EPI WATER

Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

Green energy certificates and compliance market

Deliverable no.: D3.1 - Review reports
15th December 2011

Grant Agreement no. 265212
FP7 Environment (Including Climate Change)

COOPERATION

Deliverable Title	D3.1 - Review reports
Filename	Green energy certificates and compliance market
Authors	Jaroslav Mysiak, Fabio Farinosi, Lorenzo Carrera, Francesca Testella, Margaretha Breil, Antonio Massaruto
Date	15/12/2011

Prepared under contract from the European Commission
Grant Agreement no. 265213
FP7 Environment (including Climate Change)

Start of the project:	01/01/2011
Duration:	36 months
Project coordinator organisation:	FEEM

Deliverable title:	Review report
Deliverable no. :	D3.1

Due date of deliverable:	Month 11
Actual submission date:	Month 12

Dissemination level

x	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

Deliverable status version control

Version	data	Author
1.0	November 2011	Jaroslav Mysiak, Fabio Farinosi, Lorenzo Carrera, Francesca Testella, Margaretha Breil, Antonio Massaruto (FEEM)
1.1	December 14th, 2011	Jaroslav Mysiak, Fabio Farinosi, Lorenzo Carrera, Francesca Testella, Margaretha Breil, Antonio Massaruto (FEEM)

Executive Summary

Definition of the analysed EPI and purpose

Introduction

The kinetic energy contained in natural water flow is a renewable, carbon dioxide emission-free and easily exploitable source of energy. Making use of water to generate electricity is a conventional water use, analogous to irrigation or cooling, expect for it does not 'consume' water nor alter its physical or chemical properties. The hydroelectricity generation however requires structural modification of water courses and, in the case of larger plants, a construction of water reservoirs.

In the modern carbon-free economies hydropower plays an important role, as one of few sources of renewable energy for which the technology is available, affordable, and reliable. Here being available means that the technology produces at least 1,000 terajoules a year (~277,8 MWh) (2009). The past experience shows that it takes roughly thirty years for a technology to reach a significant level of deployment (Kramer and Haigh 2009). Hence hydropower is an important source in the mix of renewable energy sources (RES) on the pathway to meet the ambitious targets set in the EU Directive 2009/28/EC and Europe 2020 strategy. In this context it is worth to recall that the national target for the share of renewable energy in electricity, in terms of gross final consumption, is 26.39 per cent by 2020 whereas in 2005 it amounted to 16.29 per cent, to a large part from hydropower.

The way the hydropower exploitation alters water courses and flow, along with the related processes (e.g. sedimentation), is or may, be if not implemented in a sensible way, at odds with the recent efforts to restore the integrity of water courses and river health (Dugan and Allison). The clash of the two objectives - renewable energy development and river restoration – caused that hydroelectricity generation grew into a controversy. On the one side, hydroelectricity generation is relatively safe, efficient and flexible technology enabling water flow regulation and flood risk management. On the other hand the hydropower development may cause negative, often significant environmental impacts, if pursued in wrong places or using wrong technology. The Hydropower Sustainability Assessment Protocol (Tollefson 2011) assessing the impacts of dams in all phases, from development to operation, is one of the recent initiative to reconcile the positive and negative environmental effects of hydroelectricity generation.

In this report we explore a mix of economic policy instruments, designed separately and partly for different purposes, but all acting together to in a way hydropower potential is exploited in Italy. Feed-in tariffs (FIT) and later tradable green energy certificates (GEC) had been introduced in Italy in 1990s in order, among others, to reduce the country's carbon dioxide emissions and dependency on energy imports. Both FIT and GEC contribute to make the production of renewable energy cost-efficient (Ringel 2006). The latter, more sophisticated among the both, also introduce a supply-side competition that should under favourable market conditions curtail the generation costs of renewables (Bertoldi and Huld 2006). Neither FIT nor GEC as implemented in Italy take into account the peculiarity of hydropower generation and treat all renewable energy sources (RES) in the same way.

The concessions to build a new HPP are in principle granted upon the results of environmental impact assessment (EIA). In addition, to limit the development of hydropower in less or not suitable places, the *water abstraction* charges can be designed in a way sensible to the environmental impacts. In Italy this hasn't been done yet but is being discussed in some regions. Finally, the government-auctioned concession for operating the state-owned hydropower reservoirs provide another opportunity to control the hydropower operations in a sustainable way and taking into account the costs of decommissioning and removing the dams. Italy extended the concessions and postponed the auctions, a move that has been contested both by the European Commission and the Constitutional Court.

Legislative setting and economic background

The green certificate system in Italy has encouraged the production of electrical energy from renewable sources. Initially introduced by the Bersani Decree, and later modified by laws 244/07 and 239/04 and Legislative Decree 387/03, the system consist of obligatory quota of renewable energy to be supplied by the importers or producers of energy. The quota were first set to 2 per cent and later increased by an annual rate of 0.35% (from 2004 to 2006) and by 0.75% (from 2007 to 2011). The producers or importers of energy can either directly produce a growing amount of energy from renewable sources or cover part or all of their requirements by buying green certificates on the compliance market. These producers of energy from renewable sources benefit from a double source of income, from both the sale of electrical energy and the sale of green certificates. The compliance market was first set for 8 years, then extended to 12 years by the decree 152/2006, and 15 years by the law 244/2007 for power plants built or restored after 2007 (Repubblica Italiana 2007; GSE 2010b). The legislative decree 28 of March 3rd, 2011 (the so-called Romano decree) marks the end of the GEC system in Italy. It gradually phases out the compulsory quota between 2012 and 2015. Green certificates exceeding the demand will be withdrawn from the market at a price corresponding to 78% of the previously determined level. The incentives introduced in favour of small renewable energy plants will remain in place for the whole envisaged incentive period.

The water concession fee (WCF) for the hydropower uses is based on the installed capacity of the plant. The WCF vary across regions in the interval between 10 and 35 Euro per kW. Additional supplementary water abstraction fees and charges have been introduced to benefit local communities. These include supplementary fee for *mountainous basins* and supplementary fee benefiting *riverine communities*. The wealth from the supplementary fees is used to finance local infrastructures and economic development of the local communities.

The final economic policy instrument addressed in this report refers to tenders for renewal of the large water derivation for hydropower purpose. Introduced in the law 79/1999, the postponed tendering and favourable conditions for the incumbents were examined both by the Constitutional Court and European Commission who initiated infringement procedure in 2004 and considered another one in 2011.

Brief description of results and impacts of the proposed EPI

As a result of the incentives, from 1999 to 2009 the number of hydroelectric power plants grew at an annual average rate of 1.3% but the installed capacity increased only by 0.7% per year. In Po river basin, the installed gross capacity has increased steadily from 10,036 MW in 1997 to 11,062 MW in 2010, with Lombardy producing 5,988 MW and Piedmont 3,544 MW, respectively 54% and 32% of the total basin hydropower production. HPP number increased from 825 in 1997 to 1,155 in 2010 (Terna, 1997-2010). Even so the ambitious indicative national target set in the Directive 2001/77/EC has not been reached. In 2008 the share of RES in the gross electricity consumption amounted to 16,6 per cent; 0,6 per cent up from the 1997 level. Ironically, the share of RES in the gross electricity consumption had been for the most period between 1997 and 2010 below the initial level of 16 per cent.

Hydropower development is meeting increasing social resistance fuelled by perceptions of social and geographic injustice. Concentrated in less developed, mountainous areas, the hydroelectricity generation is associated with negative externalities (negative environmental impacts, modification of water courses and landscape) in proximity of the plants, whereas the downstream communities take most benefits. Sondrio district is an emblematic case for overexploitation of the hydropower potential and adverse public participation. The district became one of the most hydropower-developed areas in Italy. Some 12.45% of the national and about 40% of the Lombardy's hydroelectric production is generated here. Over the past twenty years the hydropower development in the district was closely examines several times. Triggered by the local resistance, and upon invitation of almost all political parties and civil society organisations, the 13ª permanent commission (Territory, environment and environmental goods) of the Senate held hearings about the water crisis in Sondrio district, and asked the government to limit the hydropower concessions in the district for 2 years. Successively, the 2007 Financial Law (law 296/06 article 1, 1106 commas) established that new concessions for both large and small hydropower plants, exclusively for the Province of Sondrio, from 1st January 2007 to the 31st December 2008, were granted only after the binding advice of the Ministry of Environment.

The GEC system as introduced in Italy is comparable with similar schemes introduced in other counties. Under market conditions, the producers of RES bear the price uncertainty and the competition between the different sources of renewables ensures that the policy targets are achieved at least costs. In Italy, the market became soon saturated with the excessive certificates and the price of GEC started to decline. Partly, this is a result of the (many) exemptions from the initial obligation to supply energy form renewable sources granted to the producers or importers by the initial design of the scheme. The government intervened by guaranteeing a fixed price of the certificates, and by doing so removed the price uncertainty and competition between the different renewables. In principle, through this intervention the initial tradable incentive scheme had been turned into indirect subventions. Overall the costs of RES were borne by final consumers, contributing so to making the electricity price for consumers one of the highest in Italy.

