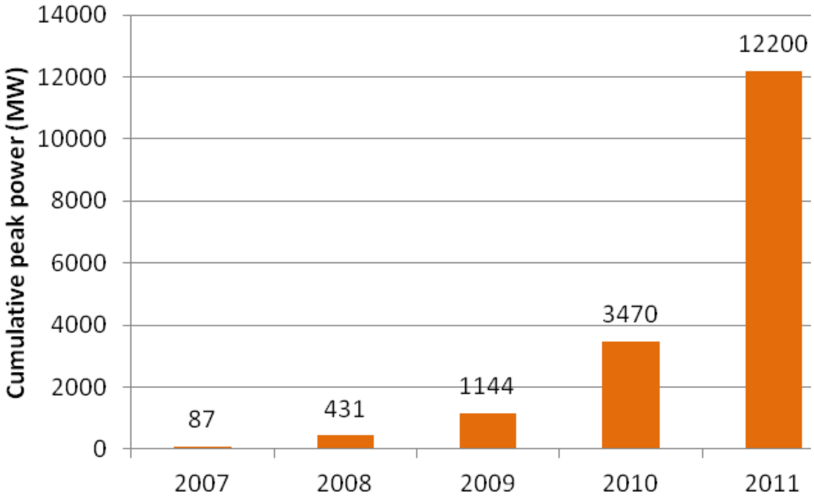
In 2010, the GSE collected about 37.7 TWh of CIP6 energy composed by 6.1 TWh from renewable sources and 31.6 TWh of an assimilated source, with €1.139 billion spent on the former and €2.975 billion for the latter.[32] The first ten industrial groups accessing the CIP6 program on assimilated sources and the corresponding percentage of production are shown in Figure 37 (Appendix, page 71). Edison group covers 33.3% of the total, followed by Saras (13.7%) and ERG (10.5%). Concerning renewable sources, A2A was the first producer with 18.8% of the total production (Figure 38).

Photovoltaic: rapid growth

Photovoltaic (PV) technology allows solar radiation to be directly converted into electricity. It exploits the photoelectric effect that is the property of a junction fabricated with two different types of semiconductor to generate current when exposed to light radiation.

[32] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

Figure 19 – Cumulative installed photovoltaic power from 2007 to 2011 (authors' calculations based on GSE data)



In Italy, photovoltaics are stimulated with a feed-in premium tariff (FIP) called "Conto Energia" that has been in force from 2005 and has resulted in the exponential growth of the number of plants installed. A review of the evolution of this tariff is reported in the BOX at page 35. In 2008, a huge increase of the installed power can be observed, about five times compared to 2007 (Figure 19): this is mainly due to the success of the second version of the so called "Conto Energia". In 2009 and 2010, the year-on-year increase of the cumulative power was a bit smaller: 2.65 and 3 times respectively. In 2011, the number of plants connected to the grid increased even more quickly (3.5 times). The greater share of this extraordinary growth (also in relation to the absolute values) is due to the race for the construction of the plants which occurred in the second semester of 2010 that became operative only in 2011 (for more details see the regulation box).

At the end of 2011, there were about 320,000 plants connected to the grid. The average size of these plants has increased over years, rising from a mean size of 11 kWp in 2007 to 38 kWp in 2011. The size of the plants changes from region to region: a lot of small or medium plants on the roofs in Northern regions and larger plants on the land in the Southern ones. Indeed, Lombardia is the region with the largest number of plants and Puglia is the region with the largest installed power. Photovoltaic plants produced 1,906 GWh in 2010, corresponding to 0.6% of electricity needs. And according to provisional data released by the TSO (TERNA), they produced 9,258 GWh in 2011 corresponding to 2.8%.[33] A search of the GSE database

[33] TERNA, Dati provvisori d'esercizio 2011,

("Atlasole") on February, 2nd 2011 indicates that there were 330,037 plants in operation, corresponding to an overall power of 12,789 MW.[34] During 2012, this installed power is expected to produce more than 14,000 GWh equivalent to 4.2% of overall Italian electricity needs. All the incentives for photovoltaics are paid by end-users within the energy bill (A3 component), by currently the overall installed photovoltaic capacity costs €5,500 billion per year.[35]

The incentives for photovoltaics have also been extended to thermodynamic solar plants (CSP). Italy is the leader in this technology, in particular thanks to the Archimede program of the Nobel Prize winner Carlo Rubbia. By now there are several projects for a total capacity of 50 MWp, but only one of them is currently working: the ENEL power station of Priolo Gargallo (5 MW).

BOX: "Conto Energia", the phototoltaic feed-in premium tariff

In Italy, the photovoltaic incentive "Conto Energia" was introduced for the first time in 2005 with the ministerial decree of July, 28th by mutual agreement between the Ministry for Productive Activities and the Ministry of Environment of the third Berlusconi government.

This policy is based on the German model and owes its name to the fact that no finance is given for the construction of the plant, but the energy produced is paid for 20 years at a level that makes the investment profitable and to ensure a rate of return on the invested capital of around 10%. The main difference between the Italian and the German model is that in Germany the incentive includes the value of the energy, for this reason it is called feed-in-tariff (FIT). In Italy, instead, it is added to the value the electricity and it is called feed-in-premium (FIP). Germany's incentive structure is more advantageous for the community, indeed the inflation of energy costs will progressively reduce the gap between the FIT and the cost of energy. In Italy, since the energy value is split from the incentive, this does not happen and the owner of the production plant will benefit from this situation. Moreover, another difference with the German model is that, in the very first version of the Italian incentive, the FIP was also adjusted year-to-year with inflation.

Even if in that period the cost of photovoltaic plants was much higher than the prices which prevail today, the tariffs were sufficient to ensure a good return on investment. The main critical point of this policy have been the cap on the overall capacity of plants that could access FIP (100 MW at the beginning, then increased to 500 MW), the intricate auction-based mechanism to determine the tariff for plants bigger than 50 kWp, and the complexity of the procedure to access incentives. Just to make an example, requests for incentives could be submitted to the appropriate agency (GSE), exclusively on certain days of the year. In addition to this, the tax rules on tariffs were not completely clear until the circular 46E of July, 19th 2007 of the Internal Revenue Service ("Agenzia delle Entrate"), two years after the

---

http://www.terna.it/LinkClick.aspx?fileticket=NyK5pNTnIpg%3d&tabid=380&mid=442

[34] ATLASOLE, http://atlasole.gse.it/atlasole/

[35] www.gse.it

FIP came into force.

The main issues of the first version of the "conto energia" were solved under the second Prodi government with the second version of the PV incentive policy by the ministerial decree of February, 19th 2007. This version of the FIP policy was broader: the tariffs, decreasing year-to-year, were set for all the plants installed until December, 31st 2010 and a cumulative cap of 1,200 MW was imposed. This modest cap was mitigated with the introduction of an additional period of 14 months after the capped output is reached, during which all the plants would be entitled to incentives, cap-free. The tariffs were distinguished per size of the plant and per typology of installation: integrated on roofs, simply fixed on them or on the ground. The complicated auction-based mechanism for big plants was removed. The most important innovation of the new version of the FIP was, for sure, the huge simplification of bureaucracy, which determined the take-off of Italian photovoltaic market.

The Italian market started to increase quickly and during 2010, and with the reduction of the prices of photovoltaic components (modules in particular) it experienced an exponential growth. At the end of June 2010, the cap of 1,200 MW was reached, but the period of 14 months guaranteed the FIP to all the plants connected to the grid by the deadline of December, 31st 2010. These circumstances created a real race to photovoltaics that was further boosted by the uncertainty in which the sector would fall as of January, 1st 2011. For example, during only the second semester of 2010 a record power capacity of 5,587 MW was installed, corresponding to the surface area of about 5,578 soccer fields. Indeed the fourth Berlusconi government delayed the presentation of the new FIP policy. But, as if not enough, the law 129/10 granted an extension of the incentives for photovoltaic systems completed by December, 31st, although not yet connected to the grid. Normally, however, the tariff is determined by the date the plant is connected to the national grid (typically months after the plant is completed). This set of factors led to the congestion of the whole chain: the installers, the operator of the distribution grid (ENEL), the agency responsible for the incentives (GSE). The effects of this congestion, in particular for GSE, have been felt for about a year.

With the third version of the FIP policy (ministerial decree of August, 6th 2010) the tariffs for the plants connected to the grid after January, 1st 2011 were reduced and the classification of the plants was simplified (the typology of plants integrated into buildings was removed); special tariffs were introduced for concentrated-photovoltaics (CPV) and for photovoltaics with innovative features. This decree set a cumulative cap of 8,000 MW that was almost reached before it came into force. It soon became clear that the tariffs were too high compared to the price of the materials so the third version of the FIP was quickly outdated by the fourth "conto energia" that is now in force.

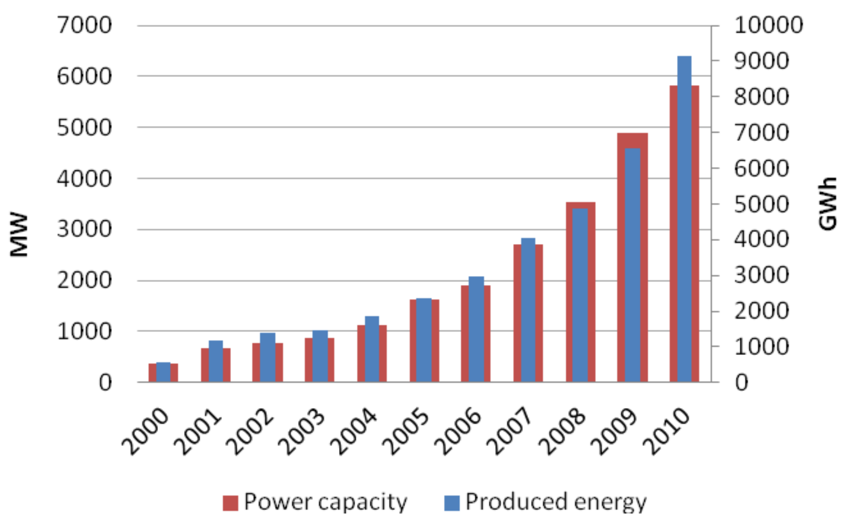
The fourth version of the FIP policy determines the tariffs until 2016, when the grid-parity is expected to be reached. A progressive reduction of tariffs is established and plants are subdivided in two families: plants on roofs smaller than 1 MW (small plants) and other plants (big plants). No cap is imposed for small plants, while big plants have to be recorded on a national register and for them a yearly limit for expenditure in the national budget is imposed. To accommodate protectionist pressures by Italian producers the government has introduced a bonus of 10% for modules manufactured in Europe. But in practice, given the definition of what a European module actually is, almost any module could be considered European. Plants that will start working in 2013 will be subject to a omni-comprehensive tariff, that is, with the value of energy included (like in Germany). New plan has also tried to reduce the construction of plants in agricultural areas, curtailing the incentives to plants bigger than 1 MW.

Despite these further changes of the rules, today the main element affecting PV is the credit crunch. The Italian incentives to photovoltaics have been successful, but the entire framework has been modified too often causing uncertainty and speculative races. The lever to be used should have been the value of the incentive that, if tied more to the module value of the PV components, would have determined more regular growth of the market and lower costs to the community. As if that were not enough, since the end of March 2012 drafts for a new, fifth FIP policy have been circulating.

Wind power and the adequacy of the grid

During the last decade, the installed power capacity of wind plants has experienced a constant increase (see Figure 20), thanks to the incentives provided by Italian government that have caused a real race to exploit this kind of source.

Figure 20 – Cumulative installed wind power and corresponding electricity production from 2000 to 2010 (source: GSE)



In 2010, the installed wind power capacity reached a value of 5814.3 MW, with an increase of 18.7% compared to 2009. As shown in Table 6, the increase was mainly due to small plants, with smaller capacity than 1 MW (+ 87.6%), but a significant contribution (+20.6%) was also given by the so-called "wind farms", characterized by a large size power capacity (> 10 MW). 98% of the installed capacity is located in Southern Italy, which presents the best climatic conditions for this kind of technology. This allows wind plants to work for more than 1,550 hours/year on average.[36]

In 2010, wind electricity production was 9.12 TWh, representing about 12% of the total renewable production. It is worth noting that the behavior of wind plants can be strongly influenced by climatic conditions that can led to large oscillations in energy production, causing unavoidable overloads of the transmission lines. In order to keep the network safe, TERNA can limit wind production: in this case producers can ask for remuneration proportional to the energy not taken up by the GSE. In 2010, the energy lost amounted to 480 GWh, about 5% of the total wind production. This underlines the fact that even though energy from renewable sources is constantly increasing, the Italian grid is not yet adequate to manage it.

The majority of the Italian wind plants, about 8 TWh, are associated with the green certificate mechanism (Table 12, Appendix, page 71), while about 800 GWh benefit from the CIP6 tariff (Table 11, Appendix, page 71). From 2007, a feed-in tariff is also available for small power stations (capacity < 200 kW): in 2010, 1.6 GWh enjoyed a FIT equal to €0.30/kWh (Table 13, Appendix, page 71).

Table 6 – Wind power and number of plants in 2009 and 2010 (source: GSE)

	2009		2010		Var % 2009/2010	
Capacity (MW)	**n°**	**MW**	**n°**	**MW**	**n°**	**MW**
P ≤ 1 MW	24	14.7	191	27.5	+695.8%	+87.6%
1 MW < P ≤ 10 MW	106	491.1	105	488.6	-0.9%	-0.5%
P ≥ 10 MW	164	4392.2	191	5298.2	+16.5%	+20.6%
Total	294	4898	487	5814.3	+65.6%	+18.7%

Provisional data of 2011 shows an abrupt fall of the increase in wind capacity increase.[37] Consequently the expected energy production will be 9.5 TWh, only 4% more than 2010. This trend, in contrast with the European one, originates from changes made by the Berlusconi government to the value of green certificates, whose price

36 GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

37 TERNA, Dati provvisori d'esercizio 2011, http://www.terna.it/LinkClick.aspx?fileticket=NyK5pNTnIpg%3d&tabid=380&mid=442

was reduced by about 20% for wind power. In addition, the uncertainty originating in the following regulatory vacuum has led investors to prefer other markets than the Italian one.

