Are Green Jobs Real Jobs?

The Case of Italy

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1. Introduction

1.1. European policies

The European Union has committed itself to increase the share of renewable energy up to 20% of the final consumption by 2020, from 9.2% in 2006 (EC 2009). The same political wave is mounting in several other countries, most notably the United States. The feeling that renewable energy sources (RES) should cover a higher share of energy production relies on two major arguments: (a) it is assumed that reliance on fossil fuels should be reduced, both for the sake of energy security and for climate-related reasons; and (b) investing in RES will spur economic growth and, in the post-recession world, will enhance economic recovery. The goal of this paper is to deal with (b). As to (a), we will just raise two issues.

The questions are the following:

- Assuming that we should reduce greenhouse gases (GHGs) emissions by a given amount (as to Europe, GHGs should be reduced by 20% below 1990 levels by 2020), is it correct to define a specific target for RES?
- How does this interact with the existing policies?

Even these questions shall not be answered in this paper. It is however important to emphasize that what we consider as a given—the need to achieve 20% RES—is actually matter of a heated debate. So, whatever conclusion we reach, our arguments will not be enough to define a proper environmental policy, under the assumption that the ultimate environmental target is GHGs abatement, regardless to the policy tools and the technologies employed. One non-negligible fact, indeed, is that emphasis on RES risks sometimes to distract attention from other technologies and policies that, in principle, might be adopted to meet the same goal of curbing emissions.

A second issue is related to the European choice of setting three parallel goals—less emissions, more RES, and more energy efficiency (although the latter is a non-binding goal under the climate package). Each goal is somehow related with the others, as are the policy instruments which have been selected. As a result, it may happen that either some goals (or instruments) are negatively correlated (such as, in the short run, the idea that investments in new capacity are needed, while consumption is to be cut) or originate inefficiencies (as is the case with a multiple certificate system—see Bye and Bruvoll 2008).

1.2. The purpose of the paper

The purpose of this paper is narrower in scope. We are just trying to answer the question whether or not the "double dividend" theory—that states that investing in RES is beneficial both for the environment and for the economy—resists to empirical scrutiny. We will assume that there is an environmental benefit, from investing in RES, although we shall not try to measure it, nor shall we rely on previous studies. Hence, we will focus on the economics of RES, trying to develop a model to perform a cost-benefit analysis. The analysis will also ignore other non-economic benefits from RES—such as their alleged health and security benefits—so it is deliberately partial. Yet, we believe a fundamental piece of information is lacking, with regard to pro-RES policies. Europeans and others are investing massively in the green sector, and a massive flow of incentives is moving from the society to green producers—either as public subsidies, or as feed-in tariffs, or as mandates,[1] or some mixtures of the above—and the society has a right to know whether this serves to create wealth as well as

[1] Mandates are not, strictly speaking, the same as subsidies, but in the end of the day they determine the same results of shifting resources by altering the supply function through an additional constraint, rather than the demand function through a price increase. On the equivalence of taxation and regulation, see Posner 1971).

achieving some environmental goal, or wealth is actually destroyed to pursue non-economic benefits, however valuable.

To the ends of this paper, and for the sake of simplicity, we will focus on just two RES—wind power and solar photovoltaic power—both of which are employed for electricity generation. We will ignore other RES (hydro power, geothermic power, biofuels, etc.) as well as incentives to energy efficiency and other policy instruments. For the sake of simplicity, from hereby on, "RES" will mean just wind & photovoltaic power, unless differently specified.

Section 2 will illustrate three supposedly successful experiences with RES: Denmark, Germany, and Spain. The German case is particularly interesting, as it is most often indicated as a model of creating wealth through subsidizing RES. In fact, Germany made RES a pillar of its industrial policies, and succeeded in creating a strong industry which is today among world leaders in the green sector. It is often cited the number of people employed in the sector—240,000 as of 2009—but it is hard to tell whether the net impact, both on GDP and employment, has been positive. A broader overview of pro-RES policies in the EU member states has been performed by Nomisma Energia (NE 2007).

Section 3 will focus on the Italian energy market, by illustrating its functioning as well as the various attempts that have been done over time to support RES. Italy is quite a peculiar market, and paradoxically it ensembles among the highest incentives in the World with a medium-to-low rate of investments. One reason for this may be the opacities in the licensing processes, which determine high development costs and place a higher-than-normal premium on bureaucratic and political risk. At the same time, Italy can leverage upon a relatively high share of RES, which it inherited from the massive investments that were done in hydropower during the XIX and the first half of XX century (Zorzoli 2009).

Section 4 will review the different subsidy schemes that have been in function.

Section 5 will review the existing estimates on green jobs in Italy. Even here, data are poor and present a wide range of variability. The analysis of the available data will allow us to pick an "optimistic" and a "pessimistic" scenario. It should be emphasized that we feel like both scenarios tend to overestimate the actual number of green jobs. Yet we assume they may represent an acceptable basis to estimate future jobs.

Section 6 will assess the cost of subsidies to renewables in the past few years in Italy. The existence of different subsidy scheme, as well as the lack of full transparency over the amount of resources that have been devoted to spur RES, have made this effort particularly significant.

Section 7 will estimate the number of future green jobs that will be created, under an optimistic and a pessimistic scenario, and under the assumptions that (a) Italy will reach by 2020 its "maximum potential" for RES (wind and PV) as defined by the Italian government in 2007, and (b) the average subsidy per unit of renewable capacity will remain the same for all the period between now and the time the subsidies will expire. All of our assumptions are aimed at overestimating the number of jobs. In this section we will also evaluate the stock of capital per worker in the RES industry, as compared with the same figure for the industrial sector and the economy as a whole, in order to assess whether resources invested in the RES are more or less apt to create jobs.

Section 8 will conclude.

2. The history of three countries: Denmark, Germany, and Spain

2.1. The importance of being small: the case of Denmark

Following the oil shocks of the '70s, Denmark, a small, rich country of 5.5mln people, implemented a radical shift in its energy policy: from being oil-based to becoming a leading country in RES. Through indirect subsidies, particularly premium rates to wind turbine owners and government support for R&D, RES energy grew rapidly. As for 2009, wind energy accounts for almost 19% of Danish power generation, with 3.160 MW installed, 70% of which in West Denmark, or 24% of total installed capacity (Danish Energy Agency, 2009). However, that doesn't necessarily mean that 19% of the Danish electricity demand is met by wind power. In fact, a modern electricity system must insure that electricity demand and supply are perfectly balanced at any given point in time: if that doesn't happen, the system fails. Normally, Transmission System Operators (TSOs) are able to estimate very accurately demand and supply and can call upon power generators to reduce/increase production, according to the situation. Balancing reserves are available but can account for just a small share, as storing electricity is, at the present state of technology, very costly. Thus, most of the burden falls upon TSO's forecast ability. With traditional energy sources (such as thermal, hydro, and nuclear power) that can be achieved because power plants are able to provide any amount x of energy (up to a maximum) whenever it is needed: as you push the button to start your dish-washer, a power plant somewhere is entering in function immediately to cover the excess demand (as compared with the earlier). RES, particularly wind and solar power, are much different, and not just because the average capacity of power plant is much smaller (with the notable exception of the Roscoe Wind Farm in Texas, with 781,5 MW installed, wind farms usually average 100 MW installed onshore, EON 2009), as compared with traditional power that are usually larger in size, (and may be as large as 8212 MW installed as for the Kashiwazaki-Kariwa nuclear power plant, JNES 2009). More importantly, you can't decide when, and how much energy is produced. Wind turbines will generate electricity only when the wind blows, according to the wind speed and direction; photovoltaic panels will generate power only when the sun shines and the sky is little cloudy. Power generation with RES is intermittent and unforeseeable—it is governed by stochastic, rather than deterministic, laws—which makes it particularly difficult to manage within a traditional grid, which was, and is, conceived as to manage a relatively small number of large generators, that can be easily driven. Stochastic power sources are especially challenging as the power demand changes in the short run, i.e. within minutes or hours. To keep the electricity systems balanced, TSOs need to access to significant amount of fast, short term balancing power. By chance, Denmark, a small country well interconnected with Germany and the Netherlands (UCTE grid) and with Norway and Sweden (NORDTEL grid), is surrounded by large and natural electricity storages, its neighboring countries, which act as "Danish electricity batteries": when "excess" wind energy is produced, it flows towards Norway and Sweden where large hydro plants can be switched off, effectively "storing" Danish wind power. In dry years, as little as 4% of Danish energy is consumed in Denmark while, on average, 57% of the produced wind energy in West Denmark (45% of East Denmark) is simultaneously exported. Ironically, notwithstanding its large investments in RES, Danes keep on consuming fossil energy (either from their Combined Heat and Power—CHP—plants or from German imports). Moreover, the exported wind, which is cheap for the final consumers because it is subsidized by Danish taxpayers, flows towards Norway and Sweden, which can postpone further investments in RES energy, at Danes' expenses. The relative success of the Danish system, hence, should be understood as a consequence of the country's peculiarities (windy climate and larger electricity pools where the excess generation can be stored), rather than an exportable model.

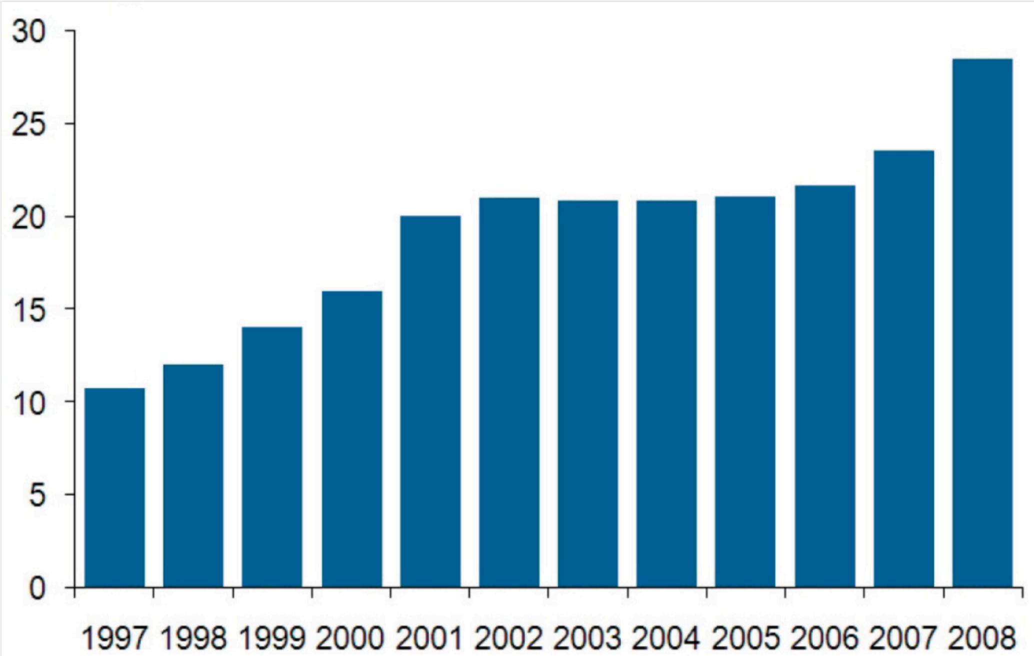


Figure 1—Total employment in the Danish wind sector (Source: Sharman and Meyer 2009)

As to the employment situation, Sharman and Meyer (2009) state that 28,400 people are currently involved in the wind sector in Denmark, 55% of which working in the manufacturing of wind turbines—i.e. the number of employed persons depends critically on the future demand for assets, rather than on current demand for energy. Two Danish-based companies, Vestas and Siemens Wind division, account together for more than 27% of the global market for wind turbines, making Danish wind industry a mostly export-oriented industry. Green jobs have grown constantly and quickly (figure 1) but the authors point out that per capita value-added, a measure of the income received by the factor, of the wind sector underperformed by 13% on average between 1999-2006, as compared to the broader manufacturing sector. According to Sharman and Meyer's estimates, this corresponds to the manufacturing industry delivering on average 10,000$ per worker above the wind sector, with a gross subsidy between 9000$ and 14000$ per worker per year.