Conclusions and lessons learnt

Hydropower energy differs from other renewable energy sources (RES) in two important aspects: First, as a mature technology it offers relatively little room for improvement in the efficiency of generation. The existing and easy-to-tap potential has been already exploited. The deployment of small (> 10 megawatts) 'run-of-river' HPP that produces power from the natural flow of water provides potential for greater hydropower exploitation, with lesser environmental impacts but at much higher costs. Second, impact assessment and certification of HPP require different, more comprehensive and meticulous procedures than in the case of other RES. The assessment should not only address the marginal effect of a single HPP, but the cumulative impacts of hydropower exploitation across the entire river system, identifying the best sites and coordinating energy production between the up- and downstream plants.

The reclamation of existing, and construction of new HPP, may require different incentive schemes. The reclamation of large HPP requires investments that are likely not paid back within the eight years of incentivised RES. The concession tendering would have been a more suitable economic policy instrument to address the peculiarity of the large HPP.

The existing water abstraction charges can be integrated with the GEC to control the environmental impacts particularly of the small HPP. To this end the abstraction charges can be differentiated according to the marginal environmental impacts of a new plant. In order to guarantee sustainable and socially beneficial hydropower exploitation, the whole system of concession and certification has to be embedded within a well developed river basin plan that identifies and priorities the sites suitable for hydropower development.

.

Table of Contents

Proposed headings for the case studies

1 EPI Background

This report addresses several economic policy instruments acting together in determining the level to which kinetic energy contained in natural water flow (hydropower) is exploited: green renewable certificates introduced in 1999 by the law 79/99, water abstraction fees and charges, and tenders for renewal of large water derivations.

In order to boost the development of renewable energy sources, in late 1990s the Italian government introduced compliance market, first specified by the decree 79/1999. The compliance market is based on mandatory targets from renewable energy to be supplied by each energy provider every year, and a scheme of renewable energy certificates (GEC). The compliance market was first set for 8 years, then extended to 12 years by the decree 152/2006, and 15 years by the law 244/2007 for power plants built or restored after 2007 (Repubblica Italiana 2007; GSE 2010b).

The mandatory target for renewable energy share was first set to 2% of the previous year's production or import of electrical energy. The target applies to the importers and producers of electricity from non renewable sources. The rule exempts the first 100 GWh of yearly production/import. The companies falling short of meeting the target are obliged to purchase the GEC for the equivalent of the underperformed renewable energy. The target was successively augmented by 0.35% per year for the period 2004-06 (decree 387/2003), and later by 0.75% per year since 2007 (law 244/2007). In 2011, the mandatory target amounted to 6.05% (GSE 2010b).

Regarding hydro energy, the tradable certificates – the GEC - are issued for each 1 MWh of renewable energy produced in the previous year by plants with installed capacity exceeding 1MW. The HPP built after December 31st, 2007 with installed capacity smaller than 1MW were excluded form the GEC scheme but remunerated with an incentive tariff. For the most part, these HPP are of the run-of-the-river type. In 2010, the volume of GEC traded, under this scheme, amounted to 301 million Euro (GSE 2010b).

The water concession fee (WCF) for the hydropower uses is based on the installed capacity of the plant. The state competences for water concessions were transferred in 1998 to regional territorial authorities. As a result, the WCF vary across regions in the interval between 10 and 35 Euro per kW. Some regions have delegated the competences for specifying and collecting the WCF to district authorities responsible for the management of water resources, further increasing the variability of the fees. In 1977, the WCF were differentiated between small and large derivations, the latter including the plants exceeding the equivalent of 3000 KW (law 7/1977). In the case of hydropower, only HPP not exceeding the capacity of 3000 kWe (small derivation according to law 7/1977) are applicable.

Additional supplementary water abstraction fees and charges have been introduced to benefit local communities. The law n. 925 del 22/12/1980 modified and regulated the supplementary abstraction fees for riverine communities (*sovracanone per gli enti rivieraschi*) and supplementary abstraction fees *mountainous basins* (*sovracanone per bacini imbriferi montani*) for hydropower plants with installed capacity exceeding 220kW. These supplementary fees were introduced in the first half of the past century in order to repair the negative externalities caused by the formation of the reservoirs. Moreover these fees were aimed to favour the economic development of the mountainous areas were most of the reservoirs were located and to economically sustain the authorities located in the mountainous basins.

Table 1: Supplementary abstraction fees

Supplementary abstraction fee for mountainous basins (2011)	21.08 €/kWh
Supplementary abstraction fee for local authorities (2011)	5.27 €/kWh

The final economic policy instrument addressed in this report refers to tenders for renewal of the large water derivation for hydropower purpose. Introduced in the law 79/1999, the postponed tendering and favourable conditions for the incumbents were examined both by the Constitutional Court and European Commission who initiated infringement procedure in 2004 and considered another one in 2011.The decree n. 79/99 (Bersani decree) decree extended the large water abstraction licenses operated by ENEL until 2029. The licences of other operators which would have expired before 2010 were extended until 2010. The law 266/2005 extended for 10 years all the concessions active at that moment. The extension was subjected to the payment of an extraordinary fee. Constitutional Court, in 2008, rejected parts of the new regulation about water concession for hydropower uses introduced by the two laws mentioned. After the decision of the Constitutional Court, all the expiring concessions were tendered publicly. The applicant for new concessions and for the renovation of existing concessions are subject to the same conditions and their industrial plans have to respect the environmental laws and regulations introduced for the sector, as for example the environmental flow.

2 Characterisation of the case study area (or relevant river basin district)

The Po river is the most important Italian river, with a length of 652km and a river basin covering 71,000 km^2 or ca. 25% of the national territory. The Italian river basin interests partly or entirely six northern Italian regions and the independent province of Trento. It comprises furthermore a part of Swiss and some small parts of French territory

The river basin extends from its source situated in the western Alps, over the Po river plains to the delta in the Adriatic sea. Following the great topographic variety (approximately two thirds consist of hill and mountain area, and one third of plain areas) prevailing land uses vary across the river basin; forestry for instance is more important in mountain areas (province of Trento and Valle d'Aosta), but is less important in the hilly and flatland areas downstream where urbanization and agricultural uses prevail (AdBPo 2006). According to the results from the census of 2001, agriculture in the Po basin accounts for approximately half of the overall land surfaces with even higher percentages in the downstream regions (Veneto, Emilia Romagna and Lombardy) (EUROSTAT, 2011), forestry for 14% and residential areas account for approximately 10% of the territory (AdBPo 2006).

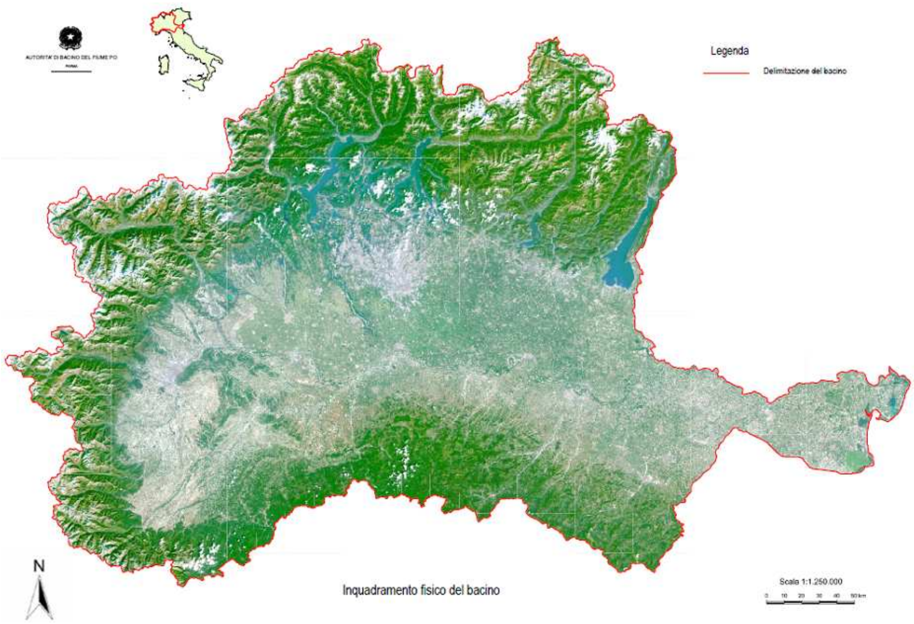

Figure 1 The Po river basin, physical characteristics and delimitation (source: AdB Po 2006)

Surfaces covered by Water and wetlands account for less than 5% throughout the overall basin (EUROSTAT, 2011), with higher percentages in the mountain regions, where artificial and natural water basins are situated, and in the coastal flat (Veneto and Emilia Romagna) due to the extended surface of the River Delta and coastal lagoons.

The Po river depends on an extended hydraulic network of more than 140 major water courses and an almost ten times larger secondary reticulum of natural and artificial water bodies, irrigation and reclamation channels.

In the Alpine area, 174 water reservoirs manage 2.803 billion m^3 a year, of which 143 artificial reservoirs for hydropower production, controlling 1.513 billion m^3, and another 1.290 billion m^3 controlled by natural lakes; furthermore the basin comprises circa 600 km^2 of glacier areas.

Average annual precipitation is nearly 1,200 mm, which corresponds to a discharge of approx. 78 billion m^3. Of these, less than two thirds, 47 billion $m^{3.}$ are discharged into the sea, and evaporation and plant consumption accounts for 31 billion $m^{3.}$

Water uses within the Po basin come from the electricity sector (about 890 hydro-electric power plants power producing 48% of the national hydroelectric production, and 400 thermo-electric plants, 31% of the national thermo-electric production), from inland navigation and for an irrigation based agriculture.