Bioenergy: long-term and stable growth

Bioenergy comes from any fuel that is derived from the biodegradable fraction of products, waste and residues from agriculture, forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of municipal solid waste. This definition includes a wide range of materials available in different physical states, with a wide range of calorific values.[38]

There are many different methods to convert biomasses into electricity, varying as a function of the characteristics of the biomass. Biomasses can be burned in the equivalent of a steam cycle thermoelectric plant (typically of smaller size than the ones fed with fossil fuels), in other cases, biomasses are converted by biochemical or chemical processes in syn-gas (CO) or bio-gas (CH4), and then burned in internal combustion engines to produce electricity. Lastly, sometimes, liquid biomasses are fed directly into internal combustion engines to produce electric power.

In the past, in Italy the conversion of biomasses into electricity was stimulated by CIP6 tariffs and by green certificates. Today, this kind of renewable energy can still enjoy green certificates or, if smaller than 1 MW, a feed-in tariff comprehensive of the energy value. Plants smaller than 1 MW connected to the grid from 2008 typically chose the FIT because of its convenience.

Table 7 – Bioenergy: number of plants, installed power capacity and electricity produced in 2009 and 2010 (source: GSE)

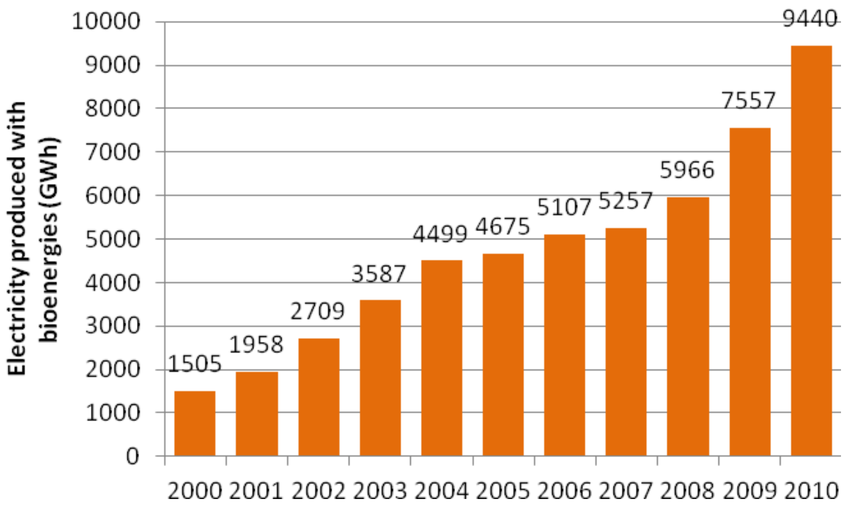
	2009			2010		
	Number	**Power (MW)**	**Energy (GWh)**	**Number**	**Power (MW)**	**Energy (GWh)**
Thermoelectricity= Biomasses	122	1255	4444	138	1243	4308
Biogas	273	378	1665	451	508	2054
Bioliquids	42	385	1448	97	601	3078
Total	**437**	**2019**	**7557**	**686**	**2352**	**9440**

[38] GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

Table 7 summarizes the number, the total power capacity and electric energy production of the plants fed with bio-energies in 2009 and 2010. The classification includes plants in which biomasses are directly burned to generate thermoelectricity (called "Thermoelectricity"), plants with production of biogas ("Biogas") and plants in which biomasses are directly fed into internal combustion engines ("Bioliquids"). In 2010, the majority of plants used biogas (66%), 20% was fed by biomasses and 14% by bioliquids. Analyzing data in terms of power, the role of biomasses and biogas is reversed: biomass power plants have an overall power capacity of 1,243 MW and biogas plants of 508 MW. This fact depends on the average size of the plants: slightly higher than 1 MW for biogas and 9 MW for biomasses. The variation of the number of the plants from 2009 to 2010 is also due to a reorganization of the classification and to the emersion of some plants never recorded before. From 2009 to 2010, the number of plants increased by 59.7%, mainly thanks to small biogas plants installed by farmers. The total power increased by 16.5% (333 MW).

The number of plants fueled by bioenergies has been characterized by continuous and sustained growth throughout the period 2000-2010. In Figure 21, the overall electric energy produced by biomasses is reported, the mean growth rate is about 20% per year. In 2010, 9,440 GWh have been produced with bioenergies, equivalent to 2.8% of Italian electricity demand. Within overall production, 4,230 MWh obtained green certificates (about €443.5 million), 4,770 MWh benefited from CIP6 incentives (€624 million) and 807 MWh got the feed-in tariff (about €208.6 million). For further details, see Table 11, Table 12, and Table 13 in the Appendix section (page 71).

Figure 21 – Electricity produced with bioenergies from 2000 to 2010 (source: GSE)



Geo-thermoelectricity: the Italian primacy in Europe

A geo-thermoelectric plant converts the thermal energy of a geothermic fluid (steam or a water-steam mixture) resulting from the contact between water and hot rock in the subsoil. The basins exploited to generate electricity are characterized by temperatures higher than 150°C and depths from a few tens to few thousands meters. The heat is then converted into electricity by steam turbines.

These plants are characterized by their small size, compared to thermoelectric plants fed with fossil fuels. The majority is smaller than 20 MW (27 in 2010) and only 6 are larger than 20 MW. In Italy the production of renewable energy from this source has been stable for years. The existing 33 plants, all located in Tuscany, have an overall peak capacity of 772 MW. In 2010, these plants produced 5,376 GWh, corresponding to 1.6% of overall electricity needs.[39]

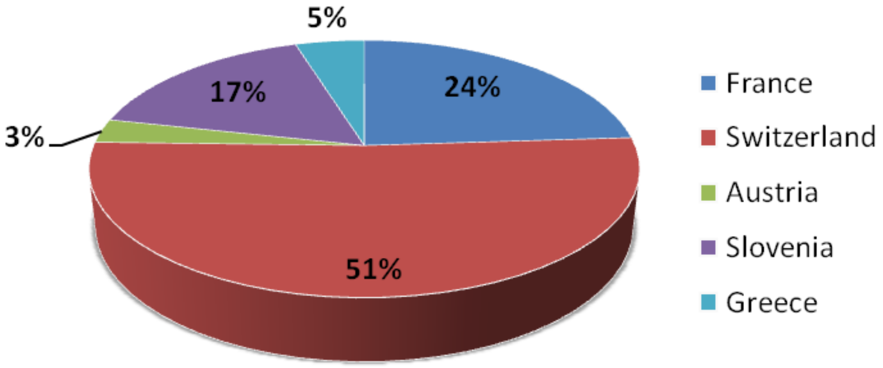
Foreign electricity imports: a matter of convenience

As already said in Section 0, Italy imports 12.9% of its entire electricity needs. Imports come from almost all the neighboring countries although the largest shares come from Switzerland (51%) and France (24%) (see Figure 22). It is worth noting that, due to

[39] GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

inadequate direct power lines, the vast majority of the energy imported from Switzerland is generated in France.[40]

Figure 22 – Foreign electricity Imports in 2010 (authors' calculations based on TERNA data)



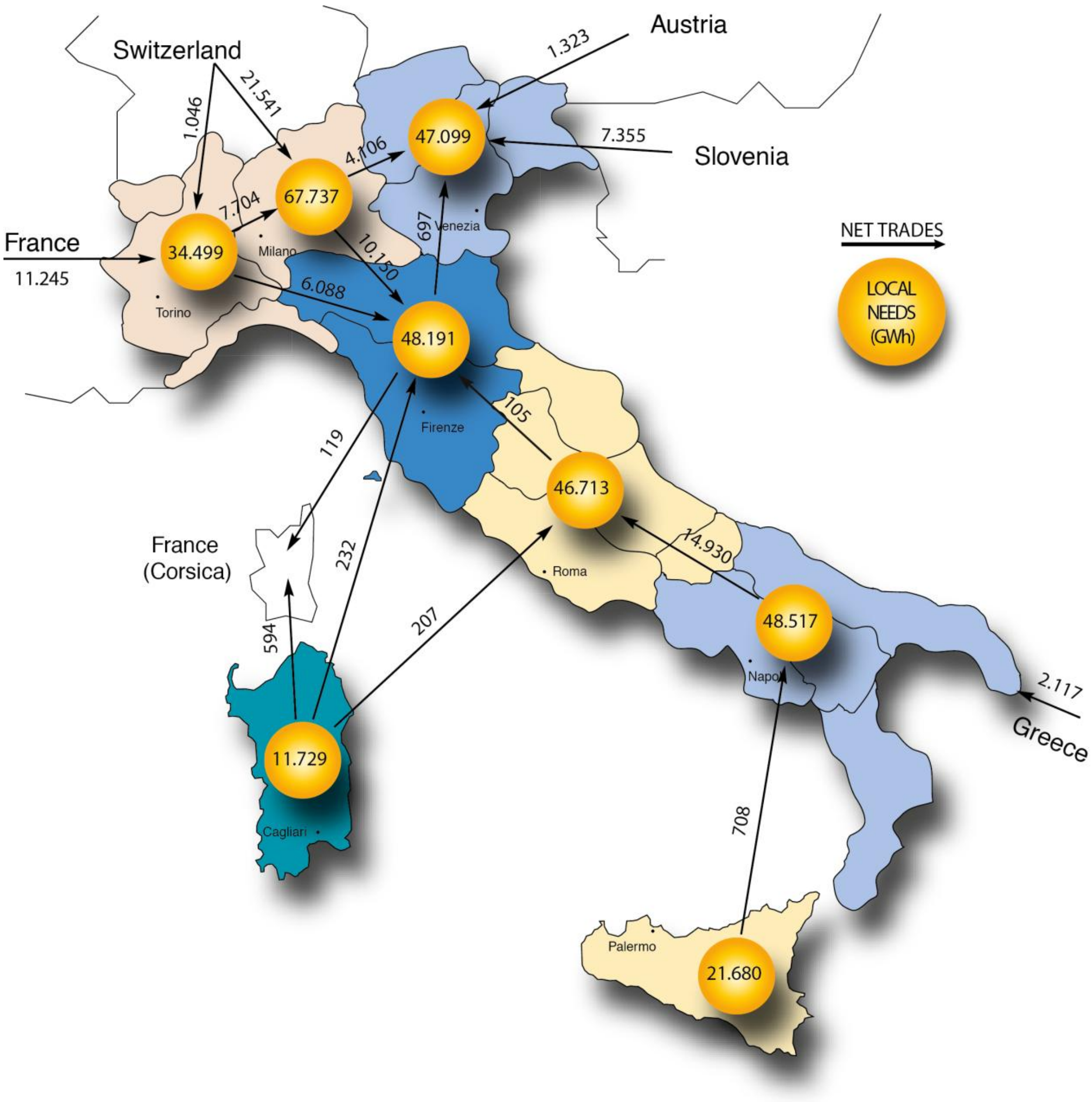
According to TERNA data (Figure 23),[41] in 2010 the net amount of imported electricity was equal to 43,944 GWh, calculated as the difference between imports (45,761 GWh) and exports (1,817 GWh).[42] The imports experienced a year-on-year reduction of 2.8%, mainly due to a strong contraction of imports from Switzerland (-1,894 GWh) and, to a lesser extent, from France (-265 GWh). The decrease of the imports from Switzerland and France was partially compensated for by the increase of the imports from Slovenia (+703 GWh).

[40] Statistique suisse de l'électricité 2010, http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=fr&name=fr_579535264.pdf

[41] TERNA, Dati provvisori d'esercizio 2010, http://www.terna.it/LinkClick.aspx?fileticket=JRKDBL4Tz0E%3d&tabid=380&mid=442

[42] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

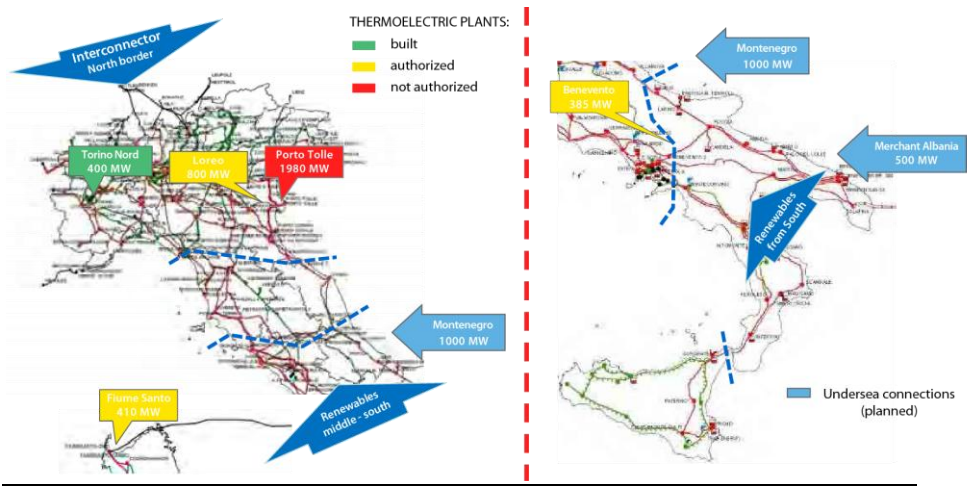
Figure 23 – Energy needs of Italian macro-regions and flows along the transmission grid in 2010 (source: TERNA). The colors of the various macro-regions only have an aesthetic purpose.