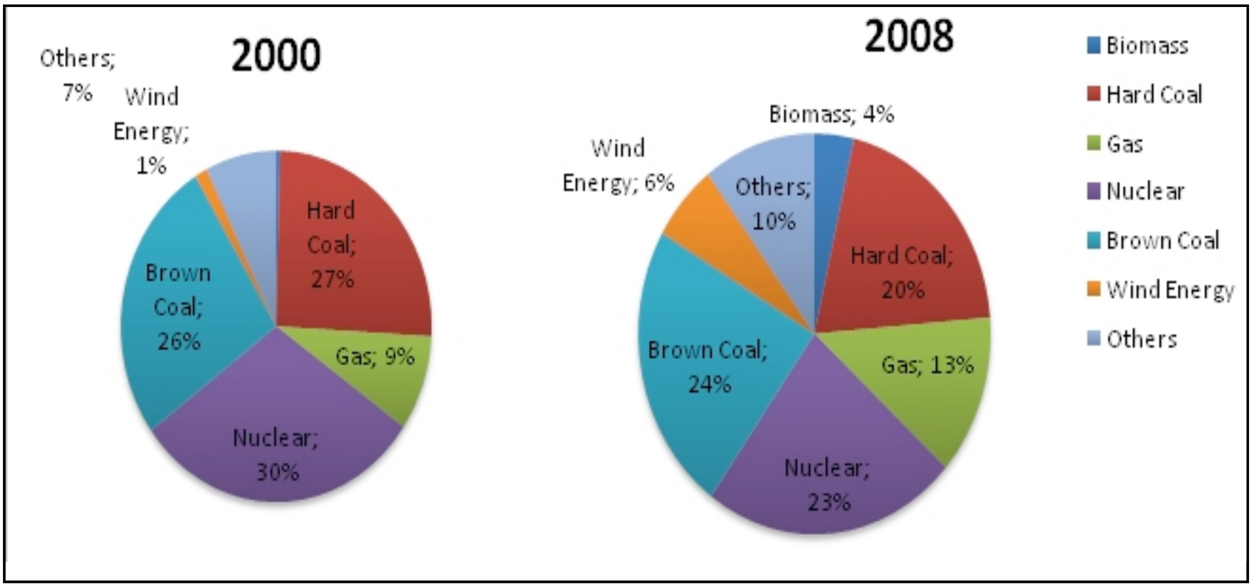


Figure 2 - German Energy Mix in 2000 and 2008 (Source: Frondel, Ritter and Vance 2009)

2.2. Green is not enough: Germany

Germany is widely regarded as one of the "greenest" countries in the world (figure 2), with more than 15% of the total electricity production from RES, twice as much as in 2000. Second only to the United States for the installed wind capacity, and well ahead Spain for photovoltaic (PV) despite its suboptimal exposure to the Sun, Germany is today considered as a "shining example in providing a harvest for the world" (*The Guardian*, 23rd July 2007). This has been made possible by massive investments in RES since 1990, when the Electricity Feed-in Law (*Stromeinspeisungsgesetz*) entered into force. In 2002 a new law was passed, the Renewable Energy SourceAct (EGG—Erneuerbare-Energien-Gesetz), which guarantees support for 20 years. The new feed-in tariffs range from 43.01 c€ per kWh for PV to 9.2 c€ per kWh for on shore wind and 15 c€ per kWh for offshore wind. Frondel, Ritter and Vance (2009) calculate a total subsidies to be as high as €35bn for PV and €19.8bn for wind, totaling an astonishing €54,8 bn of subsidies, between 2000 and 2008, i.e. €6bn per year (as much as 0,1% of German GDP in 2008). Moreover, feed-in tariffs to PV and wind power have been proved to be a costly and ineffective way of reducing emissions as we can see from Table 1 reporting the abatement costs:

Source	Abatement costs (€ per tonne)
PV	716
Wind	54
Emissions certificates	13,4

Table 1—Abatement costs in Germany, 2009 (Source: Frondel, Ritter and Vance 2009)

In the end, German's feed-in scheme resulted in heavily subsidized regime with per worker subsidies as high as €175.000 (considering PV), well above average wages. Moreover, as already seen in Denmark, RES do not provide energy security, creating the need for back up systems, such as CHP or fuel-fired, questioning the consistency of potential environmental benefits. Even the occupation numbers are debatable. While it is unquestionable that, in 2008, 278,000 people were employed in the green sector (mainly in the manufacturing segment, as in Denmark) the net effect on occupation is less clear. At the present state of technology, more RES translate into higher energy cost, which, at the margin, increases production costs (especially in energy-intensive industries) and destroys, or prevents the creation of jobs in other economic sectors. Lehr et al. (2008) argued that the net impact on employment from green subsidies in Germany has been, and will be, positive only insofar as Germany remains a net technological exporter. That suggests that the economic effect of subsidies, in Germany, is to reinvigorate the demand for material assets (such as wind turbines and solar panels), which is what requires occupation. Up to now, domestic demand has been unable to sustain an extra-employment high enough to counterbalance the negative effects in other sectors. What has made the German RES industry profitable is mostly that other EU member States, not just Germany, have enforced green targets.

2.3. Nunca mas combatir contra los molinos de viento (Never more against the windmills): Spain

Spanish landscape, plenty of windmills, has always filled literature and imagination, since the famous "Don Quixote of La Mancha". No clue, thus, that wind energy draws special attentions in Spain, which is usually referred as an example for its fast growing share of RES energy. However, Calzada et al. (2009) argued that wind energy is a good idea but "at what price"? Indeed, despite its hyper-aggressive green jobs policies, the authors' computation reports a loss of 2.2 jobs per each new green job created, with two different methodologies: the ratio of subsidy to RES, per worker, and average capital, per worker; and the ratio between annual subsidy to RES, per worker, and average productivity, per worker. Both statistics gave back 2.2, indicating that, on average, each green job destroys—or prevents—2.2 jobs elsewhere.

In order to support renewable energy, Spain enacted two mechanisms: 1) higher regulated rates (feed-in tariff) with electricity utilities forced to buy all renewable energy produced, thus making RES a guaranteed and profitable investment; 2) credits and aids from national institutes and regional subsidies.

Moreover, with €28.7bn of subsidies, each green job created cost €571,138, principally at the expenses of energy-intensive productions, such as metallurgy, non-metallic mining, food processing, beverage, tobacco industries and so on. Following Calzada et al., on average, each new MW of RES installed destroyed 5.28 jobs elsewhere in the economy: 8.99 by PV, 4.27 by wind energy and 5.05 by mini-hydro.

In this respect, Spain appears like an example of the distortions created by a system of minimum guaranteed prices or feed-in tariff: a giant "bubble" in the RES, especially PV. As for 2009, 17,227 and 3,222 MW of, respectively, wind and PV energy were installed in Spain (CNE 2010). With subsidies representing 1,162% of average or pool price for PV (data for 2004), or 44 c€/kWh for plants with capacity up to 100kW, the annual growth rate of plants of up to 100kW reached 122% in 2004 and 2005, and 215% in 2006, creating a large potential for rent-seeking: an example by the authors suggests that, by leveraging 70% of the cost, a 100kW PV plant would yield internal rates of return (IRR) of up to 17% in 2007, 1,200 basis points above a 30 year Spanish bond (considered as a benchmark due to similar risks and guarantee), or, €100,000 invested would give back, after 25 years, €5.1 mln. In this context, the Royal Decree 1578/2008 of September 26th, 2008, tried to stop speculations with a very restrictive regulation, in favor of roof installations against ground installations (because massive and "speculative" growth focused on this type), imposing a quota of 500 MW of installed capacity for 2009. As 3,464 MW have been installed only in 2008, it is not hard to imagine that this might have severe repercussions, as also pointed by the Spanish Photovoltaic Industry Association (ASIF) which, in a press release of February 2009, estimated 15,000 job losses in the months after RD 1578/2008 took effect (ASIF 2009). The situation is not very different in the wind sector where, the current law (RD 661/2007) established that wind energy producers receive €73.22 per MWh, a figure well above market prices, resulting in an accumulated rate deficit since 2000 over € 15 bn.

2.4. Partial Summary

The table below summarizes some results of the analysis of Denmark, Germany and Spain.

Country	Total Subsidies	Avg subsidy per capita	Year of the first program	Source
Denmark	/	9,000$;14,000$	1979	Sharman and Meyer 2009
Germany	€54,8 bn	€175,000	1990 (Stromeinspei-sungsgesetz)	Frondel, Ritter and Vance 2009
Spain	€28.7bn	€571,138	1994 (RD 2366/1994)	Calzada et al. (2009)

Table 2—Partial summary: subsidies, total and per capita, for Denmark, Germany and Spain

2.5. Broader evidence

In the public debate on climate policies, a huge emphasis has been placed on the alleged pro-growth effects of the "green deal", as well as on the RES sector's capability of creating jobs. Under a public choice approach, it is easy understood that a coalition of "Baptists and Bootleggers" (Yandle 1983) has soon emerged between "Baptists", or the environmental organizations, who "take the moral high ground", and "Bootleggers", or vested interests, who "persuade politicians quietly or behind closed doors" (Yandle 1998, p.6). While the two groups are not necessarily related (although more often than not they are), they form a de-fact coalition in promoting a political agenda which tends to be favorable to subsidize RES instead of pursuing alternative political goals.

The relevant economic question is whether the economic net effect of such policies—as measured either in terms of GDP created vs. GDP destroyed, or in terms of occupational impact—is positive or negative. Given the high number of variables involved, it is very hard to cast a definitive answer. In fact, there is no conclusive evidence, although it is possible to derive a few hints from the available literature.

To start with on a broader terrain, Tol and Yohe (2006) reviewed the studies on the costs and benefits of global warming vis-à-vis the costs and benefits of climate policies. They found that, despite a wide variability in the literature's results, tend to agree that the net impact of whatever policy is implemented (including the business-as-usual) will hardly be positive. In other words, humanity will anyway face costs—the choice being what costs and how distributed over time, as well as which mix of policy might be best suited to minimize the costs (whether environmental or economic) under a great deal of uncertainty. In other words, the costs of global warming are somehow of the same order of magnitude as the costs of climate policies.

Looking directly at climate policies, Nordhaus (2008) found that too stringent targets are inefficient. By the same token, he found that cap and trade schemes and other forms of incentives tend to be relatively less efficient than a straightforward carbon tax. Finally, he suggested a "policy ramp" whereas a modest carbon tax is adopted, which would increase gradually over time. Interestingly enough, given the short-run and long run characteristics of energy demand elasticity, one would expect that a moderate, albeit growing, carbon tax would not result in the generation of much green energy. Rather, it can be expected to induce energy savings in the short run, and a gradual substitution in the energy technologies over the medium to long run, as more efficient sources of energy become commercially available. A fortiori, one might draw that subsidizing today's technologies is inefficient (while a case might be made for subsidizing Research & Development investments in new RES). Prins et al. (2009) reached the same conclusion.

Lehr et al. (2008) looked at the case of Germany, widely regarded as a model in Europe in terms of the country's ability to promote an efficient renewable industry. They argue that the net effect of support to RES on employment may or may not be positive depending on a number of variables, such as GDP growth, oil prices, etc. However, the most important driver for that seems to be a country's ability to develop a competitive, export-oriented RES industry. The practical consequence of such conclusion, if it will be confirmed by further evidence, is that only the technological leaders will gain from RES incentives. To state it otherwise, countries like Germany, which were able to invest on RES soon enough, or others which will be able to develop technological breakthrough, will gain from broader policies (such as those at the EU level) in terms of job creation or destruction, while the others will lose. Calzada et al. (2009) seem to validate such result, as they found that the net occupational effect of Spanish RES policies is likely to be negative. On the contrary, Blanco and Rodrigues (2008) argued that the wind industry has directly created a significant number of jobs in Europe, although they didn't consider the indirect creation/destruction of jobs. Notwithstanding, most jobs were created in just three countries—Germany, Spain, and Denmark, accounting for 82,000 jobs out of a total estimate of 110,850, or 74% of the total. As Germany, Spain and Denmark are all technology exporters, this is consistent with Lehr et al. (2008)'s argument on Germany. Moreover, it may not be inconsistent with the findings of Calzada et al. (2009), who go beyond the mere counting of "green jobs" in order to estimate the cost of job creation to the rest of the economy.

Contra most of the evidence from past investments in RES, the European Commission (EC 2007) argue that covering 20% of total energy demand through RES by 2020 would slightly increase Europe's GDP (which would be 0.5% above the business-as-usual scenario) and would create 650,000 additional jobs, or a 0.3% increase. On the opposite, independent estimates estimate a cost of as much as € 36 billion annually in 2020, for the EU25 to meet its RES target (O'Brien and Robinson 2008).

A more recent array of paper has examined the green jobs (or green stimulus) perspectives in the US market. Pollin et al. (2008) envisioned a 10-year, US$100 billion-worth "green recovery economic programme". According to the authors, if the same amount was invested on household consumption or on the oil industry, the number of jobs created would be as low as 1.7 million and 542,000, respectively. Pollin and Wicks-Lim (2008) examined six green strategies—more or less along the lines of Pollin et al. (2008)—for a cumulative value of US$ 100 billion, and claim that the relevant workers are available in today's labor market (which he studies with reference to 45 representative occupations in 12 US states). That means that little or no training is needed, and that green policies, once implemented, would immediately become effective. However, if one looks at the two papers jointly, one would conclude that the net job creation would be zero: in fact, green policies would not create new jobs. They would rather take people out of their current occupations and move to new ones. It is arguable, although questionable, that this would result in welfare or environmental gains, but it is quite straightforward that this would have no effect on overall employment. If instead—as the study seems to suggest—the people to be employed in the green economy are currently unemployed, not enough skilled workers might be available, especially if the numbers of required human resources are as high as Pollin et al. (2008) and the studies reviewed below imply, which means that training would be necessary and green policies might have a non-negligible adjustment cost.

A report prepared by Global Insight for the US Conference of Mayors (2008) estimates that, as of today, almost 130,000 green jobs already exists in the US renewable power sector, and that—under a scenario whereby electricity generation from RES increases from 124 TWh in 2008 to 2,175 TWh in 2038—more than 1 million green jobs would be created, up to 1,236,800 in 2038.

Bezdek (2007), who adopts a broader definition of what the green economy is about, estimates that the number of workers employed in the renewable energy sector might increase from 452,000 in 2006 to 16.2-50.1 million, according to the scenario.

The above studies are critically reviewed by Michaels and Murphy (2009), who find several shortcomings—including the confusion between efficient investments and labor-intensive investments (which may or may not go together), the lack of attention to the job destruction that may arise from more expensive energy, double counting of jobs, an oversimplified vision of the labor market, and the presumption that government can just create jobs—with little or no attention for the role of the private sector.

3. THE ITALIAN ELECTRICITY MARKET

3.1. General overview

With a gross electricity production of 320 TWh (Terna, 2008) in 2008, Italy amounts to 2.1% of the world total electricity production (EIA 2009). The third largest producer of nuclear power in the '60s (with a peak of 8,758 GWh of gross production in 1986), following a Referendum in 1987, Italy decommissioned all its nuclear power plants, increasing its dependence on external energy supplies: a net energy importer since 1926, with only 3 years of exception from 1952 to 1954 (Terna, 2008), mainly from Switzerland and France (28.8 GWh and 15.2 GWh respectively in 2007, see figure 3), but also Slovenia, Austria and Greece (46.2 GWh were imported in 2007, 40 GWh in 2008, as much as 13.1% and 11.3% of gross electricity demand, respectively).