Total water abstractions account for more than 20.5 billion m^3 per annum, most part of which (16.5 billion m^3) is used in agriculture/irrigation, 2.5 billion m^3 for drinking water and 1.5 billion m^3 for industrial uses. Abstractions account for 14.5 billion m^3 for surface waters and for 6 billion m^3 for groundwater.

The Po Valley covers the economically most important and active area of Italy, hosting 27% of the national population and producing 40% of the national GDP (AdB Po 2006). The GDP per capita (thousands euro) in the regions interested by the river basin ranged, in 2009, from 21.6 € (Piedmont) to 26.8 € (Valle d'Aosta), fairly above the national average of 20 € (ISTAT 2011).

Table 2: Incidence of the Po-Valley on socio-economic variables in Italy (adapted from AdB Po 2006)

Socio-economic Variable under consideration	**% of the total in Italy**
Energy Consumption	48
Industry	37
Workforce	46
Cattle Breeding	55
Agriculture Production	35
Net Agricultural Surface	21
GDP	40
Population	27

The population residing inside the Po River Basin accounts for approximately 17 million persons, more than half of these (9 million) reside in the region of Lombardy with the metropolitan area of Milan, and another 4 million inhabitants in the Turin area. Population density in the river basin of 225 persons/km^2 is above the national average of 188 residents/km^2. This mean value includes peaks of density of almost 1,500 persons per/km2 in Milan and in the province of Turin. Patterns of urbanization vary across the basin with high percentages of concentration in the urban areas in the Lombardy region where only 5% of the population lives outside urban centres, and low concentration rates encountered in Veneto (19% of the residents living outside urban centres) and Emilia Romagna (15% living in diffusely urbanized areas). Despite of declining the population numbers, the number of households is increasing significantly, determining a still growing anthropogenic pressure on the territory (AdB Po 2006).

3 Assessment Criteria

3.1 Environmental outcomes

Hardly any renewable energy source (RES) caused more controversy that hydropower. Undeniable is its crucial importance both from a historic perspective and as modern-day constituent of energy mix. The kinetic energy contained in natural water flow is a renewable, carbon dioxide emission-free and easily exploitable source of energy. Making use of water to generate electricity is a conventional water use, analogous to irrigation or cooling, expect for it does not 'consume' water nor alter its physical or chemical properties.

Since ancient times the humans exploited the kinetic energy of running water, and by doing so, modified the morphology, discharge regimes and sedimentation processes of rivers (Walter and Merritts 2008). In 1870s they learned to turn the hydropower into electricity and make it accessible at industrial scale. Since then, hundred thousands hydropower plants (HPP) were built across the globe, producing the much-needed energy for fast growing economies and societies. Initially the HPP were producing most, if not all, electricity throughout the world. Soon enough the thermoelectric, and later nuclear power plants surpassed in capacity and generated electricity the hydropower.

There are different types of hydropower plants (HPP). Conventional hydroelectric plant exploits the gravitational force of falling water stored in a reservoir. Run-of-the-river hydroelectric plants do not require a reservoir as they exploit the power of flowing water. Pumped-storage hydroelectric plant is a semi-closed circuit consisting of two reservoirs between which the water conveyed and electricity produced on-demand, helping so to 'store' energy and make it available at times of peak demand. In terms of capacity, the HPP are usually classified into small capacity (< 1MW), medium capacity (1-10 MW) and large (> 10 MW).

Hydropower is one of a few sources of renewable energy for which the technology is available, affordable, and reliable. If the past is of any guidance, than any new energy technology takes thirty years for a technology to reach a significant level of deployment (Kramer and Haigh 2009). Hence hydropower is an important source in the mix of renewable energy sources (RES) on the pathway to meet the ambitious targets set in the EU Directive 2009/28/EC and Europe 2020 strategy.

The persistent and contentious debate about the benefits and costs (in the largest sense) of hydroelectricity is triggered by the environmental and social effects of hydropower (Schiermeier *et al.* 2008). The HPP disrupt river habitats (Vannote et al. 1980) and fish migration routes. The alterations of river flow patterns influence river stages and temperature; both have an effect on riverine and riparian flora and fauna (Nilsson and Berggren 2000). Alternation of sedimentation processes lead to lesser sediment supply downstream, amplifying so coastal subsidence and erosion.

Reduced downstream river flow creates condition for saltwater intrusion (Milligan et al. 2006; P.M and Syvitski 2003). Processes of coastal erosion and subsidence represent a serious concern for the low lying Adriatic coasts at the mouth of the river basin which are reducing their potential of natural adaptation processes to sea level rise.

Hydropower reservoirs are also a potential source of greenhouse gas (GHG) (Giles 2006), as a result of bacterial decomposition of organic material (see for instance Rosenberg et al. 1997) According to Barros et al. (2011), hydroelectric reservoirs worldwide emit about 4% of global carbon emissions from inland waters, with varying contributions from the single reservoirs according to their age (higher emissions in the first years after flooding due to decomposition of previous vegetation) and climate zone (highest contributions from reservoirs in tropical climates). Rosenberg et al. (1997) expect these impacts to last for even 100 years after the first flooding of the reservoir, whereas the statistic analysis of different measurements on GHG emissions made by Barros et al. (2011) indicates of 20 years as the critical period after flooding.

Not all environmental effects are negative. Hydropower reservoirs help to regulate river flows and cushion against too high or low river stages (Verbunt M.; Zwaaftink M.G. and Gurtz J. 2005).

In 2010 the pool of hydropower plant in Italy consisted of 2.736 power plants with an installed gross efficient capacity of 21.893 MW (Figure 2) and an average annual productivity of 54.407 GWh (Terna 2010). Most of the hydropower plants are located in the north of the country, in the Alpine area. Large hydropower facilities (>10 MW) account for around 86% of the total installed hydropower capacity.

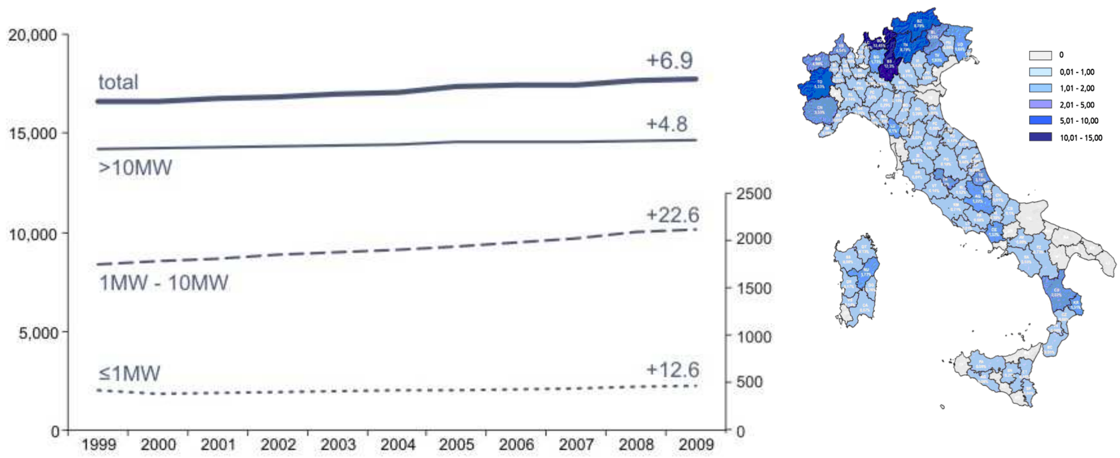

Figure 2: Development of the installed hydropower capacity per categories of plant size (own elaboration based on GSE 2010a). Left y-axis refers to the total installed capacity and the HPP with capacity exceeding 10MW. Right y-axis refers to the other two classes of installed capacity. Right: Installed hydropower capacity by districts

From 1999 to 2009, the number of hydroelectric power plants grew at an annual average rate of 1.3% but the installed capacity increased only by 0.7% per year (GSE 2010a). At national level it is observed a general increase in the number of HPPs. Small and medium size HPPs have higher rate of expansion (<1 MW and 1-10 MW), while the number of larger HPP remains constant (Figure 3).

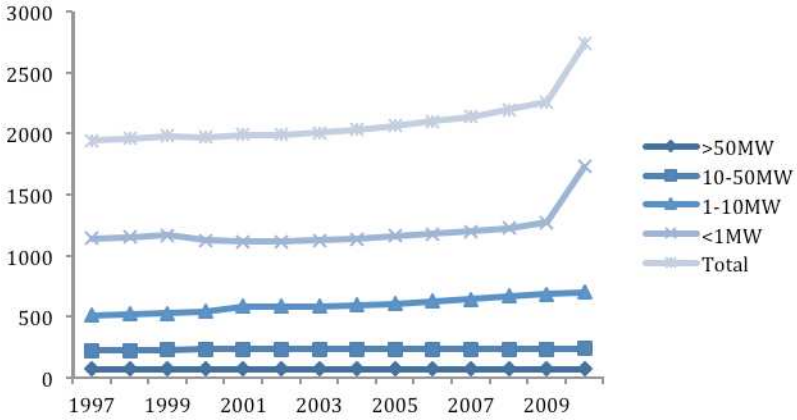

Figure 3 – Number of hydropower plants (HPP) by category of installed gross capacity (1997-2010). Source: Terna S.p.A.