It is worth noting that imports are not proportional to the hourly load: Italian electricity needs are supported by power produced abroad for a share that can fluctuate from 10% during day, to peaks equal to 25% at night. Night-imports are relatively more important than the daytime-ones. This becomes clear considering that the major part of imported energy comes from nuclear plants, characterized by the limited ability to modulate the power produced during night (when the supply exceeds demand) in a cost-effective way. This situation leads Italy to import the energy produced during night in nuclear power plants at a relatively low cost, to stop the plants with a higher cost of kWh and to accumulate energy with pumped-hydroelectric plants.

The evolution of the electric network is strongly tied to the development of the power generation system and to that of the entry points of the electricity import network. Actually, it is also necessary to face the turbulent increase of renewable sources, mainly in the Southern part of Italy, improving the network that, at the moment, constitutes the bottleneck in these areas. Moreover, as shown in Figure 24, new undersea connections with the Balkans (Albany and Montenegro) have been planned,[43] requiring further modifications to the national transport network. Finally, the construction of new thermoelectric plants or the reconversion of existing oil-fed power stations (like Porto Tolle and Fiume Santo) has to be taken into account. On the other hand, only the "Torino Nord" plant has been completed, while others are still waiting for the final approval.[44]

Figure 24 – Main planned modifications to the power generation system and to electricity import connections (authors' calculations based on TERNA data)



[43] TERNA, Piano di Sviluppo della rete elettrica di trasmissione nazionale 2011, http://www.terna.it/LinkClick.aspx?fileticket=dBsoVKFo2KM%3d&tabid=5069&mid=24684

[44] In the case of the reconversion from oil to coal of the Porto Tolle plant, the authorization has been recently revoked.

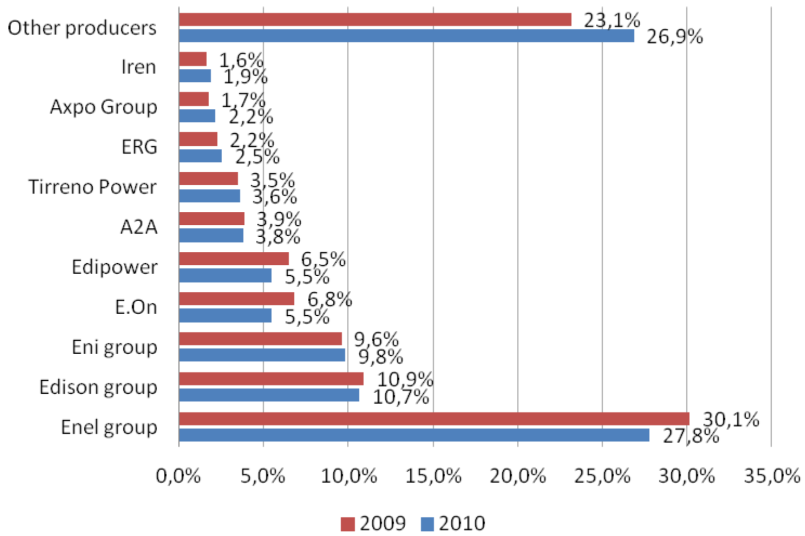
The Electricity Market

This section deals with the Italian electricity market. First of all, the share of the total installed capacity among main producers is described, highlighting the substantial primacy of Enel group in almost all the sector.[45] Then the structure of the final market is reported along with an analysis of the final prices.

Producers: Enel group is still the main player

Figure 25 shows the different contributions of the main producers to the gross electricity demand.[46] Enel group preserves its first position with a share equal to 27.8% of the total, though decreasing from 30.1% of 2009. Edison and Eni, the main competitors of Enel, have confirmed their previous production levels at about 10%. The contraction of Enel's contribution has allowed smaller producers like ERG, Iren, Axpo, Tirreno and others to increase their shares. In contrast, E.On and Edipower have experienced a reduction of about 1% compared to 2009.

Figure 25 – Different group shares of gross electricity production in 2010 (source: AEEG)



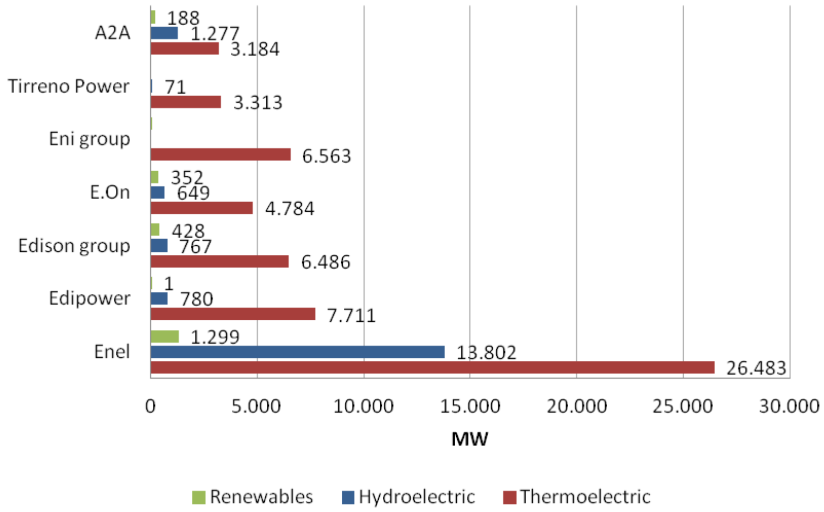
---

[45] With the Bersani decree of 1999, concerning the liberalization of the energy market, Enel group, which was the monopoly supplier in the electricity sector, was forced to sell: power plants to other companies for a total capacity of about 15,000 MW, the ownership and the administration of the TSO (TERNA) and the distribution networks of the main Italian cities.

[46] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

Considering the installed power capacity, Enel group owns the largest share of thermoelectric plants followed by Edipower, Edison and Eni (Figure 26). In particular, 72% of coal generation is managed by Enel, along with 26% and 14% of oil and gas plants respectively. Edison and Eni are otherwise leaders in the gas sector and manage about 17% each of total production. Enel is also dominant in hydro production (51%) and in the renewables field.

Figure 26 – Installed power capacity of different groups per source in 2010 (source: AEEG)



The final supply: free market vs. regulated market

This section gives a brief description of the structure of the Italian energy market. All information has been taken from a AEEG statistical research, based on data provided by the main operators.

The Italian final market can be divided into 3 categories: the regulated market ("tutelato"), the free market and the safeguard ("salvaguardia") one.[47]

The **regulated market** is composed of domestic users and small industries (low voltage) that, after the liberalization of the electricity market for domestic (2007) and non-domestic users (2004),[48] have not stipulated a contract on the free market. The service is guaranteed by specific companies and the economic conditions are established by the AEEG. As we can see in Figure 27, this category amounts to 79 TWh (29.9% of the total electricity

[47] AEEG data covers about 94% of the total amount of end-users' electricity consumption given by TERNA (265.7 TWh vs. 288 TWh) and 89% concerning only the free market.
[48] Non-domestic users are entities with a VAT number (services + industries).

consumption) with 68% given by domestic sector. In particular, 87% of domestic users hold contracts with a nominal power capacity of 3 kW and are characterized by an annual power consumption of 2,250 kWh on average (for resident users). In sales among companies, "Enel Servizio Elettrico" covers 84.4% of the market. Compared to 2009, the regulated market has shown a reduction of its quota (-5%), in terms of electricity sold, in favor of the free market.

The **free market** amounts to 180 TWh (202 TWh relying on TERNA data), equal to 67.8% of the total electricity sold in Italy.[49] As shown in Figure , only 5% is composed of domestic users, while 92% of the total relates to other uses (not domestic or for public lighting). There are 27 societies operating in the free market with Enel covering the greatest quota (19%, that was 27% in 2009), followed by Edison, Electrabel/Acea, Eni and Sorgenia. Consequently, it is possible to state that the liberalization has acted well among non-domestic users and it is worth noting that this category can stipulate contracts on the free market since 2004, while the domestic market is already concentrated and strictly connected to the old monopolist (Enel).

Finally, the **safeguard market** concerns users that cannot access the regulated market and do not have even a temporary contract on the free market. This service is given by company sales chosen by auction, and covers about 6 TWh (2.3%) of the total electricity demand in 2010.

[49] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

Figure 27 – Electricity final market structure in 2010 (authors' calculations based on AEEG data)

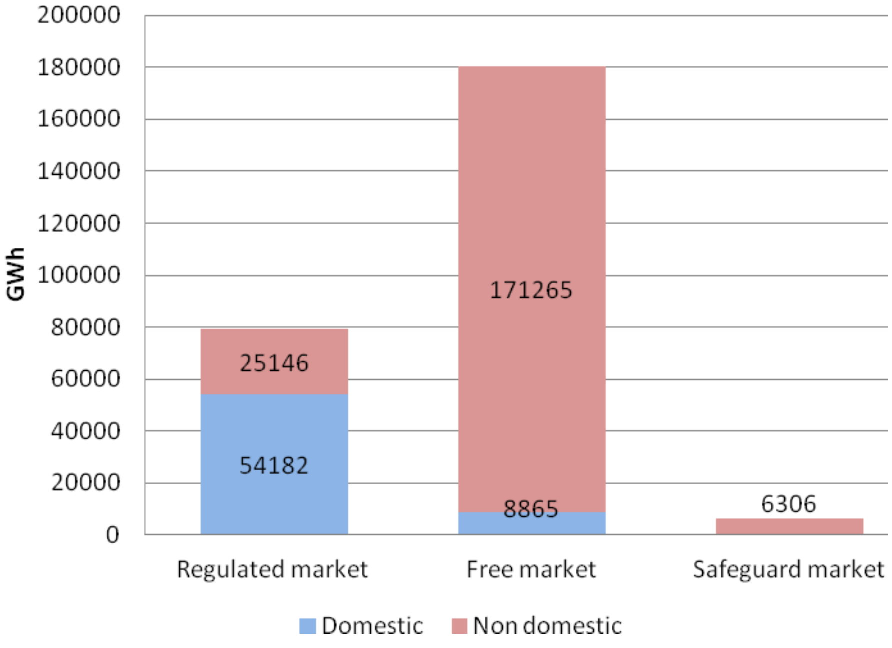
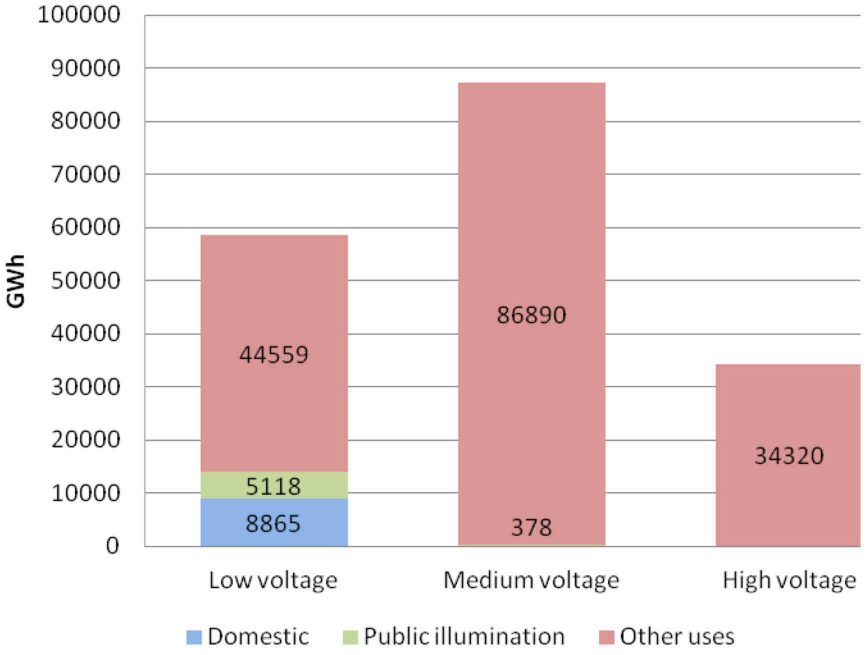


Figure 28 – Free market structure in 2010 (authors' calculations based on AEEG data)

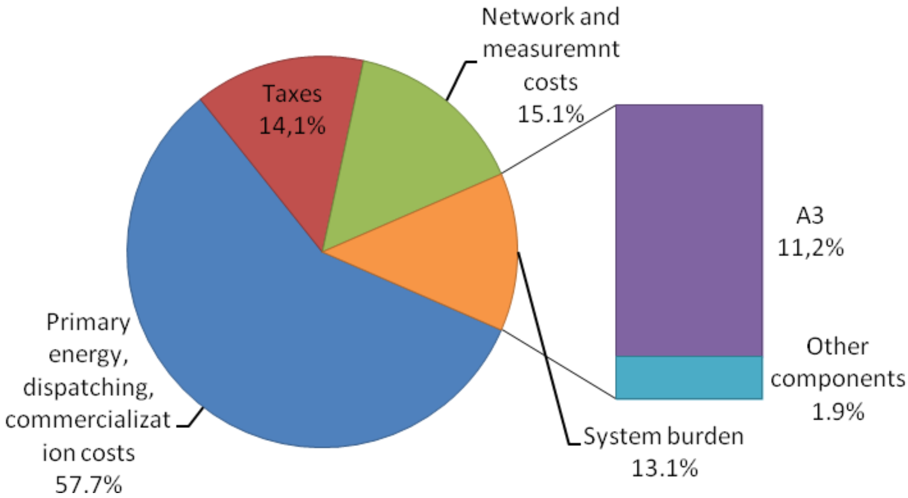


BOX: How much do renewable incentives affect the final electricity price?

In Italy, one of the most frequent questions relates to the weight of incentives for renewable sources in the final electricity price. In particular, since this is defined by the authority, every time the final price needs to be updated, the AEEG issues an official bulletin describing the motivations of the changes and reporting the percentages of the different entries composing the final value.