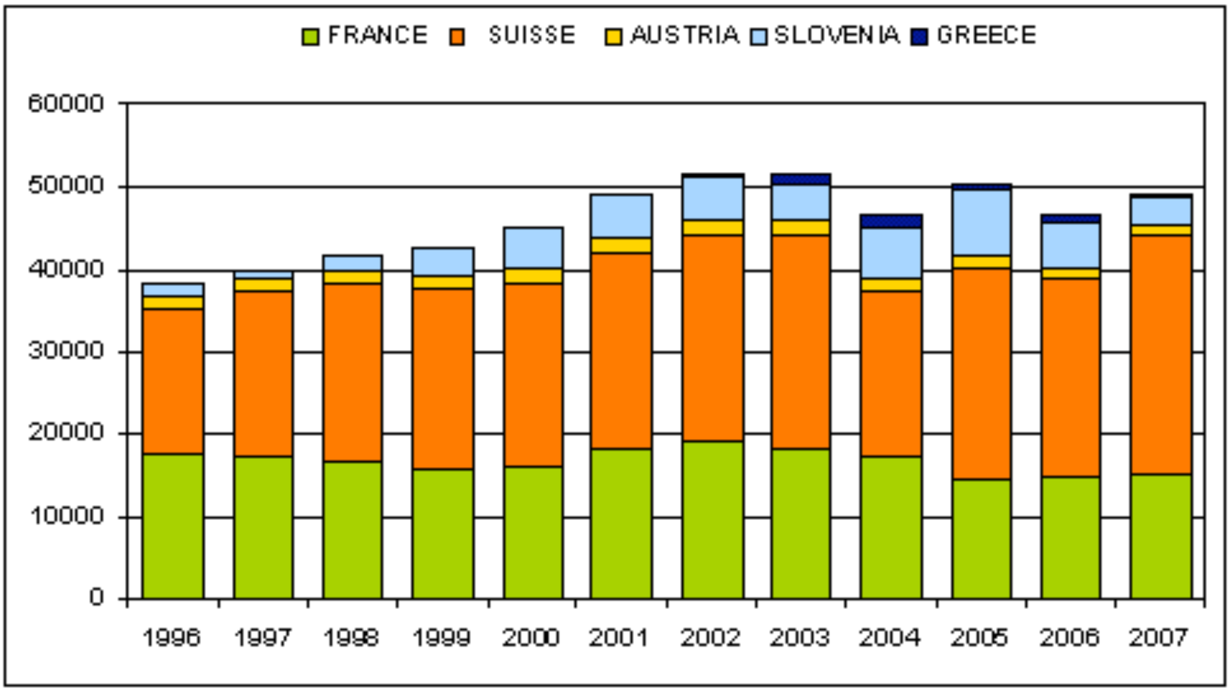


Figure 3—Energy imports (in GWh) by country (Source: Autorità per l'Energia Elettrica e il Gas, AEEG, website)

Notwithstanding its long history as net importer, Italy has not yet been able to close the gap, never falling below 11% of energy import (as % of total demand) during the last 20 years (figure 4) becoming the largest European importer (Gestore Mercati Elettrici, GME, 2009). It is possible that in 2009 electricity import decreased, both in absolute value and as a share of total demand, because the demand fell due to the crisis.

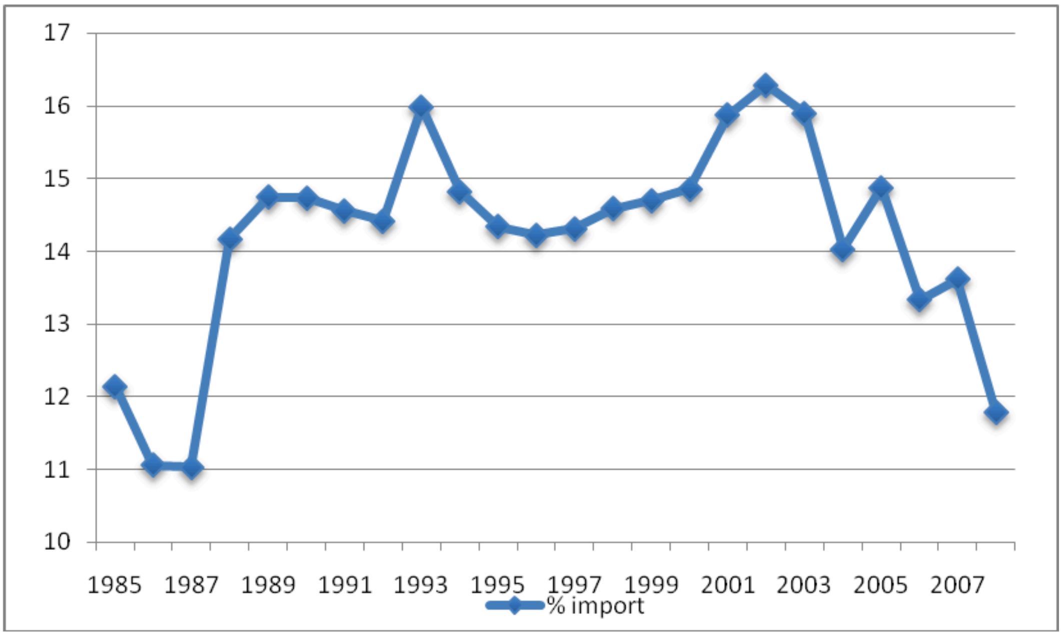


Figure 4—Energy import as % of total demand (Authors' computation based on Terna 2008)

Compared to France, Germany, and to EU-15 (figure 4 and 5), Italy is heavily reliant on natural gas (with a share of 54% in 2008), coal and oil. While oil used to be a major fuel for electricity production, since 1998 its contribution has been rapidly falling both in absolute and as a share of the total, decreasing from 42.5% in 1990 to 6% in 2008 (figure 6).

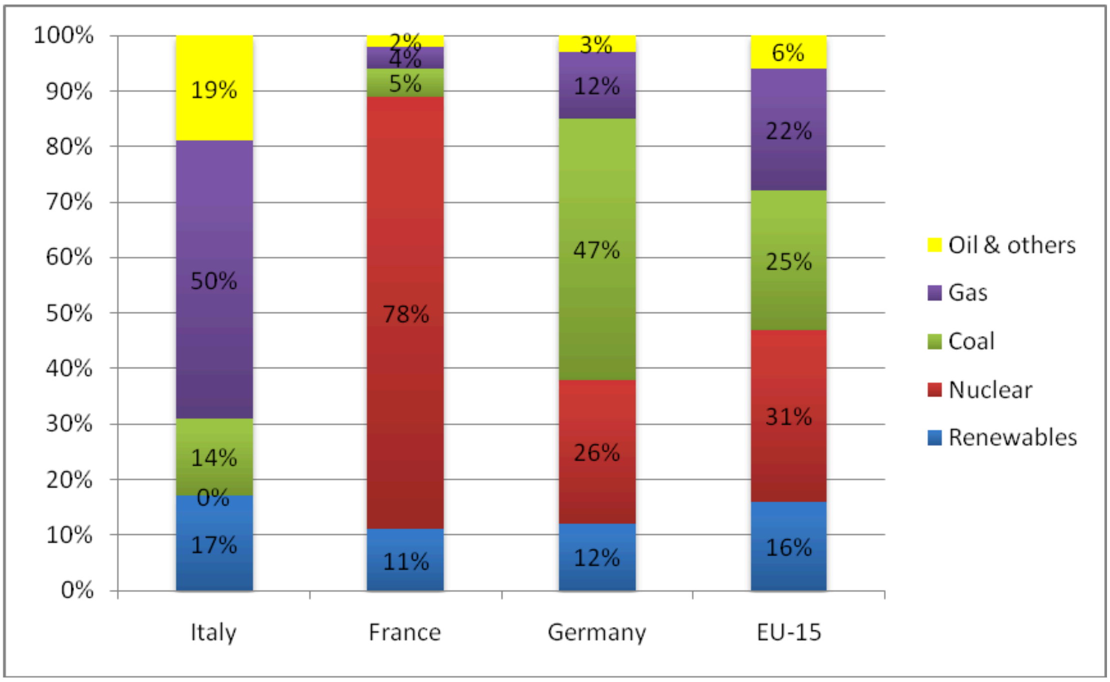


Figure 5—Energy mix in 2008 for Italy, France, Germany and EU-15 (Authors' computation based on Terna 2008)

For the most part, oil has been substituted by natural gas, a cleaner, more flexible fuel, which more than doubled its share, from 25,7% in 1998.

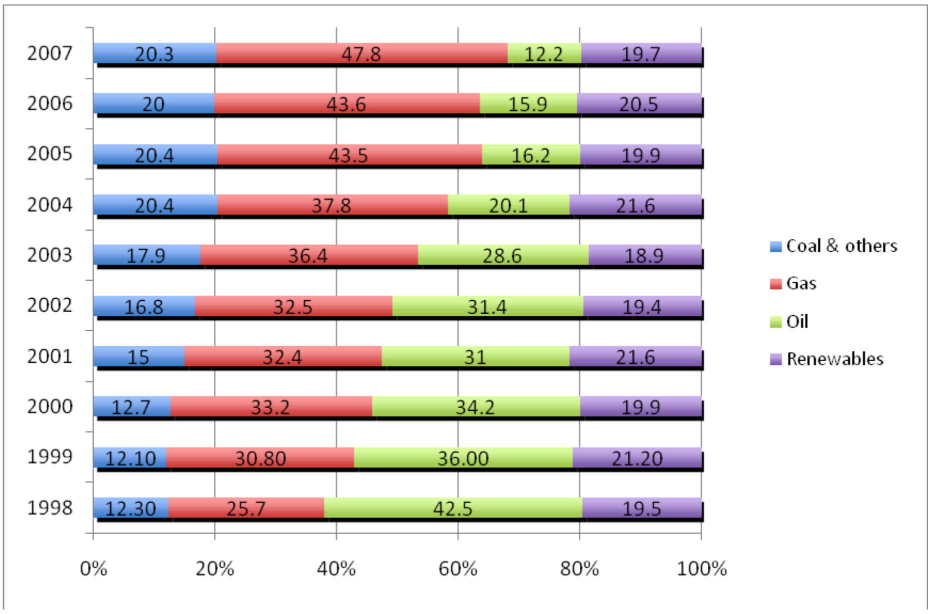


Figure 6—Italian Energy mix: 1998-2007 (Source: Rapporto delle attività del Gestore Servizi Energetici,GSE, 2010c)

The RES quota has been around 20% of the electricity production, of which the largest part is covered by old, large hydro plants. Wind power has been growing consistently in the last decade, while photovoltaic power grew significantly just after the feed-in tariff was introduced in 2007, but its contribution to the overall production remains negligible (figure 7).

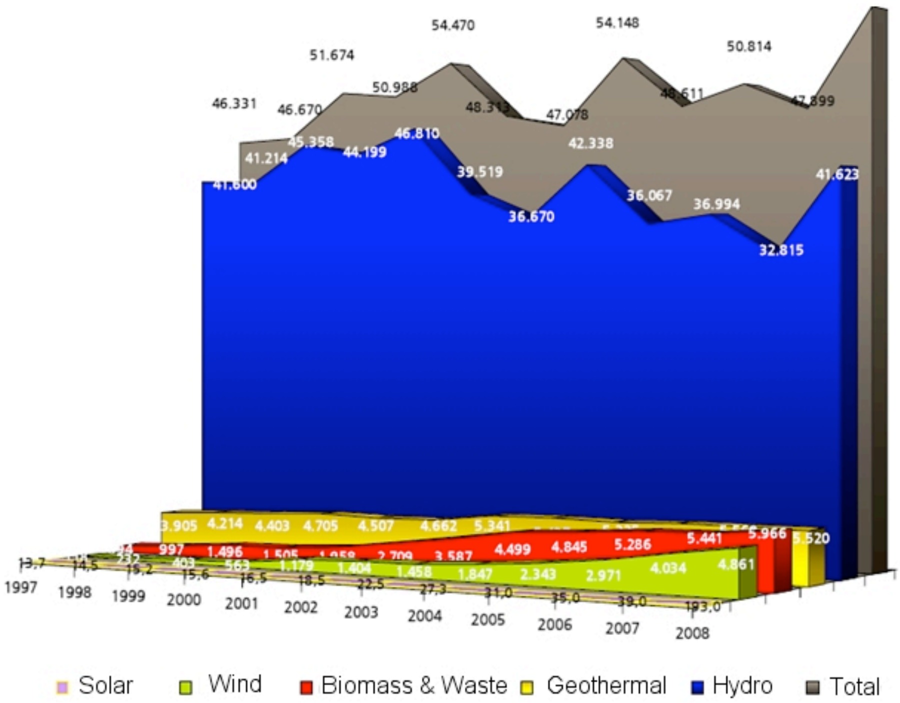


Figure 7 - RES production in Italy by source:1997-2008 -(GWh - Source: GSE 2008)

The produced-energy-to-installed-capacity ratio (figure 8) shows that geothermal energy, with 7.8 GWh per MW installed is by far the most productive RES. However, due to its specific nature, it's naturally constrained (even though recently two new plants added 72MW of power and there is a project for further 200MW—*Affari Italiani* 2009). After geothermal, biomass is the second most productive (4.8 GWh per MW), followed by Hydro (2.4), Wind (1.4) and, in the end, PV (0.4). Notably, these results are similar to productivity of RES in Spain (Wind: 1.9, PV: 0.7, mini-hydro: 2.2, Biomass: 4.1, Source: Calzada et al. 2009) while thermal energy is well above RES average (2,5) with a GWh per MW ratio of 3.6.