In the Po River Basin are located around 1,100 hydroelectric power plants. The annual electricity production within the Po River Basin is around 26,000 GWh (Terna 2010), accounting for almost 48% of the national production.

Table 3: Hydropower production in the four regions of the Po River Basin with highest hydropower potential and completely included (apart of Emilia Romagna) in the basin area (Terna, 2010)

Region	Nr of plants	Capacity [MW]	Production [GWh]
Lombardy	354	5,917	12,503
Piedmont	574	3,512	9,234
Valle d'Aosta	78	901	2,930
Emilia Romagna	88	627	1,407
All regions	**1,094**	**10,957**	**26,074**

The Po River Basin hydropower sector follows the national trend of great variability due hydro-meteorological factors. From 1997 to 2010, the linear trendline is slightly negative, producing a small decrease in the annual gross production (Figure 4).

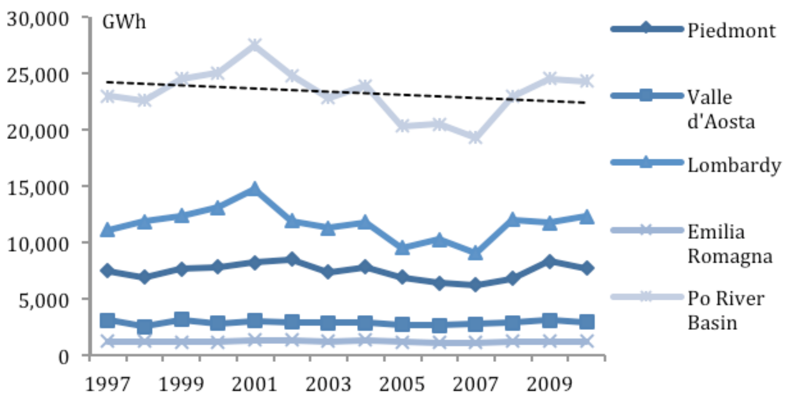

Figure 4 - Hydropower production for all Regions within the Po River Basin. Po River Basin dataset includes all hydropower plants in Lombardy, Piedmont, Valle d'Aosta, and Emilia-Romagna (1997-2010). Source: own elaboration on Terna S.p.A.

The installed gross capacity has increased steadily from 10,036 MW in 1997 to 11,062 MW in 2010 (Figure 5), with Lombardy producing 5,988 MW and Piedmont 3,544 MW, respectively 54% and 32% of the total basin hydropower production (Terna, 1997-2010).

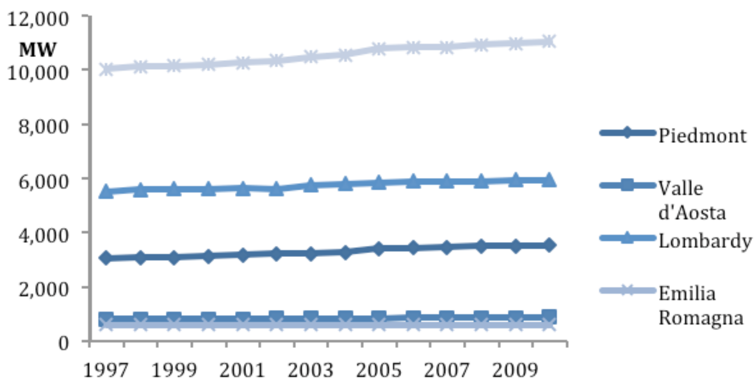

Figure 5 – Gross efficient capacities installed in all Regions within the Po River Basin. Po River Basin dataset includes all hydropower plants in Lombardy, Piedmont, Valle d'Aosta, Emilia Romagna (1997-2010). Source: own elaboration on Terna S.p.A.

HPP number in the Po River Basin grew from 825 in 1997 to 1,155 in 2010 (Figure 6) (Terna, 1997-2010).

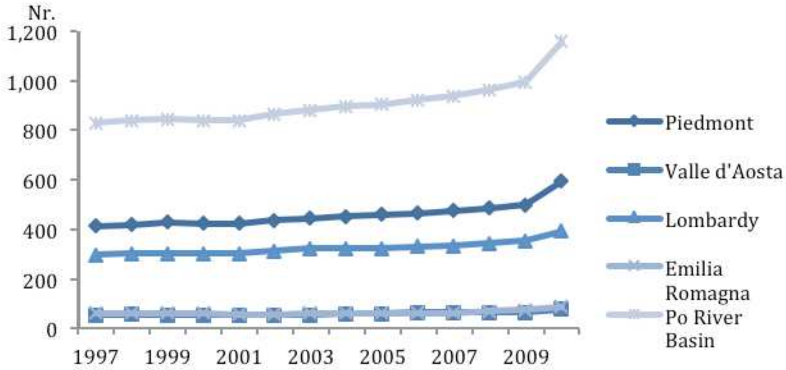

Figure 6 – Number of hydropower plants for all Regions within the Po River Basin. Po River Basin dataset includes all hydropower plants in Lombardy, Piedmont, Valle d'Aosta, Emilia Romagna (1997-2010). Source: own elaboration on Terna S.p.A.

The dataset highlights a strong increment of small HPP from 2009, due to the connection of small capacity plants to the grid. It is observed a peak of new plants in 2002 and a consecutive peak from 2008 to 2010, while the total capacity remains nearly constant (Figure 7).

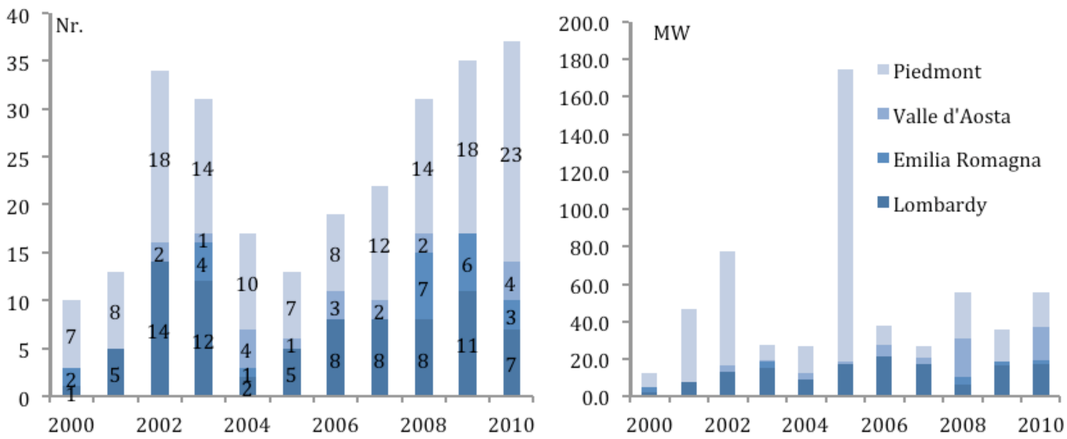

Figure 7 – New HPP installed (number of HPP on the left, gross capacity on the right) and included into Terna statistics 1997-2010 by Regions of Po River Basin. Source: own elaboration on Terna S.p.A.

Sondrio district is extensively hydropower-developed. Its hydropower density is the highest of Italy, 681 kW/Kmq and 11.97 kW/inhab. (GSE, 2009). Some 12.45% of national production is generated within district borders. According to the Province of Sondrio's Authority for water abstraction, from 2005 to mid-2011, the Province of Sondrio received 68 abstraction requests for hydroelectric generation purposes, for a total capacity of 31,445 kW. Out of them, the Provincial Authority authorized 22 concessions, producing a confirmed additional capacity of 2,079 kW (Province of Sondrio, 2011). The average capacity of all concessions is 189 kW, the larger is 1,155 kW (one authorization only is above 1 MW), while the larger concession requested was 9,289 kW. Due to its favourable morphological characteristics and its geographical position, the Province of Sondrio suffered from great exploitation of its surface bodies for power generation, which caused strong anthropization of its river network as highlighted in the River Basin Plan produced by the Province of Sondrio (Figure 8).

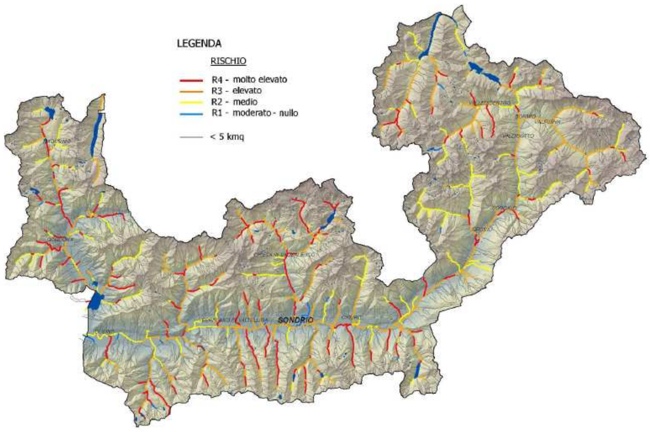

Figure 8: Index of risk not complying with water quality minimum standards (high risk in red, low in blue). Source: (Provincia di Sondrio 2008a).

Growing antrophization of water resources does not necessary imply proportional growing installed capacity and hydropower production. Run-of-the-river small HPPs provide small additional production capacity to the system, while they generate inevitable environmental impacts. According to Massarutto (Massarutto, 2011) profitability of small HPPs is negative without incentives. Massarutto estimates that margin profit for small HPP (<1MW) is 46 euro per MWh with incentives system and -99 euro per MWh without incentives.