Figure 28 relates to the update of the electricity price issued on June, 30th 2011.[50] The price composition refers to the typical domestic user with a regulated market contract of 3 kW and characterized by an average consumption of 2,700 kWh/year. Costs for primary energy amount to 57.7%, taxes (national, regional, etc.) to 14.1% and network costs to 15.1%. The system burden entry (13.,1%) includes renewable incentives, in particular in its A3 component, which represents 11.2% of the total price. The A3 entry is made up as follows: 18% by CIP6 assimilated sources, 21% by green certificates, 44% by photovoltaics and 17% by other incentives.

Figure 29 – Composition of the final electricity price for a typical domestic user (regulated market, power capacity = 3 kW, average consumption = 2700 kWh/year), (authors' calculations based on AEEG data)



Considering provisional data referring to 2011, the total cost for incentives amounted to €7.9 billion with €1.3 billion devoted to assimilated CIP6 and €4 billion to photovoltaics. It is expected that in 2012 the total costs will increase to €10.5 billion, with photovoltaics achieving a value equal to €5.9 billion. The authority also indicates that photovoltaics were the main reason of the price increase during 2011.[51]

---

[50] www.autorita.energia.it/allegati/com_stampa/11/110630.pdf

[51] http://www.associazioneacu.org/wp-content/uploads/2012/01/CS-aggiornamento-1-trimestre-2012.pdf

Electricity final prices: a comparison with Europe

Another important index to analyze is constituted by the electricity prices for domestic and industrial consumers. These aspects relate strictly to the energy policy of a country, its energy mix structure, and impact strongly on its economic growth and competitiveness.

All data reported in this section were extracted from the Eurostat database on January, 25th 2012, and refer to the first semester of 2011.[52] The average prices have been collected by dividing the users in several bands of consumption. More specifically in the case of Italy, the price is taken from a statistical sample without distinguishing between the free market and the regulated one.

As we will see in the following paragraphs, while the majority of Italian domestic users benefit from an electricity price that is lower than the European average, non-domestic bands of consumption are generally more expensive if compared with the rest of Europe.

Figure 30 shows a comparison of the electricity prices for **domestic users,** per band of consumption in various European countries (for further details see Table 15, Appendix, page 71). Considering the first band (< 1000 kWh), the final price for Italian users is slightly higher compared to the European average, €0.2779 /KWh and €0.2712/KWh respectively. It is worth noting that in Italy this band is mainly constituted by non-resident users (e.g. second houses), consequently this data cannot be considered remarkable. 60% of Italian resident families can be located in the second band (1000-2500 kWh), characterized by a price which is lower than the European one by about 10%, considering the after-tax price, or 13.5% considering the final price. For higher consumption levels, Italian tariffs are increasingly more expensive than those of other countries; to give an indication, the third band (2500-5000 kWh) is characterized by a final price 13% higher compared to the average. This value is smaller than the German one (Figure 30), that anyway is weighted by a taxation level of more than 50%.

The increasing gap between the Italian prices and average European ones (Figure 30) is mainly due to the introduction of a new progressive regulation for **domestic users**, which came into effect on June, 1st 2009, and which leads to a heavy penalization for the higher bands of consumption. Tariffs have been reduced since 2010, as the Italian authority (AEEG) has highlighted this discrepancy; in particular subsidized prices have been introduced with respect to the use of

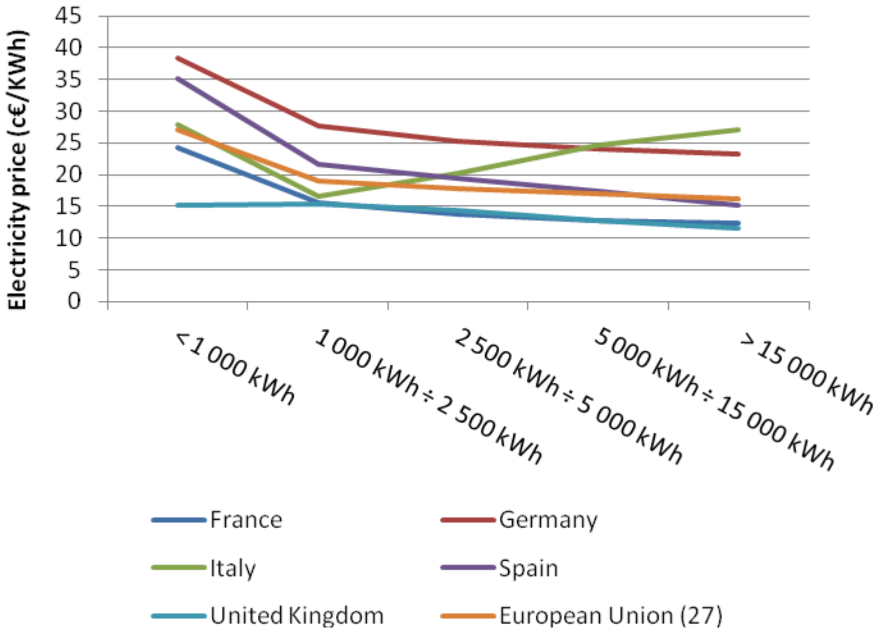
[52] EUROSTAT database, http://ec.europa.eu/eurostat

heat pumps or charging stations for electric cars,[53] whose spread can be considered fundamental to achieve the 20-20-20 objectives (lower consumption, lower emissions). From this point of view, Italian electricity prices are not still competitive compared to European ones.

Figure 31 displays prices applied to **non-domestic users** in various European countries (for further details see Table 16, Appendix, page 71). Italian prices are higher than the European ones for all the bands of consumption. With reference to the third band (500 MWh – 2 GWh), in which most Italian industries can be located, the net price is 25%, and the final one 29.5% higher than the average ones. Denmark and Germany reach the same final price but, once again, due to a higher taxation.

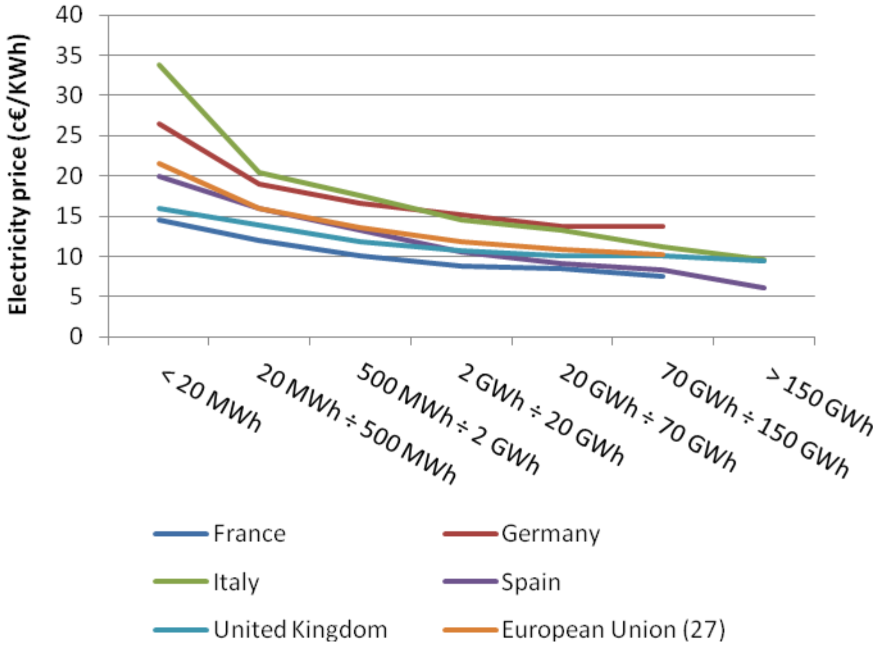
Figure 31 confirms the previously described trend and shows how prices decrease for the higher bands of consumption, becoming lower than German ones starting from the range 20 GWh -70 GWh. Anyway the Italian manufacturing sector relies mainly on small industries that experience a non-competitive tariff.

Figure 30 – Final electricity price for different bands of consumption (domestic users) for various European countries (authors' calculations based on EUROSTAT data referred to the 1st semester 2011)



[53] Resolution ARG/elt 56/10, April, 19th 2010

Figure 31 – Final electricity price for different bands of consumption (non-domestic users) for various European countries (authors' calculations based on EUROSTAT data referring to the 1st semester 2011.



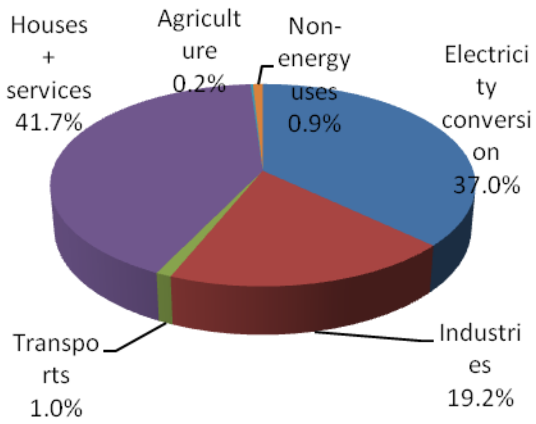
The Natural Gas Market

The interest in the natural gas supply and market in Italy is twofold, not only because natural gas is used in industries and for domestic heating, but it is also widely employed to produce electricity. In this section we will describe the market structure and the natural gas distribution network, along with the import infrastructure and projects to enhance it. We will also deal with the prices of natural gas in Italy in comparison with other European countries.

Structure, producers and operators

According to data provided by the Ministry of the Economic Development, the gross demand grew in 2010 to 83 bcm, up from 78 bcm of 2009, almost recovering the levels reached in 2008. To satisfy the higher demand, imports increased by 8.8% (from 69.3 to 75.3 bcm). In 2010 the domestic production also showed a small increase (3.6%) and covered about 10% of overall needs.[54]

Figure 32 – Natural gas consumption in 2010 by sector (authors' calculations based on AEEG data)



The overall final needs of natural gas (71.9 bcm) are subdivided among the sectors as follows (see Figure 32): heating in households and service sector (41.7%), electricity generation (37%) and industries (19.2%).

[54] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

Table 8 – Extraction, imports and sales for the main market operators in 2010 (source: AEEG)

(bcm)	Eni	Edison	Others	Total
Net internal extraction	6.7	0.5	0.8	8.1
Net Imports	28.5	13.5	31.0	73.1
Stock variations	-0.4	0.2	-0.5	-0.8
Purchase from other operators	4.4	4.1	83.6	92.1
Self-consumptions	5.4	4.7	3.8	13.9
Net transfers	1.2	-0.4	1.6	2.4
Losses	0.3	0.1	0.9	1.4
Sales to other operators	16.8	5.9	65.0	87.6
Sales to final users	17.8	7.2	46.9	72.0
- free market	10.9	7.0	32.1	50.0
- regulated market	6.9	0.2	14.8	21.9

Table 8 reports the shares of the market in 2010. It is worth noting that the main operators are Eni and Edison. The "Others" column includes some operators of a certain size, such as GdF Suez, Enel, A2A, E.On, Hera, Axpo Group, Sorgenia and dozens of other small players. It has to be noted that virtually all the domestic production of natural gas is controlled by Eni. Eni also has a dominant role in imports, controlling 39% of the total, while Edison manages 18.5%. Although with a smaller quota (24.7%), Eni is the largest operator also in terms of sales to final users. In addition to this, Eni controls Snam that owns 94% of nearly 34,000 km of grid. Eni's dominant position on the Italian market, in particular its control of the grid, is not a synonym of transparency and convenience for end users. Nowadays this is a hot issue in Italy, because the Monti government is committed to unbundling Snam from Eni.[55]

[55] The operation will involve the "Cassa Depositi e Presiti" (CDP), a company under public control with the Italian government holding 70%, which is expected to acquire the 53% of Snam from Eni by September 2013; CDP is also the main stockholder of Terna, the Italian TSO, owning its 29,95%.

Similarly to electricity, the Italian gas market can be divided into two categories: the regulated market ("tutelato") and the free market. The regulated market concerns the supply of gas services at economic and contractual conditions established by the Authority. It is restricted to residential users and customers with different uses with annual consumption not exceeding 200,000 m^3. The free market is the market where supply conditions are agreed between the parties and are not fixed by the Authority. Since January, 1st 2003, users (both domestic and non-domestic) have been free to choose the gas supplier on the free market.

The sales to users belonging to the regulated market represent 30.5% of the total, a share that decreased compared to 32% of 2009. For all the players the quota of sales on the free market is larger than that on the regulated one, in particular Edison sells almost all the gas on the free market.

As for internal production, the Ministry of the Economic Development estimates exploitable reservoirs for 103 bcm, which means about 13 years with the present rate of extraction. The predominant share, that is 56% of the exploitable reservoirs, is localized off-shore in the Adriatic Sea in front of Veneto's coast. The remaining share is localized on shore, in particular in the South of Italy.

Imports: the gas highways

In 2010, natural gas imports mainly come from Algeria (34.3%), Russia (29.6%), Libya (12.5%), the Netherlands (5.4%) and Norway (4.9%), but the quota of gas imported from Qatar is increasing as the LNG (liquefied natural gas) terminal of Porto Viro is progressively coming into operation. 88% of natural gas is imported by pipeline and the remaining share by LNG terminals.[56]

A representation of the Italian national grid is shown in Figure 33, where the entry points of both the operating pipelines and those under construction can be found. Algerian gas enters Italy mainly by the pipeline of Mazara del Vallo (Sicilia) and a smaller quota is regassified in the LNG terminal of Panigaglia (Tuscany). Russian gas flows through the entry points of Gorizia and Tarvisio (Friuli). The natural gas from Libya comes in by the entry point in Gela (Sicilia), and the natural gas from Norway and the Netherlands by the Gries Pass (Piemonte).