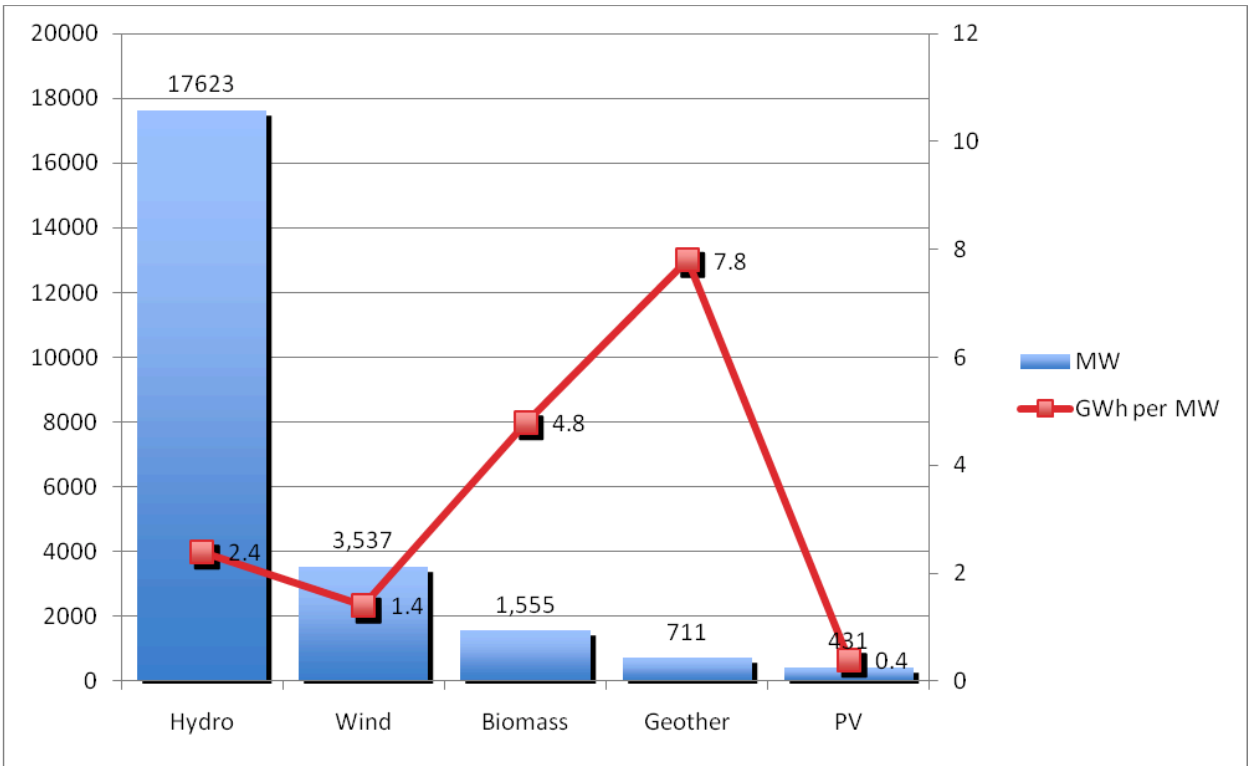


Figure 8—RES in Italy: MW installed and production (GWh) per MW (Source: Terna 2008)

3.2. Funding & Incentives

The system of incentives to RES in Italy dates back to 1992, when a particular scheme, called "CIP6" was introduced.[2] Following the GSE approach (GSE, 2007) 1999 can be seen as a turning point, when the Directive 96/92/EC of the European Commission was introduced in Italy as dlgs 79/99, the so-called "Decreto Bersani". After 1999, several policy tools to sustain green energies have been introduced: Certificati Verdi ("Green Certificates"), Certificati Grigi ("Gray Certificates", following the introduction of the EU Emission Trading Scheme), Certificati Bianchi ("White Certificates"), Conto e Nuovo Conto Energia (incentives to Photovoltaic), feed-in tariffs and voluntary certificates such as the RECS (Renewables Energy Certificate System) and the Garanzia d'Origine (GO -Guarantee of Origin). Moreover, RES producers have priority over non-RES producers in the distribution (so-called "priorità di dispacciamento"), as for 2003 (GME website)

[2] CIP6/92 stands for Comitato Interministeriale Prezzi (CIP) decision no.6 of April 29, 1992 (published in the official gazette on May 12, 1992), that created a scheme of subsidies for renewable energy sources and "assimilates" (a vague concept under which a number of non-renewable sources have been labelled, including—but not limited to—domestic coal and refining waste). See A. Clò (2008); Camera dei Deputati (2009); Donatio et al. (2007).

3.2.1. CIP6

CIP-6 is the name of the first, and up to 1999, most important program of direct incentives for renewables energy in Italy. Its name comes from the resolution (n.6 of April 29th 1992) of the "Comitato Interministeriale Prezzi", CIP, according to Camera dei Deputati (2009), all the producers of renewables energy and "assimilate" (similar to renewables) were entitled to sell their energy to ENEL (the state-owned electricity giant) up to 1999, then, following the privatization of ENEL and the partial opening of the market, to the Gestore Rete Trasmissione Nazionale (GRTN, the Italian Transmission System Operator, TSO, from 2005, GSE), at higher than market prices, for a period 8 years, sometimes extended to 15-20 years. The property of the Certificati Verdi ("green certificates", see next paragraph) produced by the incentived plants is transferred to the GRTN (then GSE). After that, the TSO would have sold the electricity and the CVs, covering the difference between the incentived and market prices mainly through an increase in energy taxes, precisely, increasing the A3 Tariff ("Tariffa A3"), shifting the cost of the incentives directly to the consumers. From 1995, following the law 481/95, the ability to change the A3 tariff was given to the brand-new Autorità per l'energia elettica ed il gas (AEEG), an independent regulatory body. Moreover, it specified that the CIP6 would have been granted only to plants already authorised and connected to the grid, authorised and under construction, or to those proposals submitted before November 19th 1995.

	% similar to RES
2003	71
2004	70
2005	69
2006	71
2007	72
2008	73

Table 3—share of "similar to RES" covered by CIP6 (authors' computation based on GSE data)

This type of system has been the object of several critics due to its definition of "similar to renewables" energy supply; indeed, the definition included also cogeneration and CHP, which attracted a sizeable share of all the CIP6 incentives (see table 3). However, following the introduction of several new incentives, and widely considered as a political scandal, CIP6 has been under reduction: it is estimated to end its effects in 2020 but its destiny is still uncertain as proved by recent events: a ministerial decree from the Economic Development Ministry, attached to the "Legge Finanziaria 2010", suggested the voluntary resolution within 6 months of all the agreements involving CIP6.

3.2.2. Certificati Verdi (CV)—Green Certificates

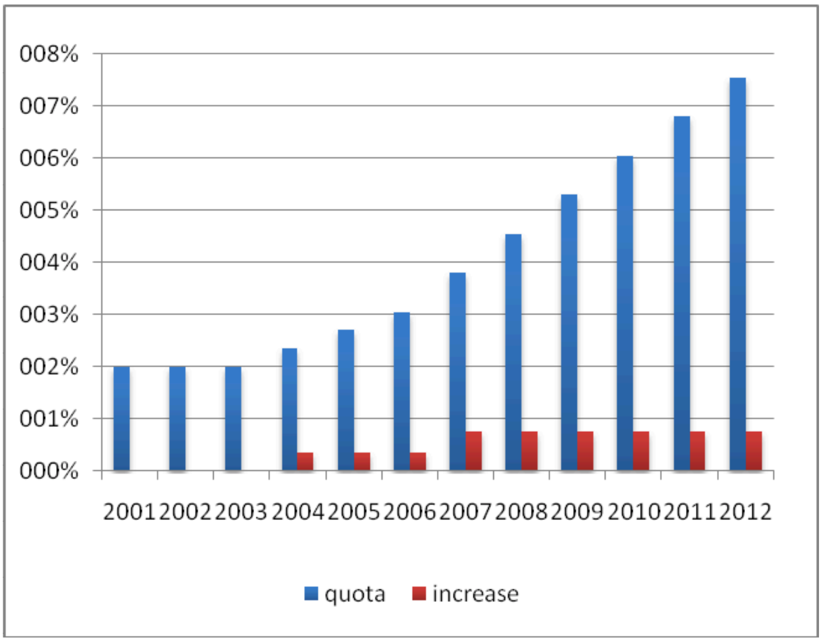
As previously said, up to 1999 there was only one way to finance RES, the CIP6 tariff. The so-called Decreto Bersani introduced a new instrument: the Green Certificates (CV); each non-RES energy supplier (either producer or importer) is obliged, since January 1st 2002, to produce 2% of its energy with RES. This quota has been increased by 0.35 percentage points annualy between 2004 and 2006, and by 0.75 percentage points annualy between 2007 and 2012 (figure 9). Each utility is free to decide whether phisically produce the required amount of RES, or to buy an equivalent amount of Green Certificates from other companies who produce more green energy than required. The Green Certificates—whose original size representing a capacity of 100 MWh was reduced to 50 MWh in 2004 and 1 MWh in 2008—are issued to all RES plants which are recognized by the GSE to be RES-E ("IAFR"). The suppliers are entitled to obtain an amount of CV proportional to the quantity of energy supplied (up to the "Legge Finanziaria 2008"—see table 4). A Green Certificate expires after 1 years if it was released between 1999 and 2007, or 3 years it it was released since 2008 onwards. The CVs are traded on a regulated market created and mainteined by the Gestore Mercati Energetici (GME), a state-owned company, which is obliged, since 2008, to buy all the unsold and expiring CVs, even though, most of the bargainings happen by bilateral agreements (AEEG 2009a). Moreover, as previously stated, the CVs produced by CIP6 plants are entitled to the GSE. This obligation has risen several controversies. Moreover, the GME is expected to set a buying and selling reference prices which can indeed provide incentives.The law 244/2007, or "Legge Finanziaria 2008", introduced several changes, the most important ones being:

- the size of each CV has been reduced to 1 MWh (and the assignation is no longer proportional to the power capacity but differentiated according to the type of RES, see table 4);
- recognized suppliers (whose plants will be start operations from January 1, 2008) will obtain the incentive for 15 years (12 years for those built before);
- all producers whose power capacity is lower than 1MW can opt between CV and the so-called "tariffa omnicomprensiva" (see next paragraph);

Energy Source	Number of CV per MWh of energy
Wind on-shore(power capacity > 200kW)	1.0
Wind off-shore	1.50
Solar	See "Conto Energia"
Geothermal	0,90
Waves and tides	1,80
Hydro (other than waves and tides)	1,0
Biomass and biogas (other than those indicated in the following point)	1,30
Biomass and biogas obtained from agricolture, animal husbandry and forestry on a short supply-line basis	1,80*
Landfill gas and waste gas from purification processes and biogas (other than those indicated in the previous point)	0,80

Table 4—Coefficient of CV per MWh of energy produced by energy source (Source: GSE 2010)
*** Subordinated to the approval of the Ministerial Decree**

What is the impact of the two main programs (CIP6 and CV) on the RES development? Data from Table 5 give us several insights: biomass, wind and biogas are completely covered by CIP6 and CV schemes, while hydro and geothermal are not fully covered. If we take into account only small hydro (i.e. plants with power capacity less than 10 MW), we can see that both schemes aim to incentive especially small hydro (the share increase from 9.3% to 43,7%). Interestingly, as the CIP6 scheme is going to disappear, geothermal (26,3%) and especially biomass (80,8%) and biogas (67,1%), which are heavily reliant on CIP6, will need to find another supportive scheme.



	quota	Year of compliance
2001	2.00%	2002
2002	2.00%	2003
2003	2.00%	2004
2004	2.35%	2005
2005	2.70%	2006
2006	3.05%	2007
2007	3.80%	2008
2008	4.55%	2009
2009	5.30%	2010
2010	6.05%	2011
2011	6.80%	2012
2012	7.55%	2013

Figure 9—Quota of green energy compliance with yearly increase (Source: GSE)

Not surprisingly, solar is just receiving a small coverage and only by the CV scheme; this is obvious, as there is a specific feed-in scheme for PV, called "Conto Energia" (see paragraph 4.2.4).

	Hydro	Geother	Biomass	Wind	Biogas	Solar	Total
Total gross energy	36,994	5,527	5,408	2,971	1,336	35	52,275
Gross Energy without hydro > 10 MW	7,875	5,527	5,408	2,971	1,336	35	23,156
Energy under CV scheme	2,123	845	447	1,745	439	1	5,602
Energy under CIP6 scheme	1,321	1,454	4,367	1,226	897	0	9,265
% gross energy under CV scheme	5.7%	15.3%	8.3%	58.7%	32.9%	2.9%	10.7%
% gross energy under CIP6 scheme	3.6%	26.3%	80.8%	41.3%	67.1%	0.0%	17.7%
% gross energy under both schemes	9.3%	41.6%	89.1%	100.0%	100.0%	2.9%	28.4%
% gross energy under both schemes, without hydro > 10 MW	43.7%	41.6%	89.1%	100.0%	100.0%	2.9%	64.2%

Table 5—% of RES by incentive scheme, GWh, 2006 (Source: GSE 2007)

3.2.3. Tariffa omni-comprensiva—feed-in tariffs scheme

A new all-inclusive feed-in tariffs scheme was introduced with the "Legge Finanziaria 2008" (law 244/2007). It affects RES plants (with the notable exclusion of solar power, see "Conto Energia"), whose power capacity is not exceeding 1 MW (200 kW for on-shore wind farms), commissioned after December 31, 2007. The scheme will support qualified RES suppliers for 15 years and it is differentiated by source (see table 6)

Energy Source	Feed-in tariff (c€ per kWh)
Wind (power capacity < 200kW)	30
Solar	See "Conto Energia"
Geothermal	20
Waves and tides	34
Hydro (other than waves and tides)	22
Biomass and biogas obtained from agriculture, animal husbandry and forestry under supply-line or frame-agreements or on a short supply-line basis	28
Landfill gas and waste gas from purification processes and biogas (other than the biogas indicated in the previous point)	18

Table 6—Feed-in tariff for 2008 (Source: GSE 2010)

3.2.4. Conto Energia—incentives to solar energy

Since 2005, a specific policy tool has been introduced to support PV energy, the so-called "Conto Energia"—which could rely on a strong propaganda effort based upon the idea that the "Paese del Sole" should rely on solar power. From 2008, the "Conto Energia" became the only available scheme to incentive PV, with CV available only to PV plants which requested before the end of 2007 (GSE, 2009b). Owners of PV plants of at least 1 kW of nominal power can benefit for 20 years of a particular feed-in tariff scheme (see table 7 for old Conto Energia, and table 8 for Nuovo Conto Energia), which has been recently modified in order to encourage small, house-integrated, panels.