From 2000 to 2010, 37 new concessions for small HPP have been released in Province of Sondrio. The number of plants in Sondrio Province doubled during the last decade, while the total capacity installed increased by 0.8%. The pressure on water resources already used for hydropower production increased by 3.7%, while the pressure on water resources used by small HPP only increased by 29%. From 2003 to 2010, it is estimated that total fees paid by hydropower producers for water abstraction amount to 3.7 millions euro, while total incentives for small HPPs development is estimated as 15.5 million euros (Table 4).

Table 4 – Statistics about small HPPs installed from 2000 to 2010 in Sondrio Province. Concessions and Incentives are calculated over the period 2003-2010.

	2000-2010	Δ Province**
New HPPs installed from 2000 to 2010	37	+82%
Capacity installed for new plants (2000-2010) [kW]	18,520	+0.8%
Waterflow for new HPPs compared to actual flow for HP uses [l/s]	10,754	3.7%
Waterflow for new HPPs compared to actual flow for small HPPs [l/s]	10,754	28.9%
2010 production by added (2000-2010) small HPPs* [MWh]	27,527	+0.5%
Incentives for new HPPs (2003-2010)* [euro]	15,563,147	
Water abstaction fee for new HPPs (2003-2010) [euro]	1,352,285	
Supp. abstraction fee (2003-2010) mountainous basin for new HPPs [euro]	1,882,121	
Supp. abstraction fee (2003-2010) local authorities for new HPPs [euro]	477,916	
Total fees (2003-2010) [euro]	3,712,322	

* estimation obtained from average HP production of Region Lombardy (Massarutto, 2011)
** GSE 2009

3.2 Economic Assessment Criteria

In order to analyse the compliance market for the GEC, it has to be considered crucial to give some details about the composition of demand and supply. Supply has been already commented describing the GEC allocation among the companies operating in renewable energy sector. The demand is represented by the compulsory quota, calculated in relation to the energy obtained from non renewable sources, that all the operators of the energy market are obliged to detain. The initial compulsory quota of 2% has been increased till reaching, on 2011, the 6.05% of the electricity produced/imported on 2010 (GSE 2010b) –Figure 9.

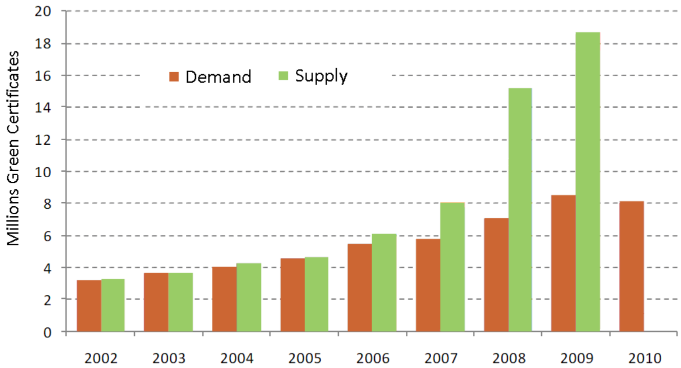

Figure 9: Demand and Supply trends (2002-2009). Source: (GSE 2010b).

As consequence of the combination of supply and demand, it is possible to justify the price trend.

Table 5 –GEC price trends. Source: Own elaboration on GME data.

Type	Size (Mwh)	Total Average price (€/Mwh) (excluding VAT)	Total volume traded (number of RECs)	Turnover (excluding VAT)	Type	Size (Mwh)	Total Average price (€/Mwh) (excluding VAT)	Total volume traded (number of RECs)	Turnover (excluding VAT)
2002	100	84.18	46,994	197.804.452	CV 2006	1	98.19	22,392	1.832.186
2003	100	82.40	20,780	171.236.533	CV 2007	1	96.90	589,363	47.588.868
2004	50	97.35	22,901	111.492.295	CV 2008	1	103.61	708,910	61.208.449
2005	50	109.40	8,065	43.972.207	CV 2009*	1	104.52*	2,224,087*	193.710.689*
2006	50	120.19	9,813	58.971.717	CV 2010*	1	100.35*	3,162,800*	264.491.734*
2007	50	96.48	1,255	6.054.301	CV 2011*	1	96.85*	1,235,125*	99.687.602*

* Last update October 2011

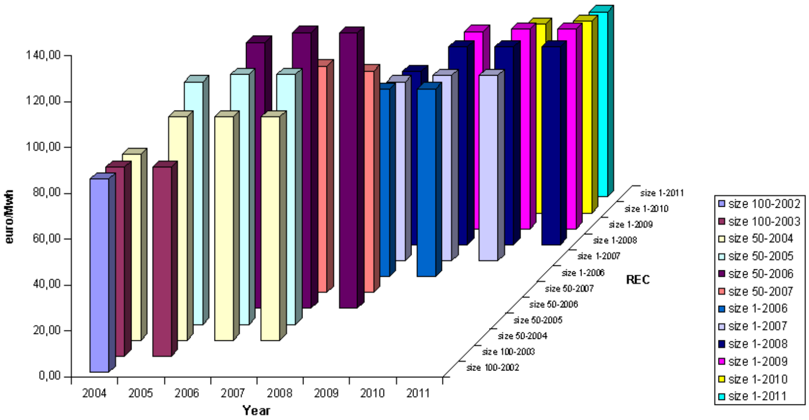

Figure 10: Yearly Price fluctuations for the different RECs emitted by GSE (2004-2011). Source: Own elaboration on GME data.

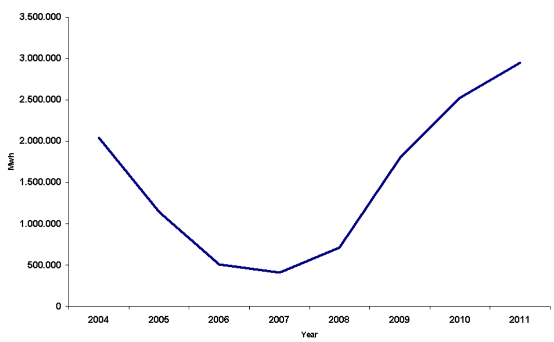

Figure: Volume of GEC (Mwh) traded per year (2004-2011). Source: Own elaboration based on GME data

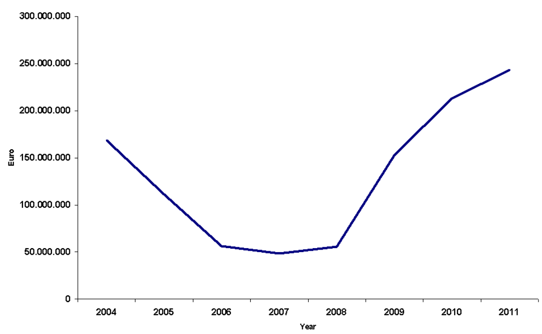

Figure: Value traded into the GEC market per year (2004-2011). Source: Own elaboration on GME data.

The market of the green certificates has been subject to different shocks on the recent past. The main problem of the market has been represented by the large increase of the supply and the general stagnation of the demand for green certificates (GSE 2011). The general surplus of supply registered from the end of 2007 determined a general collapse of the GEC price that reached its minimum value of 58€/Mwh on august 2008 (GME). The fall of the demand has been provoked by the exemption of some operators from the quota system (Barbetti T. 2009). The exemptions have been introduced since 1999 for cogeneration, energy produced for self-consumption, energy produced using coal coming from national mines, and for the first 100 Gwh yearly produced/imported by each operator (Barbetti T. 2009). It has been estimated that, on 2008, due to the exemptions, demand for GEC has been reduced by the half (Barbetti T. 2009).

The compliance market is kept alive only through the intervention of the of the regulatory agency (GSE). The excess of supply has been controlled by the introduction of the **Ministerial Decree 18/12/2008** (Ministry of Economic Development) obliging the GSE in purchasing the unsold GEC at the average price of the three years before till 2010. This intervention artificially stimulated the demand side and consequently the rise of the GEC price from 2009 avoiding the market failure (Figure 10, Figure, Figure). This reached values substantially high during the period 2007-2008, with the excess of supply of GEC, and fell down in the first trimester of 2009 after the introduction of the Ministerial Decree 18/12/2008.

The compliance market has been designed to promote the exploitation of renewable energy sources, otherwise not able to compete with fossil fuel. The EPI triggered investments with positive ripple effects on the sub-suppliers and technological innovation.

The costs born by the operators are passed on to final electricity consumers. The costs of incentives sustained by the operators, in relation to the GEC purchased to satisfy the compulsory quota, converge into the final price for energy that consumer has to pay. Moreover the final consumers are charged of the costs of the GSE through a section of the electricity bill. It has been estimated that the cost of CIP6/92 for final consumers for the year 2009 was 1.8 billion Euro; for 2010 was 800 million Euro (AEEG 2010). At the same time, the compliance market weighted final consumers with indirect costs for 600 million Euro and direct costs for 1 billion Euro (AEEG 2010).

Table 11 shows the estimation of the contribution of different users (domestic or industrial) to the GSE expenses in 2009 (GSE 2010c). Total expenditures for GSE in 2009 have been accounted for around 3.7 billion Euro (GSE 2010c). In 2009, incentives for renewable sources energy accounted for around 6% of electricity cost.

In 2009 hydropower sector for small size plants accounted a turnover of around 440 million Euro and around 3,500 people working directly or indirectly (GSE 2010c).