Four other pipelines are expected to come into operation in 2014-2015. The Trans Adriatic Pipeline (TAP) that will connect Greece, Albania and Italy will join the domestic gas network in Brindisi (Puglia); the IGI that will interconnect Italy and Greece at the

[56] Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

entry point of Otranto (Puglia); the GALSI that will connect Algeria with the entry point of Piombino (Toscana) passing via Sardinia; and the TGL that will connect Germany, Austria and will enter Italy near Udine (Friuli). The entire set of these pipelines will guarantee further capacity of about 40 bcm (about half the present needs).[57]

In Italy, there are also a lot of projects for LNG terminals, at different levels of planning, for a total capacity of about 80 bcm (for more details see Figure 33). Among these, several terminals, for a capacity of nearly 50 bcm, are expected to come into operation before 2014. Hopefully, this huge increase in import capacity by pipelines, but in particular with LNG terminals, will diversify supplies, increase competitiveness and eventually decrease costs. This scenario should become more realistic now with the impeding separation between the owner of the grid (Snam) and the biggest player on the market (Eni).

Another important part of the infrastructure for natural gas concerns storage, both for the balancing of the grid and for strategic purposes. The overall storage capacity amounts to 14.7 bcm (about 18% of the overall needs), among these 9.7 bcm are assigned to grid balancing and 5.1 bcm are reserved for strategic purposes. The majority of the storage is managed by STOGIT, completely owned by Snam (i.e. Eni). Almost every winter Italy experiences a shortage in the supply of Russian gas (because of severe climatic conditions), that tests the Italian storage capacity, and for this reason there are projects to increase the storage capacity by 40%.

However, in Italy the existing storage capacity is not well exploited due to some regulatory issues. Today, storage is shared out among the natural gas players as a function of the number of customers, which is why Eni has supremacy in this field. In addition, the LNG terminals cannot be employed for balancing purposes done in other European countries. Today some new regulations introduced by the Monti government are supposed to solve these issues.

Natural gas final prices: a comparison with Europe

This sub-section presents natural gas prices for end-users. As in the electricity market, all data were extracted from the Eurostat database on January, 25th 2012 and refer to the first semester of 2011.[58] Average prices have been collected by dividing the users into several bands of consumption.

Natural gas prices net-of-taxes for domestic users are basically lower than those of other European countries. However, the

---

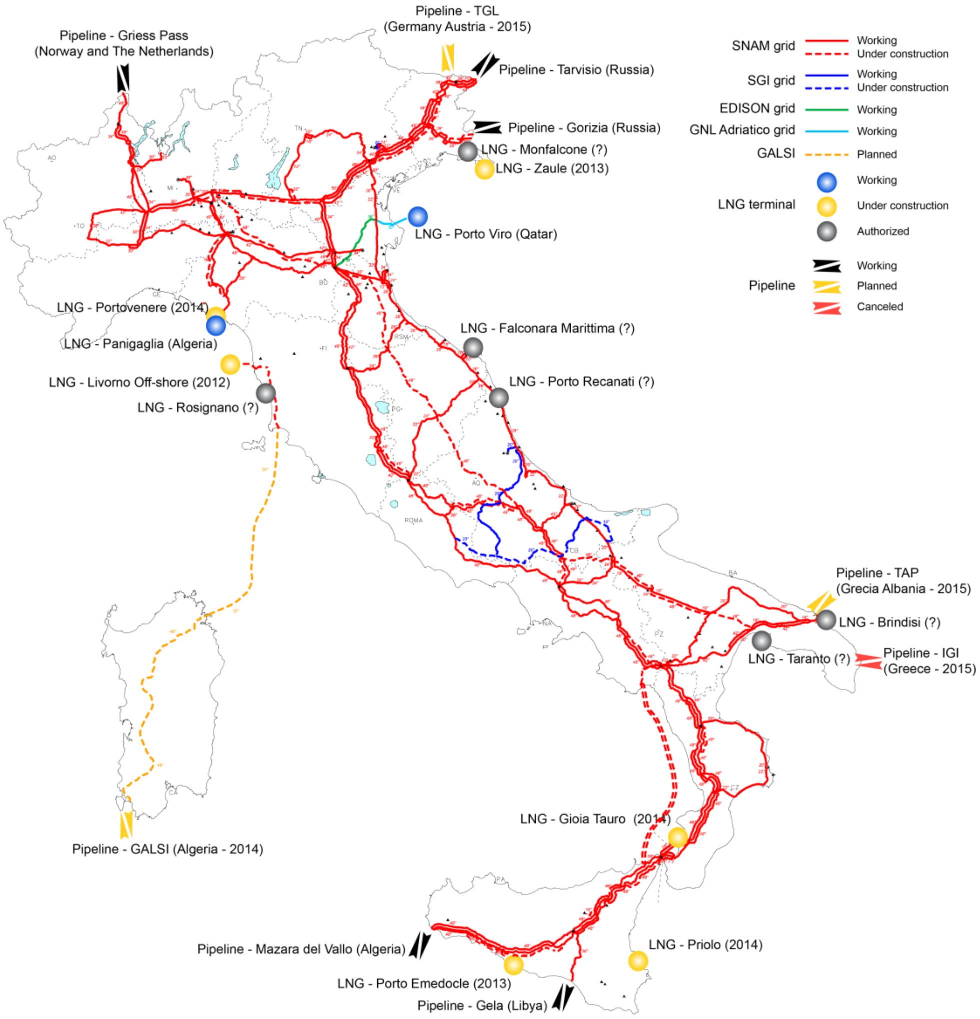
[57] The Final Investment Decision (FID) has not been taken yet for all these pipelines; in particular the IGI has been canceled.

[58] EUROSTAT database, http://ec.europa.eu/eurostat

final prices, including taxes, are higher for almost all the bands of consumption. In contrast, prices for non-domestic users are smaller than the average European ones.

As already said, in the first semester of 2011 the price of natural gas net of taxes for a **domestic user** in Italy was lower or equal to the European average for all the bands of consumption (see Table 17, Appendix, page 71). For the lowest band of consumption, the price was 14.2% lower than the European average and it was substantially aligned on European prices for other bands (+2.5%, +1.5%). Italian natural gas (net of taxes) is cheaper throughout all the classes of consumption, compared to the strongest economies (Germany and France).

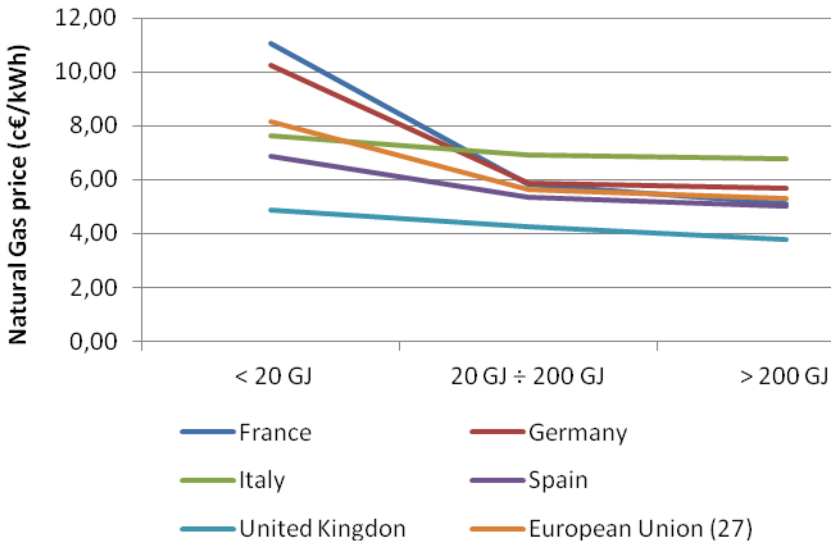
Figure 33 – Italian natural gas network: pipelines towards foreign countries and LNG terminals are highlighted (authors' calculations based on SNAM and AEEG data)



Considering the total price paid by **domestic end-users** (including taxes) in Italy, natural gas is cheaper only for the smallest customers (-6.4%). The discrepancies instead run in the opposite direction for users belonging to the second (+23%) and to the third band of consumption (+28%).

Figure 34 shows natural gas prices including taxes for various countries. As noted above for small users in Italy, the price is a bit lower than the European average and it is much lower than in France and Germany. In contrast, it is higher than in the United Kingdom and in Spain. For the higher bands of consumption, the final prices paid by Italian users are however higher than in all the other European countries, with the exception of Denmark and Sweden.

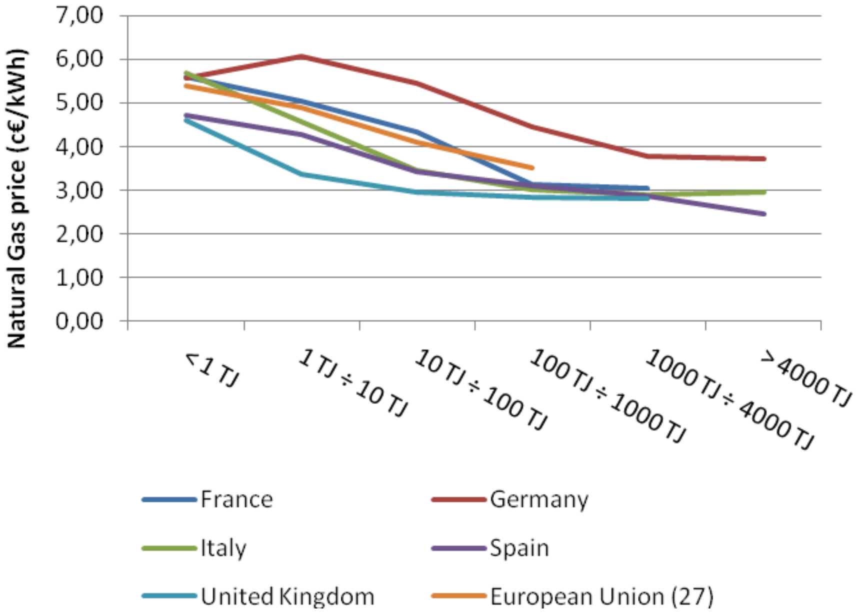
Figure 34 – Final natural gas price for different bands of consumption (domestic users) for various European countries (authors' calculations based on EUROSTAT data referred to the 1st semester 2011)



The gross price paid by Italian **non-domestic users** for natural gas (excluding non-energy uses and those for electrical generation) was higher than the European average for the lowest class of consumption, with a positive differential of 5.8%, and was lower for the classes with higher consumption (-6.5% -15.7% -14.2%). Looking at Figure 35, it is worth noting that Italian prices for non-domestic users are cheaper than French ones, and very similar to those experienced by Spanish users. In Germany, non-domestic users face prices that are higher than the European average.

For all consumption bands, discrepancies of Italian prices from the European average are more limited with regard to prices net of taxes (see also table 18, Appendix, page 71).

Figure 35 – Final natural gas price for different bands of consumption (non-domestic users) for various European countries (authors' calculations based on EUROSTAT data, referring to the 1st semester 2011)



The Italian Strategy for 20-20-20

This section deals with the Italian strategies for compliance with the 20-20-20 requirements. A national plan has been defined for both energy efficiency and renewable targets, while a clear strategy with respect to carbon emissions is not yet available.

PAEE: improving energy efficiency

The national plan for energy efficiency (PAEE),[59] presented in July 2007 in compliance with the 2006/32/CE directive, identified the targets and the measures for the reduction of the primary energy needs of the country. The directive 2006/32/CE asked European countries to define an action plan that targets, as an intermediate step, to a reduction in final energy needs by 9% (an approximate target) by 2016, with respect to the average needs of the period 2001-2005. The framework of this intermediate step is the ambitious goal of a reduction of energy consumption of 20% by 2020.

Italy is committed to reducing the energy needs by 9.6% in 2016 and has set a 3% reduction by 2010, as an intermediate step. The main measures enforced to hold down the consumption are: the introduction of energy efficiency certificates (along the lines of the green certificates), the tax deductions of 20% for the installation of high efficiency electric motors and inverters, the tax deductions of 55% for upgrading efficiency in buildings, the rise of the minimum energy requirements of the buildings and the mandatory energy certification of the buildings.

Table 9 – Energy efficiency targets for 2010-2016 and final results for 2010 (authors' calculations based on Ministry of the Economic Development data)

Savings	Final (2010) TWh/year	Expected (2010) TWh/year	Expected (2016) TWh/year
Domestic	31.47	17	56.83
Services	5.04	8.13	24.7
Industries	8.27	7.04	21.54
Transportation	2.97	3.49	23.26
Overall savings	47.75	35.66	126.33

59 Piano d'Azione Italiano per l'Efficienza Energetica (PAEE 2011), http://www.federcasa.it/news/energia_e_casa/documenti/PAEE.pdf

According to data reported in Table 9, in 2010 these measures yielded good results, in particular in the household sector where the energy savings were almost double expectations. For a correct analysis of the good results achieved by industrial sector, the period of economic stagnation should be recalled. The service and transportation sectors did not meet the goals but the good performance of the household sector widely compensated this fact, resulting in a 3.6% reduction of the final needs (compared to an expected cut of 3%).

Despite the good results obtained in 2010, the targets for 2016 and 2020 clearly require further efforts. In the 2011 edition of the action plan for energy efficiency, some areas of intervention were identified. The government will create a revolving fund to promote the installation of decentralized micro-co-generation systems and high efficiency electric motors. Another area of intervention is the improvement of the electric transmission system, in particular in the Southern regions, which is expected to provide 1200 GWh of savings.[60] The Minister for the Environment of the Monti government spoke up for the extension of the above mentioned tax deductions for energy efficiency in buildings, and to make this measure more structural. In addition to this, the government is working on a kind of feed-in tariff for solar power employed for hot water production.[61]

Currently, as we will see in the following section, these commitments for energy savings have been overtaken by the ones adopted for the 2020 European target for renewables. Considering this fact and that good results achieved in 2010 were obtained in a deflationary economic scenario, it is quite clear that energy efficiency targets should not be underestimated and that further efforts need to be made.

PAN: increasing renewables

Directive 2009/28/EC establishes a common framework for the promotion of energy from renewable sources and sets mandatory national targets for the overall share of renewables in final energy consumption in 2020. The European constraints have been transposed in the PAN plan.[62] Italy is committed to increasing the use of renewables working on three fronts: the production of electricity, the production of thermal energy for heating and cooling, as well as the use of biofuels.