Nominal power of the plant (kW)	
1 <= P <= 20	0.445 (net metering)
	0.460
20 < P <= 50	0.460
50 < P <= 1000	0.490 (max value)

Table 7—Conto Energia—details (Source: GSE 2007)

In alternative to the feed-in tariff, the owner could opt for a net metering scheme ("Scambio sul posto"), i.e. a solution in which producers may inject immediately the energy produced into the national grid and withdrawing it when needed; they will receive subsidy from GSE (GSE, 2009) that adds to the value of the electricity sold.

	Type of PV plant		
Nominal power of the plant (kW)	Not integrated (into the house)	Partly integrated	Integrated
1 < P < = 3	0.392	0.431	0.480
3 < P < = 20	0.372	0.412	0.451
P > 20	0.353	0.392	0.431

Table 8—Nuovo Conto Energia—details (Source: GSE 2007)

Given the great popularity of the first "Conto Energia" and some technical and bureaucratic problem, a new edition ("Nuovo Conto Energia") has been issued in 2007, with the following differences:

- a simpler authorization process;
- the elimination of the 1000 kW cap for each owner, substituted by a national maximum amount of 1,200 MW ;
- a new feed-in tariffs scheme which encourages small, house-integrated panels.

3.2.5. Renewable Energy Certificate System (RECS) and Garanzia d'Origine (GO)

GSE also releases the so-called Renewable Energy Certificate System (RECS) certificates to renewables energy producers. This is a voluntary scheme only, and once issued, RECS certificates (1 MW each) can be exchanged at national and international level without any time limit. In 2001, first year of the scheme in Italy, 11,400 certificates have been issued; in 2008 the number has risen to 7mln (GSE website), so that Italy is now the 5th largest member of the RECS scheme in Europe.

3.2.6. Titoli di efficienza energetica (TEE)—Energy Efficiency Certificates

Also known as "white certificates", TEEs have been created in 2004, first case in the world, in order to incentive energy efficiency. The system started its operation on January 2005. All energy/gas distributors with more than 50,000 customers are obliged to achieve a certain share of energy efficiency (according to the national targets of energy efficiency, e.g. 1,8 Mtoe). National targets and details are provided by Ministry of Economic Development, and precisely, by the latest D.M. 21/12/07 A single TEE certifies the reduction of consumption of 1 toe (tonne of oil equivalent); there are three types of TEEs, certifying :

- Type 1) reduction of final energy consumption;
- Type 2) reduction of natural gas consumption;
- Type 3) energy savings other than points 1 and 2.

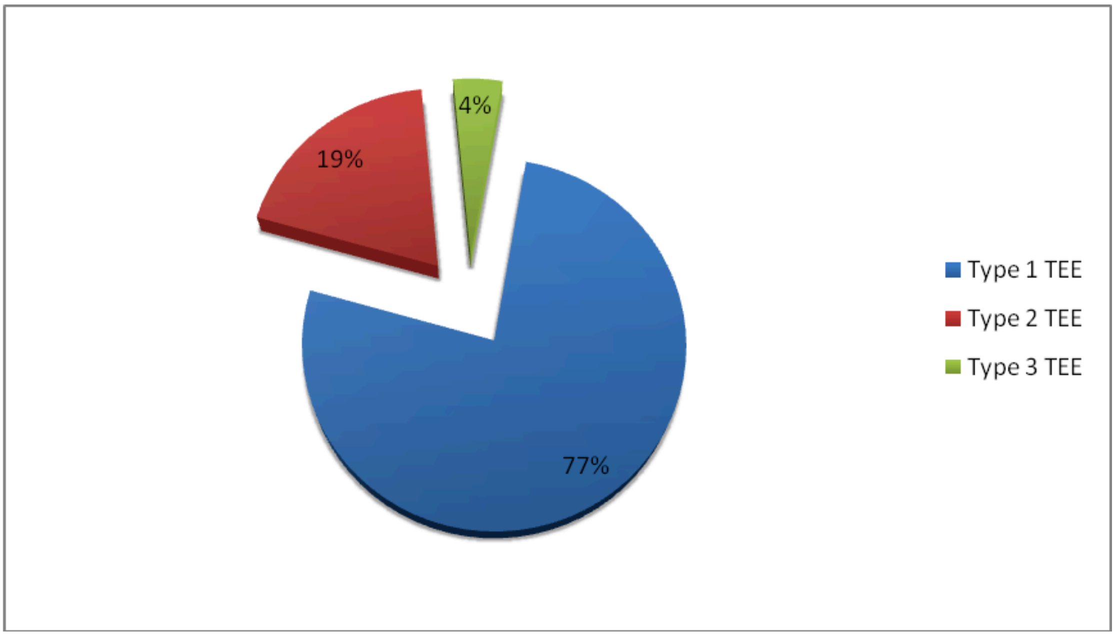


Figure 10 - Breakdown by type of TEE traded up to December 2008 (Source: AEEG 2008)

Electricity and gas distributors may achieve their energy efficiency targets either by implementing energy efficiency projects, or by purchasing TEEs from third parties, that are traded on a specific market managed by the GME. Up to December 3, 2008, a total amount of 2.7 mln TEEs had been traded (AEEG 2008), mainly Type 1 TEEs (see figure 10).

3.2.7. Certificati Grigi—Emissions Trading Scheme

In 2006, with the dlgs 216/06, Italy acknowledged the Directive 2003/87/EC, creating a European Emissions Trading Scheme (EU-ETS), which came into force on January 1, 2005. The Directive is part of a broader EU policy, aimed at meeting the Kyoto Protocol's goal of cutting carbon emissions by 8% below 1990 levels, by 2008-2012. A National Committee for the management and implementation of the Directive 2003/87/EC ("Comitato nazionale di gestione e attuazione della direttiva 2003/87/CE") was established to govern the transition in 2006. According to the scheme, each qualified firms (energy producers, iron and steel industries) should satisfy two requirements:

1) it can no longer produce without being authorized
2) the total amount of tonne of CO2 released into the atmosphere should be compensated by an equivalent amount of emission allowance

Each country concurs with the European Commission for the definition of targets and quotas through a National Allocation Plan (NAP); for Italy, the decision is jointly taken by the Ministry of Economic Development (Ministero dello Sviluppo Economico, MSE) and the Ministry of the Environment (Ministero dell'ambiente e della tutela del territorio e del mare). Up to now there have been two NAPs, one involving the first period (2005-2007) and one for the second (2008-2012). Despite the huge emphasis that has been put on ETS, so far the European cap and trade scheme has failed to reduce emissions. In fact, in 2005-7 emissions in the ETS-sectors actually increased, while in 2008 and most probably in 2009 they have been falling largely as a result of the economic crisis, rather than of policy-induced changes (S. Clò 2008; S. Clò 2009; Stagnaro 2009).

4. Costs assessment of Renewable Energy Sources in Italy

As the feed-in tariff regime (the so-called "tariffa omnicomprensiva") has recently been enacted, there are no available data concerning the amount of subsidies to RES. The same is true for all contributions at local level, such as regional and departmental ("province") funds. Thus we focus on three main scheme: CIP6, Conto Energia and CVs.

4.1 CIP6

As for the CIP6 component, data before 2003 are not publicly available; the total amount of CIP6 subsidies between 1992 and 2003 has been the object of several hearings at the X Commissione "Attivita' Produttive" (Commission for productive activities) of the Italian Lower Chamber; during the public hearing of November 6th 2003, the President of the Commission, Mr. Bruno Tabacci, stated that "Up to now there is no plausible list of the similar to RES sources, neither a clear definition of the criteria for being selected" (Camera dei Deputati 2003). CIP 6 was originally intended as a device to incentive market liberalization and renewable energy but most of it (over 70%) has been used to finance "similar to RES" plants, which included also biomass and other "what we do know is that there is a regime, the so-called CIP6, which gives same guarantees to RES and to those who recycle not biodegradable wastes (…) a tariff, far above energy market prices". Mr. Tabacci defines CIP6 as a "shadow tax", whose burden of taxpayers was estimated (in 2003) in 60.000mld of Italian Lire (almost € 31 bn at current prices). In the next table we can see a breakdown of CIP6 subsidy by year (table 9); in the first column "costs", there are the amounts paid by GRTN, then GSE, to the CIP6 producers, by type of sources (RES or similar to RES). In the second and third columns the revenues from the energy and CV sold, covering part of the costs, in the last column, "A3 component", there is the amount, the difference between costs and revenues, which has been covered yearly by the A3 component of the electricity bill; the A3 component (around 62% of the regulated part of the electricity bill) and the A2 component (22%, covering the decommissioning of the past Italian nuclear energy program) are worth as much as around 6% of the average electricity bill (referring to households).

2003		REVENUES		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	3,281.4	2,248.3		1,033.1
RES	1,341.9	531.6	196.2	614
Total CIP6	4,623.2	2,779.9	196.2	1,647
2004		**REVENUES**		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	3,511.4	2,145.1		1,366.3
RES	1,510.9	515.9	90.3	904.7
Total CIP6	5,022.3	2,661	90.3	2,271
other	281			
total c/R	5,303.3	2,878.5	90.3	2,334.5
2005		**REVENUES**		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	3,988.6			
RES	1,709.5		96.8	
Total CIP6	5,765.7	2,560.5	96.8	
other	67.6			
total c/R	5,765.7	2,560.5	96.8	3,108.4
2006		**REVENUES**		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	4,3617			
RES	1,758.1			
Total CIP6	6,119.8		2.8	
Other	297.2			
total c/R	6,417	2,736.3	2.8	3,677.9
2007		**REVENUES**		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	3,746.5			
RES	1,476.7			
Total CIP6	5,223.2		-0.1	
Other	34.4			
total c/R	5,257.7	2,834.6	-0.1	2,423.2
2008		**REVENUES**		
	COSTS	Energy sold	CV sold	A3 component
Similar to RES	3,965.8			
RES	1,497.7			
Total CIP6	5,463.5		31.3	
Other	15.7			
total c/R	5,479.1	3,052.7	31.3	2,395.1

Figure 8—CIP6 subsidy, 2003-2008 (AEEG 2003-2009a)

The sum of the CIP6 subsidy from 2003 on is equal to €15,6 bn. Adding the €31 bn figure estimated by Mr Tabacci from 1992 to 2002, we have a rough estimate of the total cost of the CIP6 program at € 46,6 bn or €3 bn per year on average, half the yearly expenditure in Germany (€6 bn), whereas the German share of RES is far above the Italian one.

4.2 Green Certificates/Certificati Verdi

As for the CVs, the cost of the system can only be estimated, as the utilities, which are obliged to buy them, shift the cost directly to the final users. AEEG (2009c), estimated the total cost from 2002 (see table 9) on, forecasting it at € 1 bn for 2012, when the quota for each producer will reach 7.55%.

	Total cost	to RES producers (IAFR)	contribution to A3 comp
2002	247	50	197
2003	243	74	169
2004	263	163	100
2005	332	317	15
2006	488	487	1
2007	306	305	1

Table 9—Costs of the CV system

4.3 Conto Energia and Nuovo Conto Energia (PV)

As for the PV, Italy has nowadays one of the most generous and profitable system of incentives . The so-called "Conto Energia", and its new edition, issued in 2008, the "Nuovo Conto Energia", provide a feed-in tariff to all PV producers within a national limit of 1,200MW (which should be met before December 31st 2010). The incentives are covered through the A3 component of the electricity bill, with an estimated cost of € 110 mln for 2008 and an estimate of € 300 mln for 2009. The AEEG (2009b and 2009c) estimates that the cost of the current PV scheme (assuming that the target will be met) will be of €1 bn per year for 20 years, covering only 0.5% of total energy supply. No clue that the same AEEG defines the "Conto Energia" as one of the most profitable system of incentive available in the whole world!

4.4 Further considerations

Finally, it has been pointed out that the actual system of incentives is highly iniquitous as all the incentives are funded through the electricity bill (and particularly through the A3 energy component), thus proportionally to energy consumption (which is not proportional to net income). In this way, a large family will contribute to a greater degree, compared to a single rich, to the system of incentive. AEEG (2009c), estimated that, as for 2008, the A3 component is worth 6% of the total expenditure of an average individual.

5. O DATA WHERE ART THOU?—GREEN JOBS IN ITALY

The increase in green jobs is likely to affect the existing jobs by two effects: 1) job losses resulting from the crowding out of cheaper and more conventional forms of energy generation; 2) job losses in energy intensive sectors, due to higher energy prices (required to sustain the incentives). The EC argues that that the number of green jobs created will likely outnumber the job losses. However, the situation is almost paradoxical; notwithstanding several proclaims by the EC in favor of the green economy, up to now there is no standard time series regarding the number of green jobs, neither a total nor a break down by type of RES. So far, not even an harmonized estimate of the national expense on green subsidies has been made available by the EU, making it impossible to verify whether political promises are supported by data.

How is it possible to evaluate the effectiveness—leave aside the efficiency—of a program if the target variable (the number of green jobs in EU) is not even available? How can we even try to understand if the green economy is really creating jobs (and not simply shifting or eliminating somewhere else), if we have no clue about the number of people actually working for the green economy? As we have seen in section 2, data for Germany, Spain and Denmark usually come from private subjects, who—in most cases—have a vested interest in supporting the green agenda. The situation in Italy is by no means different: as the National Institute for Statistics (ISTAT) does not directly collect the number of people working in the RES industry, we had to rely on different sources (table 10); we are aware that our pieces of information are fragment and there is too much variability of the estimates (eg. the figure of the direct employed into wind energy ranges from 2500 to 6300!), but it is neither our job nor in our power to provide these data: these were supposed to be already available at European level. This lack of transparency should ring a bell about the accountability of this program, which is worth billions of euro.