2009	Unit	Voltage level							
		Low voltage				Medium voltage		High	
		Domestic use		other uses					
Power	kW	3	3	10	100	500	1,000	3,000	10,000
Use	hour/year	880	1,166	1,200	1,500	2,000	2,500	2,500	3,500
Consumption	kWh/year	2,640	3,500	12,000	150,000	1,000,000	2,500,000	7,500,000	35,000,000
Incentive charge	**cEuro/kWh**	**0.73**	**0.94**	**1.7**	**1.36**	**1.09**	**1.09**	**0.99**	**0.99**
Monthly ave. cost	Euro/month	1.6	2.7	17	170	911	2,274	6,204	28,937
Annual average cost	Euro/year	19	33	204	2,037	10,937	27,287	74,447	347,247

Table 6: Incentive system cost for different final users (GSE 2010c).

3.3 Distributional Effects and Social Equity

Hydropower development is meeting increasing social resistance fuelled by perceptions of social and geographic injustice. Concentrated in less developed, mountainous areas, the hydroelectricity generation is associated with negative externalities (negative environmental impacts, modification of water courses and landscape) in proximity of the plants, whereas the downstream communities take most benefits. Public opinion about hydropower technology saw a substantial change during last decades. In the first half of the 20th century it was highly regarded thanks to the impact on the employment rate in economically disadvantaged mountain areas. Later, as the employment opportunities faded away, local communities became more aware of the hazards connected to the hydropower installations. The history of hydropower exploitation in Italy is punctuated by incidents among which the most prominent one is the Vajont disaster in 1963. At the time of the completion the tallest dam in the world (262 m), the reservoir built on the Vajont river became centre stage of a tragedy claiming the life of some two thousand people. A landslide with speed of 110 km/h hit the reservoir, causing a seiche that overtopped the dam and destroyed the villages downstream. The disaster is still in living memory of many Italians, deeming to a failure any attempt of reactivating the dam that in fact had not been seriously damaged by the seiche. Another major disaster occurred in Val di Stava in 1985, claiming a death toll of some three hundreds.

The Italian legislation introduced compensation for the local communities in hydropower project's influence areas. As explained elsewhere in this document, supplementary water abstraction fees and charges have been introduced to benefit local communities. Supplementary fee benefiting riverine communities is split between the municipalities in the territory of which the water is derived, and the higher order administrative units – districts, usually by three-quarter to one-quarter ration (Regione Piemonte 2003). Supplementary fee for mountainous basins is distributed too, but according to different patterns. Usually, the local communities constitute a consortium and distribute the collected fees according to an agreement (Regione Piemonte 2003). For other cases the central government offers an equitable scheme for dividing the collected fees: 10% is equally distributed among the communities; 20% is distributed in relation to the municipal territory; 30% in relation to the number of inhabitants; 40% in relation to size and impact of the plants installed in the municipal territory (Regione Piemonte 2003). The wealth from the supplementary fees is redistributed among local authorities and/or their consortia and the provincial administration and is generally employed to finance local infrastructures and economic development projects in promoting the economic development of the local communities. Albeit not producing important amounts at the level of the single local authority, budgets of consortia of mountain local authorities are able to produce an impressive amount of activities based on these payments[1].

Further to these forms of monetary redistribution, economic conditions for the management of hydropower plants are defined by specific requirements in terms of extra releases in drought periods in order to satisfy water needs from agriculture, and low flow regulations which should assure the maintenance of minimum living conditions for river ecosystems.

Benefits in terms of occupation induced by the construction of large hydropower plants in the last century are now decreasing, as numbers of persons employed have been reduced from 1500 to actually approx. 800 persons occupied in the sector of hydropower in the province of Sondrio (Ups 2006), which corresponds to 1% of the occupied workforce in the province.

Losses for the local population or single actors have not been quantified further, although environmental impacts and modification of water courses have clearly negative impacts on the environmental quality in the area. There are no assessments on welfare losses perceived by inhabitants of the Province of Sondrio, but in some similar situations, assessments based on contingent valuations have provided results regarding the losses perceived by leisure time anglers: results from a study on the nearby Ticino river in Switzerland show that an enhancement of river flow would have increased the annual consumer surplus for a typical angler by approximately 440 SFr. The total economic value of this improvement in the flow for this river was estimated to be approximately 1,317,000 SFr (approx. 1 million Euro) considering a population of 2.245 holders of leisure time fishing licences 2. The number of annual

---

[1] The annual amount of contributions paid by Energy producers in the province of Sondrio is estimated at an amount of approximately € 25,000,000 for local authorities of different level (www.pdsondrio.it; http://pdsondrio.it/files/foto/69180802f5d2bb32656ed0f2c6436389.pdf). This amount corresponds to a payment of ca. 136 €/year each inhabitant, although it has to be taken into account that only local authorities in proximity of the power plants receive the whole amount of payments..

[2] The questionnaire considers a population of 2,245 fishers (holders of seasonal fishing licenses)and is based on the travel cost estimates estimated on the basis of 413

licences emitted annually in the province of Sondrio is approx. 5,000, and a further 3,000 licences per year are emitted on daily basis (Province of Sondrio, personal communication). This number indicates that potential welfare losses from river alteration might even be more important in this case than in the Ticino river.

The high incidence of existing hydropower plants in the territory of the Province of Sondrio is fuelling resistance of inhabitants in the valley, opposing any project for new concessions for plants regarding the area. Further to the high percentage of exploitation of water flow in the area (some 90% of the rivers in the province are already exploited), the fact that the area provides almost half of the hydro power generated in the entire Lombardy region, but only consumes only 20% of this production, fuels political reactions opposing further exploitation plans Reasons for further expansion are based mainly founded in environmental impacts, landscape alteration, and impacts on the alternative water uses (mainly sport and leisure fisheries) judged disproportionate in relation to the increase in electric capacity generated (IAPS 2010). Since 2006, a number of civil society initiatives have been launched to oppose any new project for water abstractions.

3.4 Institutions

The system of green energy certificates (GEC) in Italy had been introduced by the Bersani Decree (79/1999) and later modified by laws 244/07 and 239/04, and the Legislative Decree 387/03.

The Bersani Decree (law 79/99) transposed the provisions of the Directive 96/92/CE. The Decree set off the process of energy liberalisation. Whereas the import, export and production of electricity was privatised; the transmission, dispatching and management of electricity lines remained under state control. Regulation of the free energy market was entrusted to the Energy Service Authority (Gestore dei Servizi Energetici, GSE). GSE certifies the renewable energy plants (see section 3.6) and oversees the market with green energy certificates.

The energy sector regulator (*Autorità per l'Energia Elettrica ed il Gas* AEEG), constituted in 1995 as part of the liberalization processr. The AEEG defines the rules – on equitable and neutral basis - for of transmission and distribution of energy. The Authority also regulates the feed-in tariffs applicable to small renewable energy plants (< 1MW) and the modalities of financing the GEC.

The law 79/99 introduced the scheme of green energy certificates (GEC) outlined in the section 1. The law obliges the electricity companies to supply a certain share of their production by energy from renewable sources, including hydropower. The companies that fail short of meeting the target may purchase tradable Green Energy Certificates (GEC) for the equivalent of the underperformed renewable energy.

Observations on actual trips and 413 observations on hypothetical trips (Buchli et al. 2003).

Initially, the mandatory quotas for renewable energy sources (RES) were set to 2 per cent and the period of the incentive scheme was set to eight years. The nominal value of the green certificates was set to 100MW. The renewable energy plants (IAFR), in order to be admitted into the system, had to be certified (see section 3.6). The tradability of the certificates was limited to 1 year.

The law specified a number of exemptions reducing the overall volume of the RES to be supplied. Most importantly, the obligation applies to energy production or import exceeding 100 GWh. Exempt is also electricity produced from coal from national mines and cogeneration; water pumping, and electricity for self-consumption.

The Bersani decree was modified by the **decree 387/2003** (so called Marzano decree) transposing into Italian legislation the EU Directive 2001/77/CE. The main changes of the GEC system included:

- Increase of the compulsory quota by 0.35% every year for the period 2004/2006. Further increases of the quota are anticipated.
- Extension of the tradability of the certificates from one to three consecutive 3 years.
- Reduction of the nominal size of the certificates from 100 to 50 MWh.

Further modification to the GEC regime was introduced in the law 152/2006 (so called Environmental Code). In order to increase the profitability of the energy production from RES and to favour the flow of private investments into the sector, the duration of the incentives was increase from 8 to 12 years.

The law 244/2007 (financial bill for the year 2008) partially overhauled the GEC system. First, it introduced a new feed-in tariff for certified small renewable energy plants certified with capacity < 1 MW (200 KW for wind power). Second, the compulsory quotas were increase annually by 0.75% for the period 2007/2012. Third, the nominal size of the green certificates was further reduced from 50 MWh to 1 MWh. Fourth, the number of certificates issued for a given volume of renewable energy was made dependent on the type of energy. This has not affected hydroelectricity. Fifth, the incentive period was extended from 12 to 15 years.

The Decree of the Minister for Economic Development 18/12/2008 compelled the authority (GSE) to stimulate the market with green certificates by purchasing the certificates in excess until the end of 2010. The fixed price at which the GSE was to bay the certificates was set to the average price over the precedent three years. Subsequently, the obligation to purchase the certificates in excess was extended until 011.