---

[60]http://www.terna.it/default/Home/AZIENDA/sostenibilita2/sost_ambiente/sostAmb_clima/sostClima_svemiss.aspx#Riduzione_delle_perdite_di_rete

[61] http://www.ilsole24ore.com/art/tecnologie/2011-11-24/ministro-clini-proroga-084852.shtml?uuid=AabhH9NE

[62] Piano d' Azione Nazionale 2010, http://www.itabia.it/pdf/Piano%20Nazionale%20Azione%20Fonti%20rinnovabili.pdf

As mentioned in the previous sections, **electricity needs** represent an increasing quota of the overall needs of primary energy. So, the development of renewables for electricity generation is becoming more and more strategic, and important to the greater energy independence of the country. As discussed widely in Section 2.3, Italy has stimulated renewables for electricity in various ways, leading to strong growth in this sector. The development of renewable sources has not been followed by an enhancement of transmission lines, of storage systems and an adjustment of the distribution networks with the implementation of the so called "smart grids".

The energy consumption in **heating and cooling** represents an important portion of final needs, but is characterized by the limited use of renewables. Therefore, this sector has been identified as an interesting area in which efforts need to be concentrated to increase the weight of renewables. The main purposes related to this sector are: the development of district heating networks, the spread of cogeneration, the input of bio-methane into the national grid, the use of solar power to produce hot-water for households.

Transportation is the second main use of primary energy, as can be inferred from Table 10. For this reason this sector is also affected by plans for renewables. The main mechanism devoted to promote renewables in transportation is the obligation for the suppliers to introduce a certain amount of biofuels into the market.

The goal for 2020 consists of a ratio whose numerator is the energy produced by renewable sources, with final energy consumption being the denominator. To achieve the renewable target, it is fundamental to define the forecast of energy consumption in 2020. According to the Baseline scenario of the Primes Study 2007 (also taken as a reference by the European Commission), Italy's final needs of primary energy in 2020 will reach 1,936 TWh. This study only considers measures to reduce consumption adopted by that date. The 2009 update of the Primes Study, which takes into account the effects of the crisis, reduced the estimates for 2020 to 1,693 TWh. In order to formulate the hypothesis of final consumptions in 2020, Italy has assumed an extra effort on energy efficiency compared to these scenarios, in order to reduce the constraint on the numerator (i.e. production from renewables). By implementing this extra effort, gross final consumption is expected to be reduced to the same value of 2008 (1,526 TWh). This target has also become more constraining than the above mentioned PAEE scenario. According to a recent report, the AEEG highlighted the fact that the investment in renewables has been favored compared to investments in energy efficiency (REF). As a result, the numerator has increased more than the denominator has decreased, contrary to what defined in the PAN.

Table 10 – PAN targets and results (authors' calculations based on Ministry of the Economic Development data)

	FINAL SITUATION						PLANS	
	2005			2009			2010	2020
	Ren. (TWh)	Needs (TWh)	Ren. Quota	Ren. (TWh)	Needs (TWh)	Ren. Quota	Ren. Quota	Ren. Quota
Electricity	56.4	346.0	16.3%	62.7	333.3	18.8%	18.7%	26.4%
Heat	25.5	769.9	3.3%	52.3	636.1	8.2%	6.5%	17.1%
Transportation	3.9	453.6	0.9%	16.1	420.9	3.8%	3.5%	10.1%
Total	**85.8**	**1569.5**	**5.5%**	**131.1**	**1390.2**	**9.4%**	**8.1%**	**17.0%**

Italy's aim is to meet 17% of its final needs of primary energy with renewables. Table 10 shows the targets broken down by sector. The goal is to cover 26% of the electricity needs with renewables, 17% of the energy used for heating and cooling and 10% of the energy used for transportation. Starting from 2016, Italy is planning to import some small amounts of renewable electricity from Switzerland, the Balkans and from Tunisia. However these targets seem difficult to achieve considering that Switzerland is going to exit its nuclear program, thus increasing its domestic energy needs, and the fact that the necessary connections with other countries have not been built yet.

With reference to Table 10, it is clear that the fulfillment of the plan for renewables has actually been in advance of forecasts. According to the final data provided by GSE, the quota of renewables reached in 2009 is higher than the plans for 2010 in every sector. With regard to the final data for 2010, currently only the data for electricity are available: in 2010, 20.1% of the electricity demand was satisfied with renewables, this value corresponds to the goal for 2012, two years in advance. Among renewables for electricity, the only sector in which results are a bit smaller than expectations is geothermoelectricity (-9%). All the other sources have exceeded expectations. In particular, according to the provisional data released by TERNA for 2011, the amount of photovoltaic energy produced was nearly four times the target value.[63] As mentioned above, this is the result of overly generous incentives, which reflect real prices of photovoltaic components too little.

[63] TERNA, Dati provvisori d'esercizio 2011, http://www.terna.it/LinkClick.aspx?fileticket=NyK5pNTnIpg%3d&tabid=380&mid=442

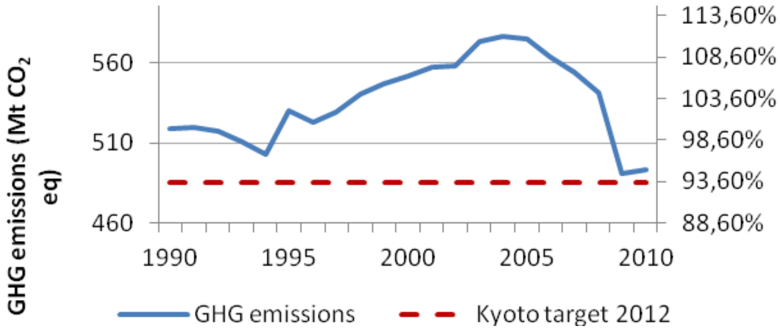
Greenhouse gas emissions: still waiting for a strategy…

Italy, in agreement with the Kyoto protocol, is committed to reducing the average greenhouse gas emissions (GHG) in the period 2008-2012 by 6.5%, compared to those of 1990. Even if Italy has entered the European Emission Trading System (ETS), a well defined national strategy, also regarding long-term targets (2020), has not been defined. This is one of the reasons why Italy is one of the least efficient countries with respect to emission, in particular considering the Kyoto protocol target.

Figure 36 reports the GHG emissions in CO_2 equivalent tonnes from 1990 to 2010. It can be noted that Italian emissions have been constantly higher than the Kyoto limit, approaching the target value only during the period 2009-2010. More specifically, a sharp reduction of the emissions can be observed starting from 2005, in accordance with the decrease of the primary energy consumption (Figure 1, page 8). As said before, this is mainly due to a substantial downturn of the industrial sector (figure 3, page 8), worsened by the economic crisis. Under these conditions, the ETS, which mainly regulates the energy and industrial areas, has had a small effect on the reduction of emissions. The Italian quotas, assigned through the PNA 2008-2012 based on the European directive 2003/87/EC, turned out to be larger than effective emissions, not forcing users to improve the efficiency of their plants.[64] As an example in 2010, the assigned quotas amounted to 200.2 $MtCO_2$, while only 190.1 $MtCO_2$ were actually verified.

[64] Piano Nazionale di Assegnazione delle quote di CO2 2008-2012 (PNA 2008-2012), Ministry of the Environment, http://www.minambiente.it/export/sites/default/archivio/allegati/autorizzazioni/pna_CO2_2008_2012.pdf

Figure 36 – GHG emissions from 1990 (=100) to 2010; the Kyoto target for the 2008-2012 period is also shown (authors' calculations based on EUROSTAT data)



On the other hand, the CO_2/primary energy trend (Figure 5, page 13) was almost flat from 2000 to 2007, and then showed a steep decrease during 2008-2010, due to the increasing weight of renewable sources in the whole energy-mix. This led to a significant reduction in the total emissions. Moreover, it is worth noting that the PAEE 2011 (Section 5.1) reported a reduction in consumption of 3.6% in 2010, mainly in the domestic/services area, with respect to the period 2001-2005, thus further contributing to emission reductions. As a result of these two positive trends, the Kyoto target could be met by 2012.

Nevertheless, a great effort must be devoted to emission reduction in order to meet the -20% constraint set for 2020. Concerning this, the Minister for the Environment Corrado Clini announced the presentation of a plan by March 2012.[65] A clear national strategy should be identified considering the benefits of renewables (PAN), consumption reduction (PAEE) and local plans (PAES, Piano d'Azione per l'Energia Sostenibile, derived from the European Covenant of Mayors). But it should also try to integrate them, acting in particular on energy (thermoelectric) and industrial areas.

From this point of view, the new ETS plan of 2013 should reduce both the total quota assigned to Italy and the free percentage of quotas allocated to thermoelectric plants and industries. On the other hand, it is necessary to pay particular attention to the economic consequences of these actions, since Italy's electricity generation depends strongly on fossil fuels and is already functioning at a high

[65] http://www.repubblica.it/ultimora/economia/Ambiente-Clini-pronto-piano-riduzione-emissioni/news-dettaglio/4111729

level of efficiency (Section 2.3.1). The reduction of the emissions quota devoted to this sector would lead to an increase in the cost of electricity for users, while an additional cost for industries may cause a further economic slump.

To be sure, an enhancement of the power grid could be of paramount importance in reducing the losses and could increase production from renewable sources, limited at the moment by the poor flexibility of the system. Moreover, a real "smart grid" could also open the way to a serious program favoring electricity mobility, thus further reducing emissions from the transportation sector.

Future Prospects

In 2011, Italy renounced the use of nuclear power. In addition to this, considering that Italy's hydroelectricity potential is almost totally exploited and that its fleet of thermoelectric plants is recent and characterized by state-of-the-art efficiency, it is reasonable to think that the future energy mix will not face substantial changes, expect for a further increase in the use of renewables. Italian power plants are mainly based on combined cycle technology and were built in the first years of 2000s: their working lives are expected to run well beyond 2020. Furthermore, the power capacity of the overall thermoelectric plants is more than enough to the power needs, even if considering ever-growing electricity demand. For these reasons, the strong dependence of Italy on the fossil fuels, and natural gas in particular, is expected to continue in the coming years.

In the thermoelectricity field, a way for the diversification of the energy mix is represented by the so called "clear coal" plants. In Italy, some pilot projects using the CCS technology have been developed. This technology, which is still at a research stage, could represent an advantage in terms of CO_2 emissions, but it is surely not the definitive solution.[66]

The other possible way of diversification is the further increase of renewables. As widely discussed in the previous sections the energy produced by renewable sources is increasing steadily. However, the development of the transmission network is not going hand-in-hand with their rapid growth. So, it is now of strategic concern to develop the transmission network, in particular in Southern regions and to stimulate the introduction of smart grids, within the distribution network. The improvement of electricity storage systems is also mandatory. Among the available technologies, pumped-hydroelectricity is the most efficient and mature, and some investments are being made in this sector. At the same time, some studies on battery-based storage are being performed by ENEL.[67] It has to be noted that the development of smart grids could be made in synergy with the diffusion of the electricity mobility. Along with the advantages in terms of carbon emissions and pollution of metropolitan areas this represents, it could lead to the creation of distributed energy storage basins.

---

[66] ENEL, Obiettivo zero emissioni, http://www.enel.it/it-IT/eventi_news/news/obiettivo-zero-emissioni/p/090027d981930306

[67] http://www.enel.com/it-IT/media/news/nuovi-investimenti-per-le-smart-grids/p/090027d981a4e024

The rapid growth of renewables in the last few years, which benefit from dispatching priority, has caused a reduction of the exploitation of Italy's fleet of thermoelectric plants. Italy could exploit this fleet, which is able to support peak loads, more effectively in the perspective of the creation of a European energy market. To implement this, a common regulatory framework for the allocation of capacity and strengthening of the connections with the neighboring countries is necessary.

All these issues should be merged into a long-term national strategy that has been put off for years, but which was announced for the June 2011 by the former government, and yet has not been published. This plan should regulate the development of the sector situating it within the European market. For now, there are only initiatives limited to certain sectors, such as renewables and energy saving. Both these initiatives have reported excellent results in terms of numbers, but raise different issues. As for the renewable sector, the fact that different types of incentives coexist has hampered the rational development of the system. Just to cite an example, in certain sectors the old CIP6 system and the green certificates coexisted, affecting the latter incentives that were less expensive for the community. Another example is the incentive for photovoltaics that has changed four times within 4 years, generating turbulent development and encouraging speculation. The problem of uncertainty has also affected the field of energy efficiency, namely the 55% tax deductions for upgrading the efficiency of buildings and which have never been transposed into a legal framework.

The wise management of renewables and energy efficiency should be a driving force for the reduction of CO_2 emissions. Italy is still late on this front: an action plan for carbon dioxide reduction has never been published and the European goal is still far off. Italy will probably respect the intermediate commitment for 2012, thanks only to the unexpected growth of renewables.

This scenario is not encouraging in terms of energy costs for end-users. Indeed, the development of renewables and of the transmission network is inevitably costly, while also maintaining dependence on natural gas. From this point of view, however, the situation could be improved by acting strongly on the development of LNG terminals and pipeline interconnections. Italy is doing much in this sense, and in the next few years its import capacity will be doubled, in particular using LNG terminals. This choice is strategic because of the abundance of natural gas in certain markets far from Europe. The reduction of the cost of natural gas for final users requires an opening of the gas market that can only be fully implemented after the unbundling of the gas network run by Eni, which is the former monopoly and the main player in the market. The development of the import infrastructure and the full liberalization of the market could make Italy the European hub for natural gas, as advocated by the Authority.[68] This would reduce the economic burden of the energy sector. Is it too late, though?