	Source	direct	indirect	total	ref year
PhotoVoltaic Energy	CNES			5700	2008
	CENSIS			15000	2009
Geothermal Energy					
	CENSIS			3000	2009
Biofuels					
	CENSIS			700	2009
WIND Energy	Nomisma Energia			10000	2009
	ANEV/UIL	3544	13630	17174	2007
	EWEA	2500			2007
	CENSIS	6300	21800	28100	2009

Table 10—Estimates of green jobs—several sources

Remark: A 2003 European Wind Energy Association (EWEA) analysis of wind energy employment in the EU-15 found that, at aggregated EU level, direct employment constituted 60% of total direct and indirect employment in wind turbine manufacturing

5.1. Defining the scenarios

The huge variability in estimates has, at least, a positive feature: it allows us to build an optimistic and a pessimistic scenario, by picking the higher and lower estimates, respectively. A greater problem derives from the fact that different estimates relate to different years. We can assume, though, that the number of people employed is proportional to the installed capacity for each RES: this will allow us to reconcile data into a common framework, however questionable.

We will consider estimates on total jobs—including both direct and indirect jobs—although this is likely to lead us to overestimate job creation, especially when the source for data is a supposedly biased one.

Finally, one peculiarity of green jobs is that most of them are (a) highly specialized and (b) temporary. In fact, while a small number of people are employed in the administration and management of existing RES plants, a much greater number of workers are involved in the development—including engineers designing the project, installers and builders, and people who are occupied in pursuing the licensing process. We will assume that permanent occupation is a function of the existing capacity at any given point in time, and we shall assume that there is some scale effect—i.e., if the existing capacity is multiplied by a factor x, the permanent occupation is multiplied by a factor $y < x$. On the contrary, we will assume that temporary occupation is a function of new capacity, and we will assume there is no economy of scale, i.e., if installing x MW requires n people, installing x * y MW requires n * y people.

Barbatella et al. (2009) estimate both temporary and permanent occupation, both for wind and PV power. While their estimates on temporary occupation seem to validate our assumption,[3] estimates on permanent occupation seem to suggest quite the opposite—that there is indeed a diseconomy of scale.[4] However such result is very much counterintuitive, and is most probably a consequence of the particular methodology employed (I/O matrixes) and the way it is performed.

According to EWEA (2009), green workers in the wind industry are divided as shown in the graph below:

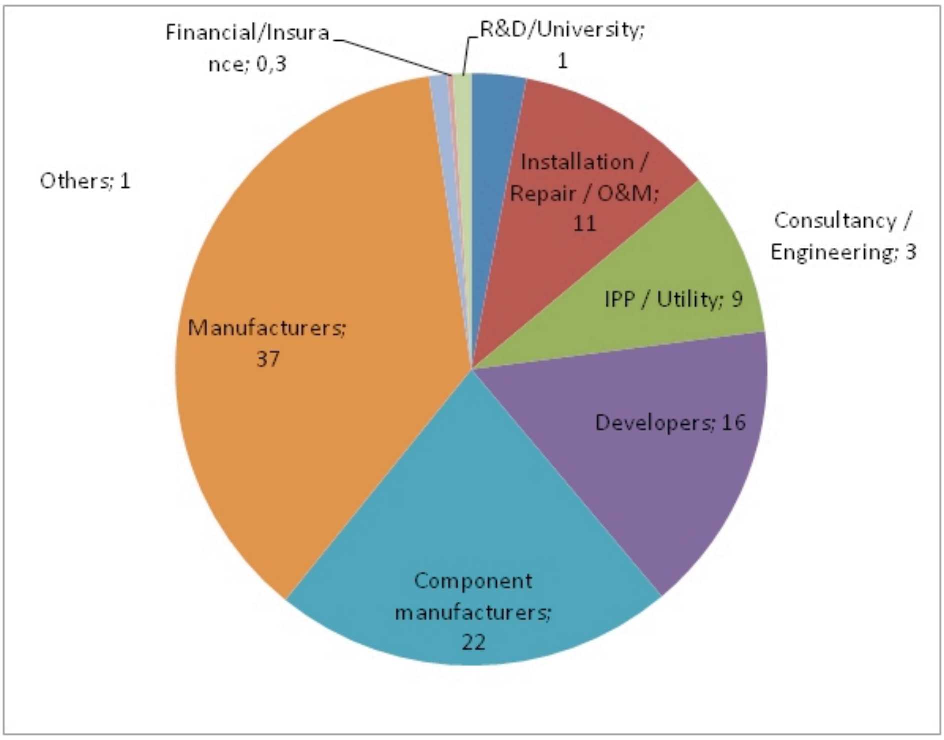


Figure 11—Wind industry' jobs distribution—breakdown by type of activity (EWEA 2009)

[3] For wind power, new capacity in 2020 would be 0.12 times new capacity in 2009, and temporary occupation would be 0.10 times. For PV, the ratios are 8.8 and 4.3, respectively.

[4] For wind power, installed capacity in 2020 would be 2.2 times installed capacity in 2009, while permanent occupation would be 7.2 times higher. For PV, the ratios are 25.8 and 41.8, respectively.

As it can be easily seen, over half of the green jobs belong to the manufacturing sector, which is not as developed in Italy as it is in other EU member states. We have deliberately ignored this fact, by accepting existing estimates even though they often rely on international benchmarks (which, in turn, incorporate a large number of green jobs in the upstream industry). This leads us to grossly overestimate the number of jobs. Looking at the composition of jobs, we have estimated that, in the reference year (2007-2009 depending on the source) 20% of the jobs were permanent ones, i.e. related with the existing capacity, while the remaining 80% are temporary jobs, i.e. they are needed insofar as new capacity is engineered, developed, or built.

Incidentally, the 20/80% figure is consistent with the only two studies that differentiate between direct and indirect employment (under the assumption that most direct jobs tend to be permanent ones, while most indirect jobs tend to be temporary ones): ANEV/UIL finds a 20.6/79.4% ratio, CENSIS finds a 22.4/77.6%. Both studies are about wind power: we will assume the same ratio applies to PV power.

To estimate the model parameters, we have further assumed that, in the short run, permanent and temporary jobs stand in a fix proportion with regard to total and new capacity, respectively. Starting from punctual estimate, then, we have been able to derive reasonable estimates for three years (2007-2009). Obviously the total number of jobs is the sum of temporary and permanent jobs.

At this point, we can develop an optimistic and a pessimistic scenario,[5] deriving the ratio of temporary and permanent jobs per MW installed according to the existing studies. To build our scenario and produce our long term estimates, we assume that the number of jobs is the sum of two function: one representing temporary jobs, the other representing permanent jobs. The former is a linear function of the new capacity that comes onstream—i.e., temporary jobs depend on the flow of new investments—while the latter is non-linear function of the total capacity at a given point in time—i.e. it depends on the existing stock of capacity, and takes into account a modest effect from scale economies. To account for the non-linearity we have assumed that jobs is proportional to the existing capacity at a 0.99 power. The functional forms we have assumed are the following:

$$J_i^T = m^T C_i^N + b^T$$
$$J_i^P = m^P C_i^{0.99} + b^P$$
$$J_i = J_i^T + J_i^P$$

Where J_i, J_i^T and J_i^P are the number of total, temporary and permanent jobs in year i, respectively; C_i^N and C_i are the new capacity and total capacity installed in year i, respectively; and m^T, m^P, b^T and b^P are constants. Arguably, we have set b^T and b^P equal to zero, because the number of jobs, both permanent and temporary, falls to zero when no capacity is installed and no new capacity comes onstream.

5.2. Photovoltaic power

As to PV power, CNES estimates 5,700 jobs in 2008, whereas CENSIS estimates 15,000 jobs in 2009 and CNEL estimates 15,239 jobs for the same year. According to Terna (2008), in 2008 a PV gross capacity of as much as 431,504 kW was installed, producing as much as 193 GWh, while only 86,750 kW were in function at the end of 2007. By the end of 2009, 750,574 kW

[5] The choice of "optimism" and "pessimism" refers merely to the number of jobs that have been "created". Of course, all else being equal, since the revenues to the green industry are a given, one may expect workers to earn less in the "optimistic" scenario, and to earn more in the "pessimistic" scenario. For the employed workers "optimism" may have a different meaning than for the supporters of "green jobs".

had been onstream. Hence, while most of the capacity in function at the end of 2008 had been built that very year, more than half of the capacity existing in 2009 had already been in function. By factoring out the different proportion, having estimated permanent and temporary jobs, and recalculating the values for the missing years (under the assumption that we may employ fixed proportion between capacity and employment in the short run), we find the following estimates. As it will be seen, estimates on the number of green jobs in the PV sector in Italy is particularly high: a suspect of a systematic bias upwards naturally arises. Table 11 summarizes.

	2007	2008	2009
Pessimistic Scenario			
Total jobs	1,282	5,633	6,203
Temporary jobs	1,053	4,360	4,220
Permanent jobs	229	1,273	1,983
Optimistic Scenario			
Total jobs	3,340	14,598	15,000
Temporary jobs	2,993	10,966	12,000
Permanent jobs	347	1,832	3,000

Table 11. Number of jobs in the PV power industry. Source: own elaboration on CNES, CENSIS.

5.3. Wind power

For wind power, we have very disomogeneous estimates, which need to be adjusted to 2008 in order to assess which one is the most optimistic, and which one is the most pessimistic one. Table 12, below, reports the results from our estimates, including the operations we have described. Notably, for wind power MITRE (a EU-sponsored programme aimed at assessing the perspective of RES in the EU member states) forecasts a negative rate of employment, or a loss of jobs, subsequent to the lack of an upstream industry. We reject this scenario, although we recognize it is a possibility.

	2007	2008	2009
Pessimistic Scenario			
Total jobs	7,969	9,238	10,000
Temporary jobs	6,786	7,576	8,000
Permanent jobs	1,183	1,642	2,000
Optimistic Scenario			
Total jobs	22,394	25,966	28,100
Temporary jobs	19,069	21,652	22,480
Permanent jobs	3,325	4,314	5,620

Table 12. Number of jobs in the wind power industry. Source: own elaboration on Nomisma Energia, CENSIS.

6. The Bill, Please

In this section we will try to estimate the per capita cost of PV and wind energy subsidies in 2008. As previously stated, concerning the costs of RES we have three sources: CIP6, Conto Energia and CVs. We have no data for the "tariffa onnicomprensiva" so we will assume this didn't contribute at all to PV and wind energy in 2008.

6.1.Cip6

According to AEEG (2009c), in 2008 CIP6 net subsidies (i.e., the difference between the cost of subsidies and the market value of the generated electricity) totaled € 2.3 bn, of which € 0.95 bn (41%) for RES and € 1.37 bn for "similar to RES" sources (59%). Of the € 0.95 bn dedicated to "real" RES, the largest beneficiaries of subsidies were biomass, biogas, and waste-to-energy plants (with 30%, 11%, and 34% of the subsidies, respectively). PV energy didn't benefit at all from CIP6, while wind energy got € 174.2 mln.

Wind energy	174.2
PV energy	0

Table 13. CIP6 net revenues to wind and PV energy [€ mln] in 2008.

6.2. Green certificates

AEEG (2009c) estimates the total cost of CV in 2008 to be around € 400 mn. To estimate how many CV actually remunerated wind power, we shall look at the actual or estimated energy production. Since the total amount of PV energy is relatively small, we will assume that CV didn't contribute in any way to PV energy production.

The GSE publishes an yearly Bulletin with the results for the market of CVs ("Bollettino Certificati Verdi"). The last available Bulletin refers to the situation up to June 30th 2009, published in December 2009 but made available online in January 2010 (GSE 2010). We remark that at the beginning of 2008, the IAFR producers request for 10,337,326 CVs initially, but, after taking into account the real amount of green energy produced during the year, and the compensation with previous years, the GSE subtracted 824,372 CVs. However, due to greater than expected energy production, the GSE gave back 463.303, with a total net amount of CVs for 2008 of 10.800.629 CV's, mainly due to hydro (GSE 2010). As for wind energy, the GSE entitled 232 plants (+93% y-o-y), or 3,614 GWh (equivalent to 3,614,258 CVs) of incentive energy.

As regards the value of CVs, starting from 2006, there has been a constant disalignment between market price of 1 CV and the price suggested by the GSE. Particularly, during 2007 and 2008, wide fluctuations have been observed, with the price crashing from 100 €/MWh to 60 €/MWh during the first semester of 2008 (vis-à-vis a suggested price of 112.88 €/MWh), recouping only from October. The "Legge Finanziaria 2008" introduced a new methodology of the reference price for CV; the new price will be the difference between 180 and the average selling price of energy (as defined by the AEEG) with respect to the previous year. This will result in the following prices for, respectively, 2008 and 2009: 112.88€/MWh and 88.66 112.88€/MWh (GSE 2010). In the end, the average price, as suggested by the AEEG (2009a) for 2008, was of 92.1 €/MWh, which we will take as reference. Summing up all these information, we can estimate a total of € 332.9 mln for wind energy due to CV.

Wind energy	332.9
PV energy	0

Table 14. CVs net revenues to wind and PV energy [€ mln] in 2008.

6.3. Conto energia and Nuovo conto energia

AEEG (2009c) estimated that incentives for PV (including both the Conto energia and the Nuovo conto energia) totalled € 110 mln in 2008. The GSE (2010b) reports that between October 2008 and August 2009, the sum of both program (conto energia + nuovo conto energia) amounted to € 144 mln while in the same period one year before that was only € 39 mln, suggesting that € 110 mln could be a conservative estimate.

Wind energy	0
PV energy	110.0

Table 15. Conto energia and Nuovo conto energia [€ mln] in 2008.