In 2009, the legislators shifted the obligation to supply renewable energy from the producers and importers of energy to the companies dispatching energy to the final consumers (law 99/2009). Only a year after this provision was taken back by the law 72/2010.

The legislative decree 28 of March 3rd, 2011 (the so-called Romano decree) marks the end of the GEC system in Italy. It gradually phases out the compulsory quota between 2012 and 2015. Green certificates exceeding the demand will be withdrawn from the market at a price corresponding to 78% of the previously determined level. The incentives introduced in favour of small renewable energy plants will remain in place for the whole envisaged incentive period.

3.5 Policy Implementability

Sondrio district is an emblematic case for overexploitation of the hydropower potential and adverse public participation (Annex 1). The district is situated in the Alpine part of the Lombardy, in the Valtellina valley comprised entirerly within the Adda river basin. Thanks to the great availability of water resources and topography favourable for hydropower generation (Provincia di Sondrio 2008a), the Sondrio district became one of the most hydropower-developed areas in Italy. Some 12.45% of the national and about 40% of the Lombardy's hydroelectric production is generated here (GSE 2010a).

Over the past twenty years the hydropower development in the district was closely examines several times. In the aftermath of the 1987 flood in Valtellina that claimed 53 victims and caused huge economic damage, the law 102/90 (so called Valtellina law) suspended new water concession fees for hydropower generation until the provision River Basin Plan was developed for the Sondrio district. The Plan, approved by Prime Minister Decree 24 May 2001, specifies the procedure for releasing new water concession for hydropower. Successively, in 1999 the regional government's decision 4244/99 introduced the obligation for all hydropower plants (HPP) to maintain minimum environmental flow (MEF) (50 l/s) in all sub catchments. The Lombardy's Water Protection Plan (regional decision 1083/205 and 2244/2006) extends the obligations with respect to the MEF.

Triggered by the local resistance, and upon invitation of almost all political parties and civil society organisations, the 13ª permanent commission (Territory, environment and environmental goods) of the Senate held hearings about the water crisis in Sondrio district, and asked the government to limit the hydropower concessions in the district for 2 years. Successively, the 2007 Financial Law (law 296/06 article 1, 1106 commas) established that new concessions for both large and small hydropower plants, exclusively for the Province of Sondrio, from 1st January 2007 to the 31st December 2008, were granted only after the binding advice of the Ministry of Environment. This moratorium was due to the critical situation of the hydrographical basin of Province of Sondrio caused by the extraordinary weather conditions of July and August 1987.

In the last years, political debates arouse in Italy about the nuclear and renewable energy sources. Nuclear energy generation was introduced in Italy in 1960s and deserted in 1990s, as a result of the public referendum in 1987 (81% in favour of stopping nuclear power generation). The 1987 referendum also put an end on the participation of the state-controlled energy provider ENEL (Ente Nazionale per l'Energia Elettrica) in nuclear power development abroad. After the 1986 nuclear accident in Chernobyl the nuclear power generation faced hostile attitude.

More recently, most of the political parties, both conservative and democratic, expressed their support of nuclear energy generation in Italy. The largest centre-left party 'Partito Democratico' (PD, Democrat Party) placed the nuclear power development as a way out of carbon in their parliamentary election campaign in 2008. The centre-right coalition that had won the election was also in favour of nuclear power and took tangible steps to clear the way for the re-birth of nuclear power. These plans were put a stop by another referendum, held in June 2011, shortly after the Fukushima Dai-ichi nuclear accident. The green and extreme-left parties, both with a marginal position in the parliament, opposed the attempts to reintroduce the nuclear energy. Instead, they proposed a strategy based on development of renewable energy sources and increasing energy efficiency. Contrary to their views, it is widely believed that renewables can contribute to solving energy issue but cannot solve it (alone) (ENEA 2011).

In 2010-2011, the "Industry, Commerce and Tourism Parliamentarian Committee" of the Italian Senate held hearings related to national energy strategy. The experts witnessing in Senate include representatives of public authorities, energetic companies, research organisations, professional associations, electric network operators, and energy providers. Hydropower, the most important renewable energy source in Italy, is captured by a technology that is widely believed efficient, advanced and technically mature (Markandya A.; Bigano A.; Porchia R. 2010). It is hard to believe that the plans to construct new large (> 10 MW) hydropower plants in Italy would obtain the necessary political support, local acceptance, and financial backing. Even small (<1MW) and medium-sized (1-10 MW) HPP are occasionally opposed because of the implied environmental impacts and social effects. What is left is i) increase of efficiency and/or capacity of existing plants, and ii) development small and medium sized HPP.

The economic incentives for renewable energy sources (RES) made the further expansion of hydropower profitable. In order to increase the participation of local communities on the profits, the government proposed to extend the large hydropower water concessions by five years, or seven if the public municipal or district authorities were engaged in running the business. In July 2011, the Italian Constitutional Court declared unconstitutional the article 15, commas 6-ter and 6-quarter of the Law 122/2010. The Court recognized that the article infringed the regional competence and represented an obstacle for the market. Before the Court sentence, the European Commission expressed the intent to open infringement procedure.

Hydropower sectors in Italy is dominated by ENEL Group (Ente Nazionale per l'Energia Elettrica – National Company for Electricity) with its branch Enel Green power. After energy liberalisation, a large number of smaller companies entered the market, especially with the small run of the river power plants. There are different associations representing the interests of electricity production from renewable energy sources, such as: Federpern (hydropower sector operators association) and Aper (renewable energy operators association). The economic incentives gave a new sprint to the sector, increasing the profitability and giving new chances to enlarge the production through the installation of new plants. Especially after 2007, with the introduction of the convenient feed-in-tariff for small size (less than 1MW) plants, the requests for installation of new hydropower capacity substantially increased.

Civil society organisations (CSO) such as Legambiente, Greenpeace Italy, WWF and IAPS (Intergruppo Acque Provincia di Sondrio) issued their positions towards hydropower development, cautious to environmental and social impacts of the sector. Political and social debate forged development of best practices for hydropower. The Ch2Oice project (Certification for HydrO: Improving Clean Energy, http://www.ch2oice.eu) developed a certification protocol for the hydropower sector. The Alpine Convention, international territorial treaty for the sustainable development of the Alps, supports voluntary environmental certifications could represent a possible tool to harmonise the needs for electricity production with the needs for environmental protection.

3.6 Transaction Costs

Transaction costs outlined in this section include compulsory certification of renewable energy plants and the concessions for water derivation for (hydro) energetic purposes. The normative background for both is described in the section 3.4. Relevant for this section is also costs of politics (processes of collective decisions) and litigation discussed in the sections 3.4 and 3.5, and briefly outlines further down in this section.

In order to be admitted to the GEC incentive system, the renewable energy plants (in Italian *impianti alimentati a fonte rinnovabile* IAFR) have to be formally recognised as such. The certification is conducted by the authority (GSE *Gestore dei servizi Energetici*). The Decree of the Minister for Economic Development of July 31, 2011 specifies in detail the procedure. The applicant has to register and submit detailed technical and administrative information relative to the plant. With respect to hydropower, the investors are requested to submit a detailed report about the technical and hydrological information from the area the HPP is situated. GSE verifies the accuracy of the applications and releases the certification within 60 days, if the application satisfies the requirements.

The authorisation for building a new renewable energy plant is authorised by the regional or provincial authorities. Concession for water derivations for hydropower purpose is a separate and cumbersome legal procedure. The water concessions are issued by regional authorities. The regional authority may delegate the competences to lower (district) authorities for small water derivations. The application is published in the *regional bulletin* and the notice board of the affected municipalities (since 2011 the dedicated page of the authority's web site). The reasoned opinions are collected from all competent institutions. In some cases the *environmental impact assessment* is required. The competent authority attests the availability of water resource and impact on the minimum environmental flow based on the River Basin

Plan. Subsequent to the release of the concession, the applicant is to submit the executive project relative to the concession. The project is assessed and approved based on the criteria specified in the legislative decree 387/2003. The application for water derivation is aggravated if territorial development plan for hydropower sector is not in place, and by the lack of centrally managed water information systems. Between 2005 and 2011, the Sondrio district authority received some 68 applications for new concessions, out which only 22 have been authorised so far.

The Constitutional court intervened several times on the matter related to hydropower in Italy. The latest sentence n. 205 of July 13th, 2011 the Court found unconstitutional the extension of the water concessions for hydropower generation introduced in the law decree 78/2010 (see section 3.5). In 2008 the Court intervened on the matter of tendering procedures to renew expired concessions for large water derivations, declaring the provisions of the law n.266/2005 in parts unconstitutional. The European Commission started in 2004 the infringement procedure against Italy for similar reasons and drop the case in 2006, after the publication of the above Court's decision.

3.7 Uncertainty

Responding to the indicative target for electricity share from renewable sources share in gross electricity consumption set in the Directive 2001/77/EC, the scheme of green energy certificates had a well specified objective. The White Paper for Development of Renewable Energy Sources specified the roadmap to achieving this ambitious target: the production of hydroelectricity from HPP with capacity above 10 MW was to increase from 13.942 MWe in 1997 to 15.000 MWe in 2008-2012 (+ 7 per cent). Hydroelectricity from was to increase from 2187 MWe in 1997 to 3.000 MWe in 2008-2012 (+ 2,1 per cent).