[68] Autorità per l'energia elettrica e il gas (AEEG), Indagine Conoscitiva sulle Strategia Energetica Nazionale (PAS 23/11), http://www.autorita.energia.it/allegati/audizioni/parlamentari/023-11pas.pdf

Appendix

Table 11 – CIP6 from renewable sources (assimilated not included): power capacity installed, energy produced and costs in 2010 (source: GSE)

Source	Power	Energy	CIP6 remuneration			Sell proceeds	Tariff burden
	MW	GWh	€k	%	€/kWh	€k	€k
Hydro	114.89	178.3	25767	2.39	0.14	11514	14252
Bioenergy	856.73	4770.13	932319	86.40	0.2	308055	624263
Wind	622.36	816.34	79709	7.39	0.1	52719	26990
Geothermal	122.53	282.64	41226	3.82	0.15	18253	22974
Photovoltaics	-	-	-	-	-	-	-
Total	1716.51	6047.41	1079021	100	0.18	390541	688479

Table 12 – Green certificates system: power capacity installed, energy produced and costs in 2010 (source: GSE)

Source	Power	Energy	Green cerificates		Value at 2011
	MW	GWh	n°	%	€k
Hydro	5895.91	18104.76	7539609	34.83	658811
Bioenergy	1134.89	4230.96	5076265	23.45	443564
Wind	4963.04	8083.17	8083102	37.34	706301
Geothermal	360	2051.5	945906	4.37	82653
Photovoltaics	1.78	2.02	2018	0.01	176
Total	12355.62	32472.41	21646900	100	1891505

Table 13 – Feed-in tariff system: power capacity installed, energy produced and costs in 2010 (source: GSE)

Source	Power	Energy	Feed-in tariff	
	MW	GWh	€k	%
Hydro	139.61	494.12	108706	34.20
Bioenergy	213.32	807.19	208612	65.64
Wind	3	1.65	494	0.16
Geothermal	-	-	-	-
Photovoltaics	-	-	-	-
Total	355.93	1302.96	317812	100

Table 14 – RID and SSP plants: power capacity installed, energy produced and costs in 2010 (source: GSE)

Source	Power	Energy	energy value	
	MW	GWh	€k	%
Hydro	1233.83	3932.49	297192	37.13
Bioenergy	445.63	958.99	69202	8.65
Wind	3213.84	4801.89	332297	41.52
Geothermal	60	0.164	11	0.00
Photovoltaics	1921.07	1167.14	101720	12.71
Total	6874.37	10860.67	800422	100

Figure 37 – CIP6 electricity production from assimilated sources per group (source: AEEG)

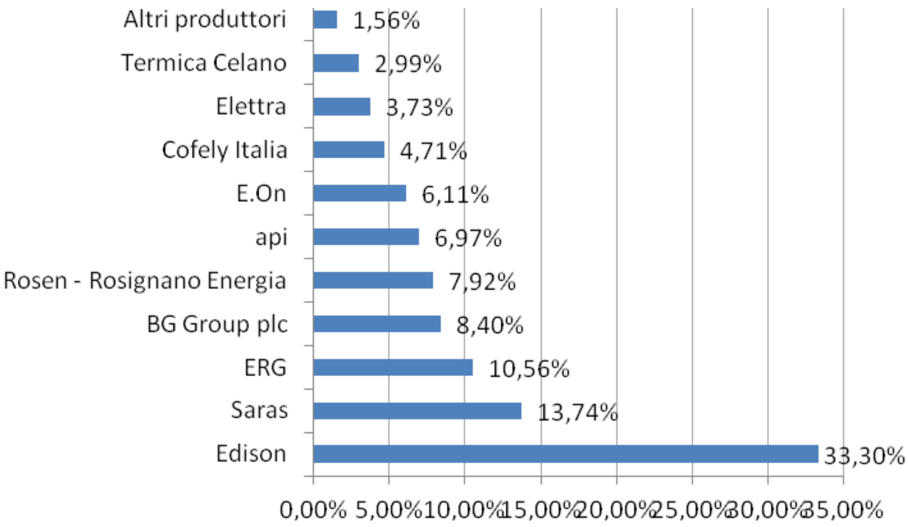


Figure 38 – CIP6 electricity production from renewable sources per group (source: AEEG)

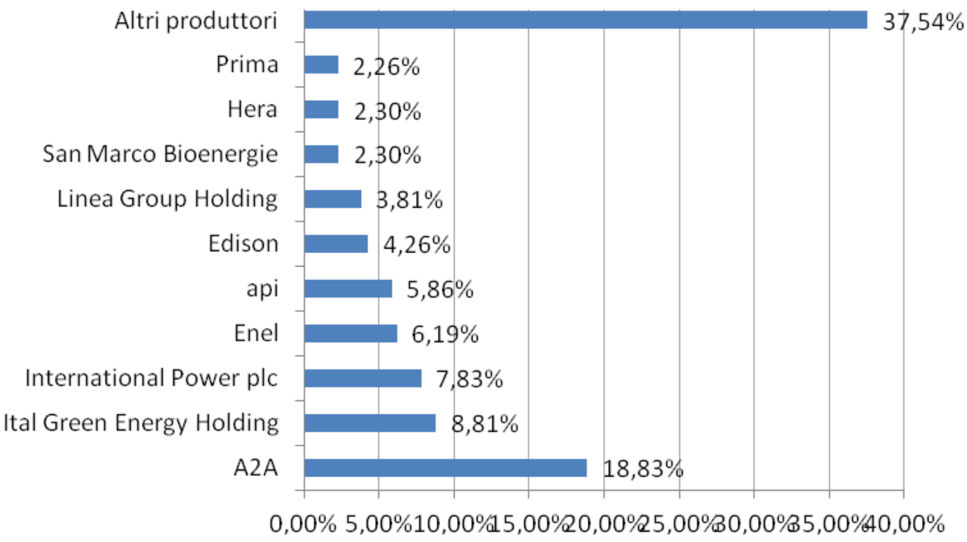


Table 15 – Final electricity price for different bands of consumption (domestic users) for various European countries (authors' calculations based on EUROSTAT data referring to the 1st semester 2011)

DOMESTIC USERS - BAND OF CONSUMPTION										
	< 1 000 kWh		1 000 kWh ÷ 2 500 kWh		2 500 kWh ÷ 5 000 kWh		5 000 kWh ÷ 15 000 kWh		> 15 000 kWh	
(all prices in €c/KWh)	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL
Austria	20.55	29.46	15.74	22.1	14.42	19.86	13.15	18.05	11.91	16.31
Belgium	23.04	30.34	17.65	23.69	15.72	21.36	13.99	19.28	11.81	16.66
Bosnia and Herzegovina	n.a.	n.a.	n.a.	n.a.	6.39	7.47	n.a.	n.a.	n.a.	n.a.
Bulgaria	6.99	8.4	6.91	8.29	6.88	8.26	6.86	8.23	6.91	8.29
Croatia	14.75	18.22	9.02	11.18	9.18	11.37	8.8	10.91	8.46	10.49
Cyprus	19.94	23.53	17.28	20.47	17.31	20.5	16.79	19.9	15	17.83
Czech Republic	26.04	31.38	19.3	23.29	12.32	14.95	10.31	12.53	8.91	10.84
Denmark	15.09	32.15	15.09	32.15	12.63	29.08	10.83	25.41	10.83	25.41
Estonia	7.33	10.08	7.23	9.95	7.04	9.73	6.74	9.37	6.03	8.51
Finland	20.98	27.9	13.98	19.29	10.81	15.4	9.3	13.54	7.67	11.53
France	19.73	24.22	11.58	15.58	9.94	13.84	8.86	12.69	8.6	12.45
Germany	24.78	38.35	16.09	27.74	14.06	25.28	12.99	23.99	12.67	23.19
Greece	12.91	15.11	8.9	10.7	10.01	12.5	10.81	15.22	10.27	15.44
Hungary	15.04	18.92	13.73	17.28	13.35	16.81	12.63	15.92	13.11	16.51
Ireland	31.48	42.62	18.92	23.53	15.84	19.01	13.46	15.8	11.46	13.18
Italy	**22.09**	**27.79**	**12.65**	**16.55**	**14.15**	**20.13**	**17.47**	**24.57**	**19.6**	**27.03**
Latvia	9.57	11.68	9.56	11.67	9.57	11.68	9.67	11.8	9.91	12.09
Lithuania	10.57	12.78	10.34	12.51	10.04	12.14	9.74	11.78	9.2	11.13
Luxembourg	22.19	24.92	16.25	18.63	14.51	16.78	13.42	15.63	11.86	13.97
Malta	37.05	39	19	20	16.15	17	17.1	18	31.35	33
Netherlands	23.88	n.a.	15.08	10.24	13	17.43	11.48	20.88	10.39	16.96
Norway	36.47	47.38	23.16	30.74	15.63	21.33	11.51	16.19	10.29	14.65

DOMESTIC USERS - BAND OF CONSUMPTION										
	< 1 000 kWh		1 000 kWh ÷ 2 500 kWh		2 500 kWh ÷ 5 000 kWh		5 000 kWh ÷ 15 000 kWh		> 15 000 kWh	
(all prices in €c/KWh)	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL
Poland	14.85	18.89	12.4	15.87	11.45	14.71	10.83	13.94	10.79	13.9
Portugal	19.12	33.3	11.39	18.62	10.15	16.54	9.12	15.04	8.97	14.42
Romania	8.48	10.84	8.62	11	8.48	10.82	8.36	10.67	7.92	10.14
Slovakia	19.03	23.2	15.45	18.9	13.72	16.82	12.22	15.02	10.7	13.2
Slovenia	15.78	23	12.11	16.73	10.79	14.41	10.24	13.32	9.9	12.59
Spain	28.9	35.24	17.68	21.56	15.97	19.47	14.26	17.38	12.51	15.25
Sweden	26.03	36.35	15.21	22.82	13.76	20.92	11.41	18.01	10.07	16.33
Turkey	9.77	12.15	9.77	12.16	9.78	12.16	9.74	12.12	9.74	12.13
United Kingdom	14.51	15.23	14.58	15.31	13.65	14.33	12.07	12.67	10.98	11.53
European Union (27 countries)	20.61	27.12	14.1	19.01	12.75	17.84	11.86	17.02	11.34	16.28

Table 16 – Final electricity price for different bands of consumption (non-domestic users) for various European countries (authors' calculations based on EUROSTAT data referred to the 1st semester 2011)

NON-DOMESTIC USERS - BAND OF CONSUMPTION														
	< 20		20 MWh		500		2 GWh		20 GWh		70 GWh		> 150	
(all prices in	NO	FI	NO	FIN	NO	FIN	NO	FI	NO	FIN	NO	FIN	NO	FI
Austria	n.a.	n.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	n.a.	n.a.	n.a.	n.a.	n.a.	n.
Belgium	16.	22	12.6	17.	9.77	13.	8.6	11.	7.41	10.	6.69	9.0	n.a.	n.
Bosnia	n.a.	n.	n.a.	n.a.	6.14	7.1	n.a.	n.a	n.a.	n.a.	n.a.	n.a.	n.a.	n.
Bulgaria	7.7	9.	7.1	8.6	6.38	7.7	5.74	7	5.04	6.1	4.88	5.9	4.5	5.
Croatia	11.	14	10.3	12.	9	11.	7.68	9.5	6.03	7.5	5.68	7.0	n.a.	n.
Cyprus	19.	22	18.4	21.	16.0	19.	14.4	17.	13.8	16.	13.8	16.	n.a.	n.
Czech	18.	22	14.4	17.	10.9	13.	9.84	11.	10.0	12.	9.56	11.	n.a.	n.
Denmark	10.	25	9.48	21.	8.75	20.	8.7	20.	7.93	19.	7.93	19.	n.a.	n.
Estonia	6.9	9.	6.39	8.9	6.16	8.6	6.16	8.6	5.85	7.9	5.55	7.8	n.a.	n.
Finland	8.8	11	8.05	10.	6.86	9.3	6.63	9.0	5.81	8.0	5.63	7.7	n.a.	n.
France	10.	14	8.85	12.	7.22	10.	6.52	8.8	6.38	8.5	5.62	7.5	n.a.	n.
Germany	16.	26	10.9	19.	9	16.	7.91	15.	7.07	13.	7.16	13.	n.a.	n.
Greece	13.	15	11.0	13.	9.39	11.	7.73	9.4	6.88	8.4	5.69	6.8	5.7	6.
Hungary	11.	15	9.97	12.	9.32	12.	8.48	11.	8.67	11.	7.44	9.7	6.8	9.
Ireland	16.	20	12.9	14.	11.2	12.	8.58	9.7	7.55	8.4	6.78	7.8	n.a.	n.
Italy	**24.**	**33**	**13.5**	**20.**	**11.6**	**17.**	**10.2**	**14.**	**10.1**	**13.**	**8.72**	**11.**	**8.1**	**9.**
Latvia	12.	15	10.5	12.	9.84	12.	9.05	11.	8.92	10.	8.06	9.8	n.a.	n.
Lithuania	13.	15	11.3	13.	10.4	12.	10.1	12.	10.0	12.	n.a.	n.a.	n.a.	n.
Luxembou	15.	18	10.9	12.	9.6	10.	7.1	7.7	6.09	6.5	n.a.	n.a.	n.a.	n.
Malta	29	30	20	21	18	18.	16	16.	15	15.	n.a.	n.a.	n.a.	n.
Netherland	14.	22	10.2	17.	8.41	12.	7.54	10.	7.03	9.3	6.99	9.3	6.6	8.
Norway	10.	14	9.89	14.	9.62	13.	8.17	12	7.11	10.	4.46	7.3	n.a.	n.
Poland	15.	19	11.5	14.	9.63	12.	8.11	10.	7.61	9.9	7.41	9.7	7.8	10
Portugal	10.	18	9.2	13.	9.03	10.	8.41	9.5	6.56	7.7	6.1	7.4	n.a.	n.
Romania	10.	13	9.87	12.	8.03	10.	7.03	9	6.28	8.0	5.91	7.6	n.a.	n.
Slovakia	19.	23	14.6	18.	12.3	15.	11.1	13.	10.2	12.	9	11.	9.0	11
Slovenia	12.	17	10.5	13.	8.89	11.	7.55	10.	6.71	9.0	6.77	9.2	n.a.	n.
Spain	16.	19	13.1	15.	10.8	13.	8.72	10.	7.51	9.1	6.77	8.2	5	6.
Sweden	16	20	10.0	12.	8.87	11.	7.83	9.8	7.13	8.9	6.68	8.4	n.a.	n.
Turkey	8.7	10	8.28	10.	7.6	9.2	6.78	8.2	6.05	7.3	5.82	7.1	5.9	7.
United	12.	15	11.0	13.	9.39	11.	8.56	10.	8.15	10.	8.08	10	7.8	9.
European	**15.**	**21**	**11.1**	**15.**	**9.36**	**13.**	**8.24**	**11.**	**7.64**	**10.**	**7.14**	**10.**	**n.a.**	**n.**