6.4. Summing up

In the Table 16,below, we estimate the total amount of subsidies to PV and wind Energy in 2008, as well as the net subsidy per worker both in the optimistic and pessimistic scenarios, as defined above.

	Wind	PV
Total installed capacity [MW]	3,537.578	431.504
Energy production [GWh]	4,861.3	193.0
Total incentives [mln €]	507.07	110
Optimistic scenario		
Green jobs	25,966	14,598
Jobs-to-Subsidies [jobs / mn €]	51.18	132.4
Subsidies-to-jobs [€ / job]	19,535	7,555
Pessimistic scenario		
Green jobs	9,238	5,633
Jobs-to-Subsidies [jobs / €]	18.2	51.1
Subsidies-to-jobs [€ / job]	54.892	19,568

Table 16. Summary of all the results for each scenario

Depending on the scenario, according to our estimates, on average a green job costs 19,535-54,892 euro in pure subsidies in the wind power, or 7,555-19,568 euro in pure subsidies in the PV, in 2008. The figures for PV are apparently lower than for wind power, probably due to a more significant overestimation of the number of green jobs. Obviously, that is a partial information. On the one hand, RES industry doesn't get just subsidies: it also has revenues from the market value of the energy produced. On the other hand, labor cost is by no means its only, or major, cost.

We know that, in 2008, 4,861.3 GWh were produced from wind power and 191.3 GWh were produced from PV power. Under the existing schemes, PV power is entirely remunerated under a feed-in tariff, while wind power is remunerated both through the market price of the generated energy, and the associated CVs. A regulatory subsidy also exists, as (a) electricity consumers pay for the cost of connecting RES to the national grid (however distant they may be), and (b) green energy is entitled to priority access through the grid (so-called "priorità di dispacciamento"). We will not factor in the regulatory subsidies, partly because it is very hard to tell their actual value, and partly because this allows us to provide a very conservative estimate.

Since the average price for electricity in 2008 (PUN) was as high as 86.99 €/MWh (AEEG 2009a), we can estimate the value of the wind energy generated in 2008 to be as high as 422.8 million euro. This adds to the subsidies, raising the figure up to 930 million euro or +119,9% with respect to average price while, regarding PV, the average cost is 570 € / MW , or 655.2% above market price.

Table 17 summarizes.

	Wind Power	PV Power
Subsidies [mln €]	507.1	110.2
Market revenues [mln €]	422.9	16.8
Total revenues [mln €]	930	110
Average cost [€ / MWh]	191.3	570
Difference from market price (PUN) [%]	+119.9	+655.2

Table 17. Average cost of green energy in Italy in 2008. Source: own elaboration.

7. ARE GREEN JOBS REAL JOBS?

In this last chapter, we will try to evaluate the effectiveness of the green economy in creating jobs and/or spurring economic growth. To be fair, we should emphasize that not necessarily job creation and growth acceleration go together. Green economy might turn out to be pro-growth while not being labor-intensive; or it might prove to be labor-intensive but with little or no positive effect on growth.

We will compare the results obtained for green energies with the industry sector, as well as the economy in general. There is a rationale for doing so. In the first place, one may expect that—all else being equal—the higher costs of energy would largely impact the industry sector, as other sectors of the economy, such as agriculture and services, are very little energy-intensive and tend not be much sensible to variations in electricity prices. As a consequence, one might expect some substitution effect as a consequence of the green economy: all else being equal, more green jobs would translate into higher energy prices, and thus a lower job creation (or a faster job destruction) and a lower return on capital, and/or less investments, in the rest of the industrial sector. Finally, the green industry is often presented as an alternative to the industrial model of development: in the ideal green world, we don't expect—nor do its proponents expect, as is clear, for example, from Lovins et al. (2004)—to see less services, but less (or, which is the same, different) energy-intensive production processes and goods. By the same token, we will assume that there will be no substitution effect for the employment in the conventional power sector, as green energy production and green jobs grow. Such assumption is supported by the estimates developed by Barbabella et al. (2009). While these authors argue that the net economic and occupational impact from green subsidies is highly positive, they show that the substitution effect is mostly about energy-intensive activities, not conventional energy production.

7.1. Capacity, jobs, subsidies

First of all, we have estimated the capacity that will come onstream until 2020. To do so, we have assumed that in 2020 Italy will have installed its maximum potential renewable capacity, as defined in the Italian government's 2007 position paper (Governo Italiano 2007). So, we have assumed a capacity of 9,500 MW for PV and 20,200 MW for wind power in 2020. Then we have estimated the new capacity that will be installed yearly, by fitting the past capacity as well as the projected capacity for 2020. We have done so through a polynomial regression of 4th order for wind and 5th order for PV. We have picked the order by minimizing the R^2 coefficient, that measures how well the fitting curve approximates the observed points. Figures 12 and 13 illustrates our results.

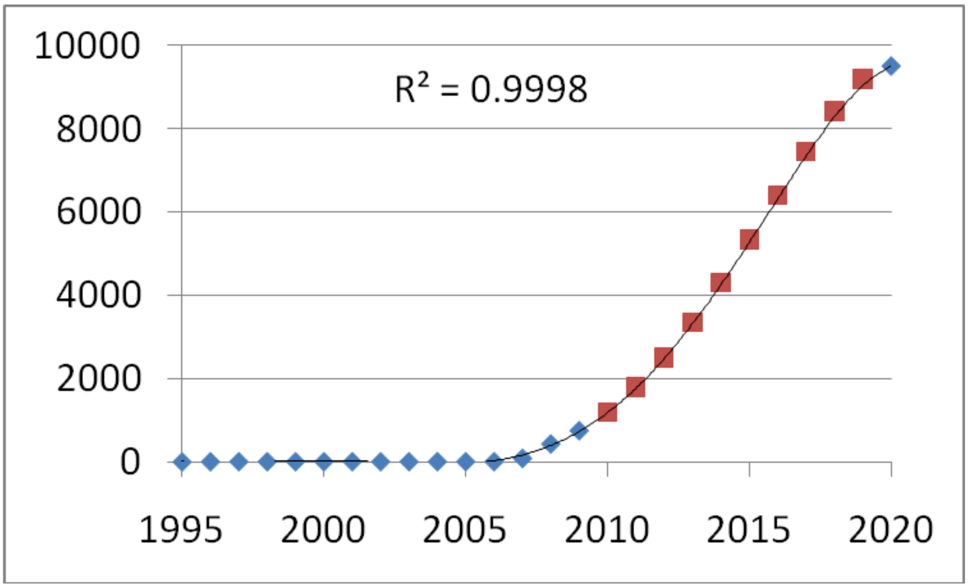


Figure 12. Installed (1995-2009), projected (2020), and estimated (2010-2019) PV capacity (MW). Source: own elaboration on GSE (2010), Terna (2009), Italian Government (2007).

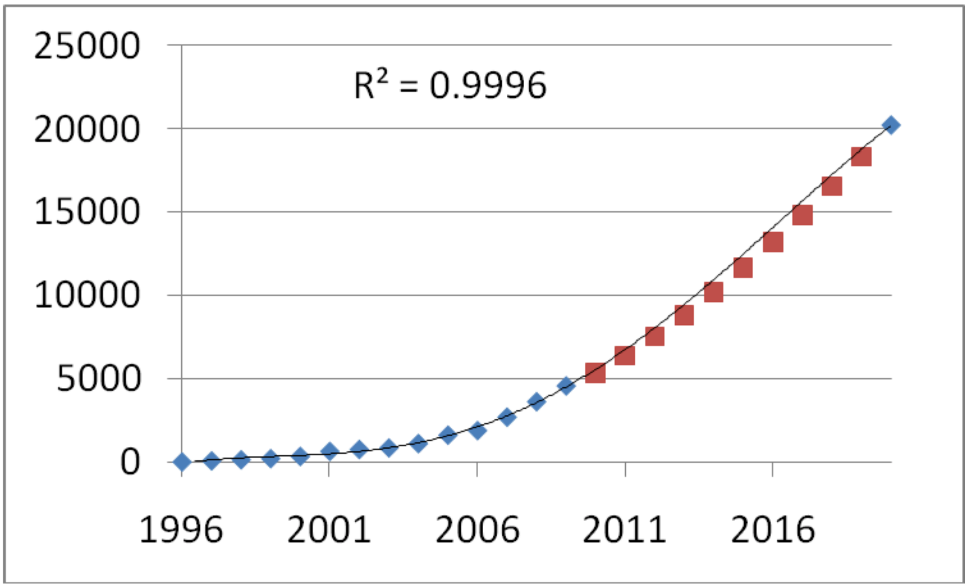


Figure 13. Installed (1995-2009), projected (2020), and estimated (2010-2019) wind capacity (MW). Source: own elaboration on GSE (2010), Terna (2009), Italian Government (2007).

This is likely to be an overestimate of the capacity that will be installed, as the Italian Government itself defines it as a "theoretic potential" that is "conditional to a number of issues, political, institutional, economic and technological" (p.7).

Subsequently, we have estimated the amount of subsidies that have been, and will be, perceived because of the installed capacity. The amount of subsidies is dependent on the political choices as well as on the energy actually produced. As for the former, we have assumed no major change will occur: particularly, we have deliberately ignored the reduction of subsidies from the Nuovo Conto Energia (see paragraph 4.2.4), thus potentially overestimating the total subsidies—at least for PV power. On the other hand, we don't know how much green energy will be produced in the next decade. However, from existing data we know that the amount of energy produced per MW installed has been decreasing steadily in the last decade: if fell from 1738 MWh/MW in 1999 to 1336 MWh/MW in 2008 for wind power, and from 1000 MWh/MW in 1999 to 447 MWh/MW in 2008 for PV power (as deducted from data made available by Terna). This is consistent with the assumption that the "low hanging fruit" has already been picked: on average, new installation will be made under less favorable conditions (i.e., they will be placed in less windy or less exposed to the Sun places than the existing capacity). We have chosen not to take into account such phenomenon, hence we have overestimated production (hence subsidies). We have assumed that the two changes offset each other. To do so, we have calculated the average amount of subsidies per MW in 2006-2008 for wind power, but as far as PV is concerned we have picked only the 2008 figure as representative of the ratio subsidies / capacity, because poor data were available before 2008 and because policies were less favorable before that date.

Finally, we have assumed after 2020 no new capacity will be installed. This allows us to estimate both subsidies and jobs for 15 years after 2020 for wind power (as CVs expire after 15 years) and for 20 years after 2020 for PV (as the Nuovo Conto Energia expires after 20 years). Obviously, we have taken into account that, year by year, capacity older than 15 or 20 years will be no longer subsidized.

For the same period of time (i.e., 1997-2040 for PV and 1997-2035 for wind power) we have estimated the number of temporary and permanent jobs that would be created both under the optimistic and the pessimistic scenario, by applying the model detailed in §6 of this paper. As to the past subsidies, we have not considered them where reliable estimates were not available. This will lead to underestimating, however slightly, the total amount of subsidies over the considered period. Table 18 summarizes.

Year	Wind				PV			
	Capacity	Subsidies (M€)	Jobs (Optimistic)	Jobs (Pessimistic)	Capacity	Subsidies (M€)	Jobs (Optimistic)	Jobs (Pessimistic)
2000	363.44		3539	1259	6.31		25	17
2001	663.86		7871	2801	6.58		36	21
2002	780.11		3645	1297	6.41		25	14
2003	873.64	188.70	3213	1144	7.04	0.29	51	27
2004	1131.49	234.53	7393	2631	7.12	0.10	31	20
2005	1638.96	329.07	13873	4937	7.12	0.10	28	18
2006	1908.29	382.96	8541	3040	7.17	0.12	30	19
2007	2714.13	437.56	22141	7879	86.75	0.20	3324	1272
2008	3637.58	507.07	25966	9238	431.50	110.22	14598	5633
2009	4587.58	766.58	27645	9839	750.57	300.00	14808	6076
2010	5340.88	892.46	23830	8481	1205.38	394.84	21593	8982
2011	6393.14	1062.65	32074	11415	1794.77	587.91	28822	12195
2012	7552.00	1245.68	35883	12770	2515.14	823.88	36388	15673
2013	8815.46	1445.72	39758	14149	3359.20	1100.36	44124	19347
2014	10180.36	1662.43	43669	15541	4309.93	1411.79	51599	23048
2015	11642.40	1884.71	47584	16934	5339.07	1748.90	58290	26558
2016	13196.11	2094.14	51467	18317	6405.70	2096.54	63569	29611
2017	14834.88	2348.55	55286	19676	7454.78	2439.97	66709	31891
2018	16550.92	2619.67	59005	20999	8415.69	2754.79	66869	33022
2019	18335.31	2874.75	62585	22273	9200.78	3011.81	63093	32572
2020	20200.00	3101.54	66534	23679	9500.00	3109.82	45901	26859
2021	20200.00	3056.54	22410	7976	9500.00	3109.74	34647	22901
2022	20200.00	2921.88	22410	7976	9500.00	3109.79	34647	22901
2023	20200.00	2767.58	22410	7976	9500.00	3109.58	34647	22901
2024	20200.00	2608.83	22410	7976	9500.00	3109.56	34647	22901
2025	20200.00	2482.95	22410	7976	9500.00	3109.56	34647	22901
2026	20200.00	2307.12	22410	7976	9500.00	3109.54	34647	22901
2027	20200.00	2113.48	22410	7976	9500.00	3083.47	34647	22901
2028	20200.00	1902.35	22410	7976	9500.00	2970.54	34647	22901
2029	20200.00	1674.28	22410	7976	9500.00	2866.03	34647	22901
2030	20200.00	1429.97	22410	7976	9500.00	2717.05	34647	22901
2031	20200.00	1170.35	22410	7976	9500.00	2523.98	34647	22901
2032	20200.00	896.51	22410	7976	9500.00	2288.01	34647	22901
2033	20200.00	609.76	22410	7976	9500.00	2011.52	34647	22901
2034	20200.00	311.59	22410	7976	9500.00	1700.10	34647	22901
2035	20200.00	0.00	22410	7976	9500.00	1362.98	34647	22901
2036					9500.00	1013.59	34647	22901
2037					9500.00	669.95	34647	22901
2038					9500.00	355.19	34647	22901
2039					9500.00	98.01	34647	22901
2040					9500.00	0.00	34647	22901

Table 18. Capacity, subsidies, and jobs (1997-2040), Source: own elaboration or estimates on Terna (2009), GSE (2010), Italian Government (2007), AEEG (2009c).