Table 17 – Final natural gas price for different bands of consumption (domestic users) for various European countries (authors' calculations based on EUROSTAT data referred to the 1st semester 2011)

DOMESTIC USERS - BAND OF CONSUMPTION						
	< 20 GJ		20 GJ ÷ 200 GJ		> 200 GJ	
(all prices in €c/kWh)	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL
Austria	6.21	8.33	5.12	6.94	4.55	6.22
Belgium	6.16	8.17	4.57	5.71	4.28	5.48
Bosnia and Herzegovina	3.55	4.53	3.55	4.53	3.55	4.53
Bulgaria	3.56	4.27	3.58	4.30	3.62	4.34
Croatia	3.05	3.75	3.05	3.75	3.05	3.75
Czech Republic	7.26	8.72	4.54	5.44	4.28	5.14
Denmark	5.93	11.61	5.93	11.61	5.93	11.61
Estonia	4.17	5.27	3.27	4.19	3.22	4.13
France	9.19	11.06	4.83	5.80	4.28	5.13
Germany	7.79	10.26	4.35	5.88	4.17	5.67
Hungary	4.79	5.99	4.48	5.61	4.48	5.61
Ireland	4.65	5.59	4.21	5.09	3.99	4.84
Italy	**5.50**	**7.64**	**4.41**	**6.94**	**4.03**	**6.77**
Latvia	5.64	6.33	3.45	3.87	3.39	3.81
Lithuania	5.49	6.64	3.59	4.35	3.12	3.77
Luxembourg	6.17	6.76	4.58	5.11	4.17	4.82
Netherlands	6.63	10.40	4.17	7.16	3.83	6.69
Poland	5.06	6.22	3.77	4.63	3.48	4.28
Portugal	7.32	7.87	5.67	6.10	5.06	5.46
Romania	1.50	2.86	1.49	2.84	1.47	2.78
Slovakia	8.26	9.91	3.88	4.65	4.31	5.18
Slovenia	6.24	8.01	5.12	6.68	4.42	5.84
Spain	5.80	6.85	4.54	5.36	4.26	5.02

DOMESTIC USERS - BAND OF CONSUMPTION						
	< 20 GJ		20 GJ ÷ 200 GJ		> 200 GJ	
(all prices in €c/kWh)	NO TAX	FINAL	NO TAX	FINAL	NO TAX	FINAL
Sweden	11.92	18.89	6.60	12.24	5.80	11.24
Turkey	2.46	3.02	2.35	2.89	2.37	2.92
United Kingdom	4.63	4.85	4.05	4.25	3.58	3.76
European Union (27)	**6.41**	**8.16**	**4.30**	**5.64**	**3.97**	**5.30**

Table 18 – Final natural gas price for different bands of consumption (non-domestic users) for various European countries (authors' calculations based on EUROSTAT data referred to the 1st semester 2011)

NON-DOMESTIC USERS - BAND OF CONSUMPTION												
	< 1 TJ		1 TJ ÷ 10 TJ		10 TJ ÷ 100 TJ		100 TJ ÷ 1000 TJ		1000 TJ ÷ 4000 TJ		> 4000 TJ	
(all prices in €c/kWh)	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX
Austria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Belgium	4.71	5.91	3.94	4.96	3.09	3.91	2.57	3.20	2.41	2.99	n.a.	n.a.
Bosnia and Herzegovina	3.55	5.61	3.55	5.61	3.55	5.61	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	3.27	3.93	3.12	3.74	2.87	3.45	2.65	3.19	2.57	3.08	n.a.	n.a.
Croatia	4.05	4.97	4.05	4.97	4.05	4.97	4.05	4.97	n.a.	n.a.	n.a.	n.a.
Czech Republic	4.33	5.35	3.73	4.62	3.01	3.76	2.81	3.53	2.56	3.22	n.a.	n.a.
Denmark	5.93	11.61	5.93	11.61	3.40	8.43	3.29	8.29	n.a.	n.a.	n.a.	n.a.
Estonia	3.01	3.88	2.76	3.54	2.63	3.35	2.57	3.24	2.51	3.13	n.a.	n.a.
Finland	n.a.	n.a.	n.a.	n.a.	3.36	5.14	3.25	4.99	2.91	4.58	n.a.	n.a.
France	4.56	5.59	4.14	5.05	3.55	4.32	2.65	3.14	2.62	3.03	n.a.	n.a.
Germany	4.27	5.57	4.68	6.05	4.17	5.44	3.34	4.46	2.77	3.78	2.73	3.73
Hungary	4.46	5.73	3.73	4.81	3.22	4.18	3.89	5.00	3.24	4.20	3.26	4.22
Ireland	3.54	4.33	3.43	4.21	3.56	4.22	2.73	2.98	n.a.	n.a.	n.a.	n.a.
Italy	**4.06**	**5.70**	**3.64**	**4.57**	**2.97**	**3.45**	**2.71**	**3.01**	**2.66**	**2.91**	**2.72**	**2.97**
Latvia	3.46	4.23	3.22	3.93	2.92	3.57	2.80	3.42	2.60	3.18	n.a.	n.a.

NON-DOMESTIC USERS - BAND OF CONSUMPTION												
	< 1 TJ		1 TJ ÷ 10 TJ		10 TJ ÷ 100 TJ		100 TJ ÷ 1000 TJ		1000 TJ ÷ 4000 TJ		> 4000 TJ	
(all prices in €c/kWh)	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX	NO TAX	TAX
Lithuania	3.54	4.28	3.49	4.23	3.51	4.24	3.38	4.09	n.a.	n.a.	n.a.	n.a.
Luxembourg	4.60	4.99	4.34	4.68	4.17	4.49	3.29	3.52	n.a.	n.a.	n.a.	n.a.
Netherlands	3.68	6.58	3.25	5.43	2.70	3.92	2.52	3.31	2.40	2.94	2.31	2.79
Poland	3.81	4.68	3.64	4.48	3.28	4.03	2.87	3.53	2.57	3.16	n.a.	n.a.
Portugal	5.27	5.70	4.32	4.61	3.38	3.59	2.88	3.06	2.62	2.78	n.a.	n.a.
Romania	1.48	2.82	1.47	2.78	1.52	2.81	1.57	2.63	1.55	2.46	1.47	2.05
Slovakia	4.45	5.50	3.74	4.64	3.32	4.14	2.91	3.65	2.57	3.24	n.a.	n.a.
Slovenia	4.82	6.32	4.82	6.32	4.03	5.37	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	4.00	4.72	3.63	4.28	2.91	3.43	2.62	3.10	2.44	2.88	2.08	2.46
Sweden	5.64	11.03	4.95	10.19	4.23	9.26	3.91	8.90	3.42	8.30	n.a.	n.a.
Turkey	2.39	2.94	2.23	2.75	2.08	2.57	2.02	2.50	2.00	2.48	n.a.	n.a.
United Kingdom	3.69	4.61	2.66	3.37	2.33	2.96	2.29	2.84	2.32	2.82	n.a.	n.a.
European Union (27)	**4.06**	**5.39**	**3.75**	**4.89**	**3.18**	**4.09**	**2.76**	**3.51**	**n.a.**	**n.a.**	**n.a.**	**n.a.**

Bibliography

TERNA, Statistical Data on electricity in Italy: general data 2010, http://www.terna.it/LinkClick.aspx?fileticket=9mXvJCVFoN4%3d&tabid=670&mid=13878

ISTAT, Italian Historical Statistical Repository: gross inland energy consumption, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.13.xls

ISTAT, Italian Historical Statistical Repository: gross electricity production and final electricity consumption in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.14.xls

ISTAT, Italian Historical Statistical Repository: Simplified Energy Balance in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.12.xls

Ministry of the Economic Development, Tabella Dati Energetici 2010, http://dgerm.sviluppoeconomico.gov.it/dgerm/downloads/tabella_dati_rge_2010.xls

General Direction for Mining and Energetic Resources 2011, Ministry of the Economic Development (Energy department), http://unmig.sviluppoeconomico.gov.it/unmig/stat/ra2011eng.pdf

GSE, Rapporto statistico 2010: impianti a fonti rinnovabili, http://approfondimenti.gse.it/attivita/statistiche/Documents/Statistiche%20Rinnovabili%202010.pdf

Sistema Italiano Monitoraggio Energie Rinnovabili (SIMERI), http://approfondimenti.gse.it/approfondimenti/Simeri/Pagine/default.aspx

ISTAT, Italian Historical Statistical Repository: Reconciliation of Gross Domestic Product (GDP) and Gross National Income (GNI), http://timeseries.istat.it/fileadmin/allegati/Conti_economici_nazionali/Tavole_in_inglese/Table_12.8.xls

ISTAT, Italian Historical Statistical Repository: Pollutant emission in atmosphere in Italy, http://timeseries.istat.it/fileadmin/allegati/Ambiente_ed_energia/tavole_inglese/Table_1.20.xls

Autorità per l'energia elettrica e il gas (AEEG), Grado della dipendenza energetica dall'estero 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/int03.xls

Autorità per l'energia elettrica e il gas (AEEG), Energia primaria per fonte 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/int02.xls

Autorità per l'energia elettrica e il gas (AEEG), Produzione dell'energia elettrica per fonte 2010(elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/ele/int04.xls

Autorità per l'energia elettrica e il gas (AEEG), Consumi finali di energia elettrica 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/ele/int06.xls

Autorità per l'energia elettrica e il gas (AEEG), Consumi di gas naturale negli usi finali 2010 (elaboration on ENERDATA data), http://www.autorita.energia.it/allegati/dati/gas/int07.xls

European Heat Pump Association, Heat Pump Statistics 2011, http://www.ehpa.org/fileadmin/red/Heat_Pump_Statistics/Preview_2011_finished.pdf

Wikipedia, European Pressurized Reactor, http://en.wikipedia.org/wiki/European_Pressurized_Reactor#cite_note-6

MIT, The future of nuclear power, 2009, http://web.mit.edu/nuclearpower/

Graig A. Severance, Business Risks and Cost of New Nuclear Power, 2009

Mark Cooper, The economics of nuclear reactors: renaissance or relapse?, June 2009

Autorità per l'energia elettrica e il gas (AEEG), 150 anni di energia in Italia, http://www.autorita.energia.it/allegati/dati/150anni.xls

TERNA, Dati Statistici sull'energia elettrica in Italia 2010, http://www.terna.it/LinkClick.aspx?fileticket=68ZI9snVJNA%3d&tabid=418&mid=2501

ENEL, L'efficienza delle centrali italiane, http://www.enel.it/it-IT/eventi_news/news/lefficienza-delle-centrali-italiane/p/090027d981986fa4ùù

ENEL, Obiettivo zero emissioni, http://www.enel.it/it-IT/eventi_news/news/obiettivo-zero-emissioni/p/090027d981930306

GSE, Rapporto statistico 2009: Idroelettrico, http://approfondimenti.gse.it/approfondimenti/Simeri/fer/DocumentLibraryStatisticheFER/idroelettrico_2009.pdf

www.nextville.it, La risoluzione anticipata delle convenzioni CIP6, http://www.nextville.it/index/332

Autorità per l'energia elettrica e il gas (AEEG), Relazione annuale sullo stato dei servizi e sull'attività svolta 2011, http://www.autorita.energia.it/it/relaz_ann/11/11.htm

TERNA, Dati provvisori d'esercizio 2011, http://www.terna.it/LinkClick.aspx?fileticket=NyK5pNTnIpg%3d&tabid=380&mid=442

ATLASOLE, http://atlasole.gse.it/atlasole/

Statistique suisse de l'électricité 2010, http://www.bfe.admin.ch/php/modules/publikationen/stream.php?extlang=fr&name=fr_579535264.pdf

TERNA, Dati provvisori d'esercizio 2010, http://www.terna.it/LinkClick.aspx?fileticket=JRKDBL4Tz0E%3d&tabid=380&mid=442

TERNA, Piano di Sviluppo della rete elettrica di trasmissione nazionale 2011,

http://www.terna.it/LinkClick.aspx?fileticket=dBsoVKFo2KM%3d&tabid=5069&mid=24684

EUROSTAT database, http://ec.europa.eu/eurostat

Piano d' Azione Nazionale 2010, Ministry of the Economic Development, http://www.itabia.it/pdf/Piano%20Nazionale%20Azione%20Fonti%20rinnovabili.pdf

Piano Nazionale di Assegnazione delle quote di CO2 2008-2012 (PNA 2008-2012), Ministry of the Environment, http://www.minambiente.it/export/sites/default/archivio/allegati/autorizzazioni/pna_CO2_2008_2012.pdf

ENEL, Nuovi investimenti per le smart grids, http://www.enel.com/it-IT/media/news/nuovi-investimenti-per-le-smart-grids/p/090027d981a4e024

Autorità per l'energia elettrica e il gas (AEEG), Indagine Conoscitiva sulle Strategia Energetica Nazionale (PAS 23/11), http://www.autorita.energia.it/allegati/audizioni/parlamentari/023-11pas.pdf