As it can be easily seen, our estimates tend to under evaluate the number of jobs in the early years of renewable investments. Alas, we don't regard this as a major problem, especially because the way we have built out estimates warrants that we have overestimated jobs nearly anywhere else.

Figures 14 and 15 further illustrate our scenarios (figure 14 for wind energy, figure 15 for pv).

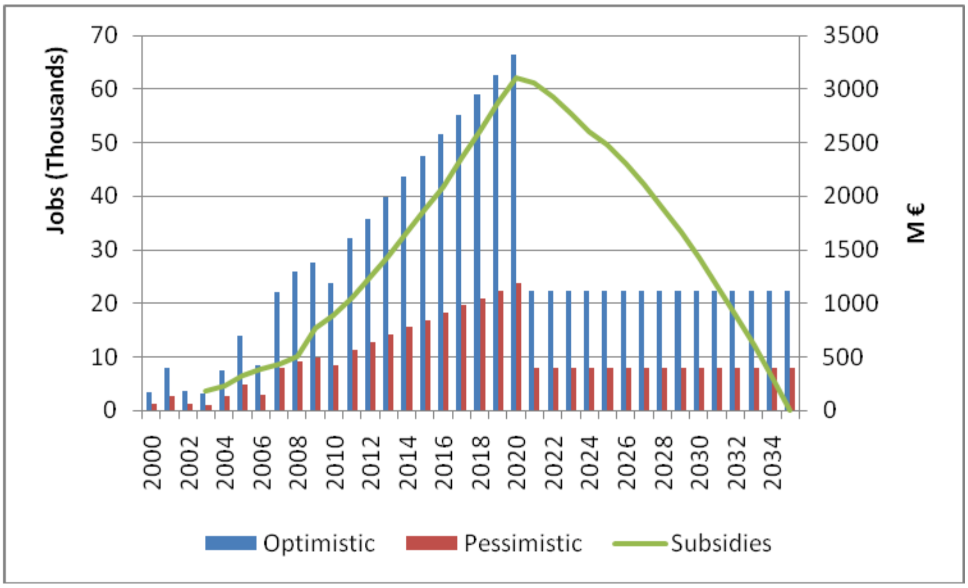


Figure 14 Jobs (two scenarios) and subsidies to the wind power industry.

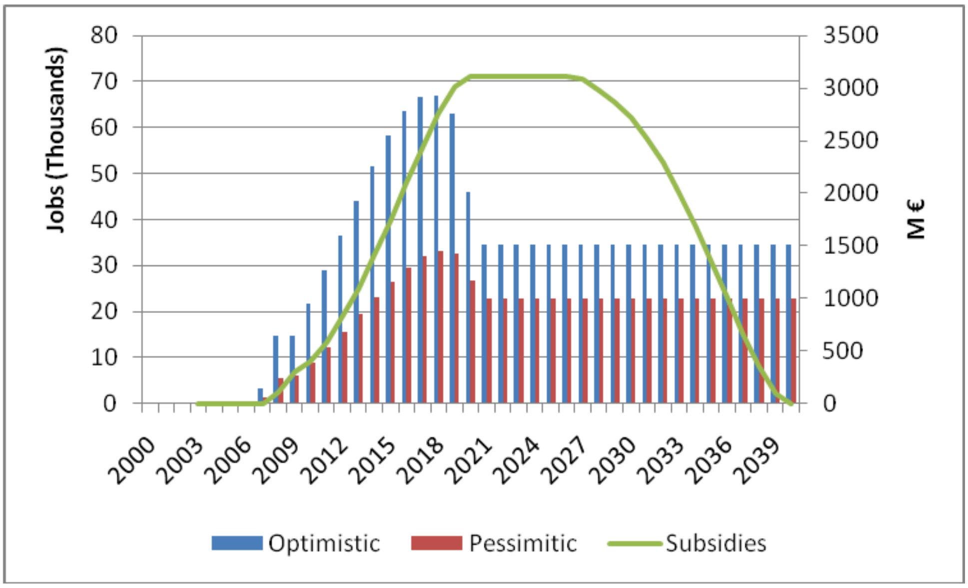


Figure 15 Jobs (two scenarios) and subsidies to the PV power industry.

7.2. Evaluating job creation

Having estimated all the relevant data, we can now evaluate whether the so-called "green deal" can be an effective strategy to create jobs. To do so, we have followed the methodology employed by Calzada et al. (2009) of estimating the stock of capital per worker in the green industry with the same ratio for the industry and the economy in general. For the latter, we rely on Istat (2009b).

For the green energies, we have estimated the stock of capital per worker by summing all the subsidies that have been, and will be, given to the programmed capacity until the current subsidy schemes expires, in 2035 for wind and 2040 for PV. We assume no new capacity is brought onstream after 2020. According to our estimates, the entire flow of subsidies to renewable energy will result in the creation of some 23,700 to 45,100 jobs in the wind power sector, and 26,900 to 45,900 jobs in the PV sector, in 2020. We wish to emphasize that we deem these estimates as grossly exaggerated, since they are based on figures that, according to our own informal surveys, are themselves grossly exaggerated.

In order to insure the creation of such an apparently huge number of jobs, a significant amount of subsidies has been given or committed. According to our estimates, the capital stock embodied in the renewable capacity that we have assumed will be installed by 2020, calculated as the sum of all the subsidies spent and committed and discounted at a 4% rate, is as much as 30,800 million euro for the wind power and 32,700 million euro for the PV in pure subsidies. Notably, the aggregate amount of subsidies devoted to the wind power is approximately as much as the amount we estimate for PV, but the installed wind capacity in 2020 would be more than twice as much as PV capacity, and the production will be nearly seven times higher (we estimate 29,500 GWh versus less than 4,300 GWh).

Under these figures, we find that the average stock of capital per worker in the wind power sector is 464,000 to 1,304,000 euro, depending on the scenario. The same figure for the PV is 713,000 to 1,220,000 euro approximately. From Istat (2009b) we know that the average stock of capital per worker in the industry, over 2005-2008, has been 112,500 euro, while the same figure for the whole economy is 163,200. Table 19 and 20 summarizes the ratios we found.

Wind	Optimistic Scenario	Pessimistic Scenario	Average
Stock of capital per worker in the industry (€) [S_i]	112,525		
Stock of capital per worker in the entire economy (€) [S_e]	163,250		
Stock of capital per worker (€) [S]	464,010	1,303,801	684,436
S / S_i	4.12	11.6	6.1
S/S_e	2.8	8.0	4.2

Table 19. Average stock of capital per worker and ratios in the wind power industry. Source: Istat (2009b); own estimates.

PV	Optimistic Scenario	Pessimistic Scenario	Average
Stock of capital per worker in the industry (€) [S_i]	112,525		
Stock of capital per worker in the entire economy (€) [S_e]	163,250		
Stock of capital per worker (€) [S]	713,755	1,219,762	900,547
S / S_i	6.3	10.8	8.0
S/S_e	4.4	7.5	5.5

Table 20. Average stock of capital per worker and ratios in the PV power industry. Source: Istat (2009b); own estimates.

According to our estimates, the total stock of capital embodied in the renewable capacity to be installed by 2020 is as much as over 63.6 billion euro, that will take to the creation of 50,500 to 112,400 jobs in 2020, according to the scenario, with an average of 81,500 jobs. The stock of capital per worker would range between 556,000 euro to 1,259,000 euro, with an average of 781,000 euro. This would stand in a ratio between 5.0 and 11.2, with an average of 6.9, with the average stock of capital in the industry; and a ratio of 3.5 to 7.7, with an average of 4.8, with the average stock of capital in the whole economy.

Figure 16 below summarizes with respect to the industry, that—for the reasons detailed above—we deem as the correct benchmark.

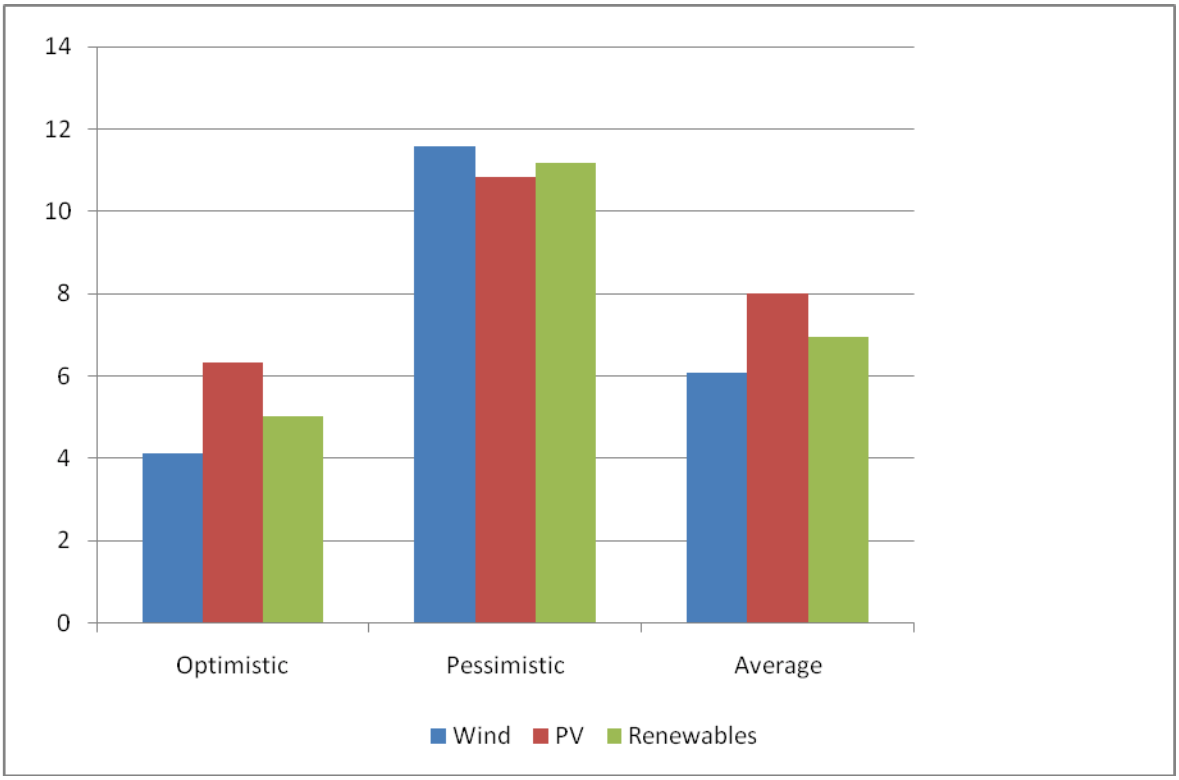


Figure 16. Average stock of capital per worker in the RES with respect with the average stock of capital in the industry.

That means that, on average, one extra green job is equivalent to 6.9 jobs in the industry, or 4.8 jobs in the whole economy. That suggests that investing in RES is not an effective strategy to create jobs.

8. Conclusion

In this paper we have reviewed the available evidence on green jobs, finding that no conclusive evidence is possible regarding the net effect of green subsidies on total employment. According to the existing literature, though, the net occupational effect of green subsidies may be positive insofar a country is a technology-producer and -exporter. Italy is neither, which leaves room for a presumption of a negative net impact on employment. Moreover, some studies—most notably Calzada et al. (2009)—find that the net occupational effect may be negative in Spain, which is a technology-producer and -exporter.

In order to assess the situation in Italy, we have first of all estimated the amount of subsidies that have been spent or committed on renewables. To do so we have assumed the country will meet its 2020 "maximum potential" for wind and PV power, as calculated by the Italian Government (2007). This is likely to be an overestimate, leading to overestimating the number jobs that will be created. Then, we have reviewed the existing estimates on the actual number of green jobs. Even though we feel like virtually all these studies overestimate the number of green jobs, we have taken them as a given, in order to use them as a basis for our projection of job creation by 2020. With these data, we have been able to estimate the total stock of capital embodied in the wind and PV capacity that will be on field in 2020, and hence to estimate the average stock of capital per worker.

Finally, we have compared the average stock of capital per worker in the RES with the average stock of capital per worker in the industry and the entire economy, finding an average ratio of 6.9 and 4.8, respectively. To put it otherwise, the same amount of capital that creates one job in the green sector, would create 6.9 or 4.8 if invested in the industry or the economy in general, respectively,—although differences exist between RES themselves, with wind power more likely to create jobs than PV power. This fact is particularly relevant because we didn't even consider the non-trivial value of the renewable energy produced, but we focused on pure subsidies. If we had considered the energy value, the average stock of capital per worker would result even higher. Since subsidies are forcibly taken away from the economic cycle, and allocated for political purposes, it is especially important to have a clear vision of what consequences they beg.

This does not necessarily mean that the creation of one green job would destroy 7 jobs in the industry. This just suggests what is obvious by anecdotal and financial evidence, i.e. that the green industry is a capital-intensive, not a labor-intensive industry. It is no surprise, therefore, that green investments generate less jobs than investments in other sectors of the economy, and most notably the industrial sector. This does not even necessarily mean that the green economy is a net loss of resources, although there is some evidence even for this.

The only scope, and we dare to say the only result, of our study is to show that green investments are an ineffective policy for job creation. Regardless to their other merits, that we have not reviewed in this paper, to the extent that the "green deal" is aimed at creating employment or purported as anti-crisis or stimulus policy, it is a wrong policy choice.

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