The environmental impacts of the increased hydroelectricity production has not been analysed comprehensively and can only be inferred from the number of plants of different capacity classes and the density of installed capacity/number of plants per (sub)basin or administrative unit. More difficult it is to assess the proportion of HPP and their capacity/annual production that have been built only thanks to the incentive scheme. The economic outcomes (costs) are well documented and their estimates are reliable.

A key difference between the feed-in tariffs and GEC as discussed throughout the document relates to the uncertainty in costs and benefits. Feed-in tariffs bases on a constant price for an additional unit (MW) of hydroelectricity fed into electricity network. Uncertain is the expected impact in term of the total amount of additional hydroelectricity units produced by the scheme. In contrary, the GEC are associated with low uncertainty with respect to the achievement of policy targets, while allowing for a large uncertainty with respect to the costs at which these targets are met. Through the GEC market intervention the price uncertainty and competition between the different renewables was eliminated. In doing so the initial tradable incentive scheme had been turned into indirect subventions with little uncertainty with respect to both, achievement of the policy targets and the overall costs.

The regulatory uncertainty is a deterrent to investments. Similarly, the uncertainty about the health of the financial system has slowed the rate of new investment dramatically.

4 Conclusions

4.1 Lessons learned

The ambitious goals set in the Directive 2009/28/EC (and before in the Directive 2001/77/EC) can only be achieved by full exploitation of all available renewable energy sources (RES). By 2020, Italy has to increase the share of RES in the gross energy consumption from 5,2 to 17,0 per cent. Electricity from renewable sources has to be increased form 14,5 to 26,6 per cent. Recall that the indicative target for the RES share in gross electricity consumption set by the Directive 2001/77/EC – 25 percent in 2010 from 16 per cent in 1997 – has not been achieved despite the efforts made not at least through the tradable green certificates scheme explored in this report. In 2008 – the latest available data at Eurostat, the share of RES in the gross electricity consumption amounted to 16,6 per cent; 0,6 per cent up from the 1997 level. Ironically, the share of RES in the gross electricity consumption had been for the most period between 1997 and 2010 below the initial level of 16 per cent.

The transition to less carbon-intensive economies should be pursued at lowest possible costs, to reduce overall economic costs of emissions reductions. Green energy certificates (GEC) schemes are a compelling mean to this end, in synergy with other economic policy instruments incentivising production of RES and greater energy efficiency.

In modern carbon-free economies hydropower plays an important role, as one of few sources of renewable energy for which the technology is available, affordable, and reliable. However, hydropower energy differs from other renewable energy sources (RES) in two important aspects: First, as a mature technology it offers relatively little room for improvement in the efficiency of generation (Schiermeier *et al.* 2008). The existing and easy-to-tap potential has been already exploited. In 1999 when the GEC system was introduced, the already installed gross capacity exceeded 10.036 MW. Reclamation of existing, mostly large hydropower power plants (HPP) could increase the operating efficiency and the environmental performance of hydropower facilities. Alternatively, the deployment of small (> 10 megawatts) 'run-of-river' HPP that produces power from the natural flow of water provide potential for greater hydropower exploitation, with lesser environmental impacts but at much higher costs.

Second, impact assessment and certification of HPP require different, more comprehensive and meticulous procedures than in the case of other RES. The assessment should not only address the marginal effect of a single HPP, but the cumulative impacts of hydropower exploitation across the entire river system, identifying the best sites and coordinating energy production between the up- and downstream plants.

Furthermore, the reclamation of existing, and construction of new HPP, may require different incentive schemes. Recall that the law 79/1999 had extended the concessions to operate large HPP that would have otherwise expired between 2004 and 2010, up to 2029. This is because the reclamation of large HPP requires investments that are likely not paid back within the eight years of incentivised RES. In addition, the law put the incumbent - outgoing concession-holder in a favourable condition when tendering the renewal of the concession. As discussed elsewhere in the report, the concession tendering would have been a more suitable economic policy instrument to address the peculiarity of the large HPP.

The GEC system as introduced in Italy is comparable with similar schemes introduced in other counties. Under market conditions, the producers of RES bear the price uncertainty and the competition between the different sources of renewables ensures that the policy targets are achieved at least costs. In Italy, the market became soon saturated with the excessive certificates and the price of GEC started to decline. Partly, this is a result of the (many) exemptions from the initial obligation to supply energy form renewable sources granted to the producers or importers by the initial design of the scheme. The government intervened by guaranteeing a fixed price of the certificates, and by doing so removed the price uncertainty and competition between the different renewables. In principle, through this intervention the initial tradable incentive scheme had been turned into indirect subventions. Overall the costs of RES were borne by final consumers, contributing so to making the electricity price for consumers one of the highest in Italy.

The existing water abstraction charges can be integrated with the GEC to control the environmental impacts particularly of the small HPP. To this end the abstraction charges can be differentiated according to the marginal environmental impacts of a new plant. In order to guarantee sustainable and socially beneficial hydropower exploitation, the whole system of concession and certification has to be embedded within a well developed river basin plan that identifies and priorities the sites suitable for hydropower development.

4.2 Enabling / Disabling Factors

Any economic policy instrument, even more so a market-based one, requires a clear definition of regulatory roles, independent and trustworthy authority, and flexibility to adapt to changing or emerging trends. In Italy, the market with tradable CGE has not been insulated from political inference. The design of the GEC has been adapted more to changing political mood than to the requirement of the renewable energy sector. The regulatory mistakes in managing the market with tradable GEC have been remedied by overhauling the whole incentive system, phasing out the CGE and introducing a new system of auctions so far not further described. As stressed by the Energy Commissioner, investments in renewable energy resources require 'clear, stable and predictable' regulatory rules and conditions.

Beyond that, hydropower development can only be reconciled with environmental concerns and social responsibility if planned in a holistic way, within a well articulated river basin management plan. A precondition for the latter are clearly defined competences and authority over water resources within hydrographic boundaries. Water governance in Italy is too fragmented, prone to power struggles between regions and state, and subject to many reforms.

River basin authorities are public bodies constituted by the state and regions and operating within the river basin district boundaries with competences for hydro-geological risk, integrated water resource management, and water and environment preservation the River District Basin Plan including the programme of measures, a roadmap to achievement of the basins' environmental objectives. A part of the DBRP is the Water Management Plan and Water Protection Plan.

5 References

AdBPo (2006). Caratteristiche del bacino del fiume Po e primo esame dell'impatto ambientale delle attività umane sulle risorse idriche del Fiume Po. Parma, Italy, Autorità di Bacino del fiume Po (AdBPo).

AEEG (2010). Indagine Conoscitiva Sulla Strategia Energetica Nazionale (Italian). Rome, Autorità per l'energia elettrica e il gas.

APER (2011). Rapporto Rinnovabili 2010-2011. Situazione e prospettiva delle fonti rinnovabili in Italia., Associazione Produttori Energia da Fonti Rinnovabili.

Barbetti T. (2009). "Certificati Verdi. Cosa accadrà? (Italian)." Rete Ambiente: *Milano*-*Edizioni Ambiente S.r.l. Milano*

Capicotto L. (2011). "Nuove politiche legislative in materia di energia rinnovabile: c.d. "Decreto Romani" e "Quarto Conto Energia". (Italian)." Diritto.it: -*Diritto & Diritti*

ENEA (2011). Indagine conoscitiva sulla strategia energetica nazionale. Audizione al Senato della Repubblica Italiana. (Italian), Agenzia Nazionale per le Nuove Tecnologie, L'energia e Lo Sviluppo Economico Sostenibile.

GSE (2010a). Idroelettrico 2009, Rapporto statistico 2009., Gestore dei Servizi Energetici.

GSE (2010b). Guida agli incentivi per la produzione di energia elettrica da fonti rinnovabili, Gestore dei Servizi Energetici.

GSE (2010c). Indagine conoscitiva sulla strategia energetica nazionale. Audizione al Senato della Repubblica Italiana. (Italian), Gestore Servizi Energetici.

GSE (2011). Incentivazione delle fonti rinnovabili: Certificati Verdi e Tariffe Onnicomprensive. Bollettino aggiornato al 31 dicembre 2010, Gestore dei Servizi Energetici.
ISTAT (2011). Noi Italia. 100 statistiche per capire il paese in cui viviamo, ISTAT (Istituto Nazionale di Statistica).
Markandya A.; Bigano A.; Porchia R. (2010). The social cost of electricity. Scenarios and policy implication.
Poletti C. (2009). "Le prospettive del mercato dei certificati verdi." -*Gestore Mercato Elettrico (GME)*
Provincia di Sondrio (2008a). Relazione tecnica, Bilancio Idrico della Provincia di Sondrio.
Regione Piemonte (2003). Bacini Imbriferi Montani: Gestione dei sovracanoni provenientiagli impianti idroelettrici.
Repubblica Italiana (2007). Legge n. 244 del 24/12/2007: Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato (Legge finanziaria 2008).
Terna (2010). Dati Statistici sull'energia elettrica in Italia 1997-2010.
Verbunt M.; Zwaaftink M.G. and Gurtz J. (2005). "The hydrologic impact of land cover changes and hydropower stations in the Alpine Rhine basin." Ecological modelling **187(1):**

AdBPo (2006) Caratteristiche del bacino del fiume Po e primo esame dell'impatto ambientale delle attività umane sulle risorse idriche del Fiume Po. In: Parma, Italy: Autorità di Bacino del fiume Po (AdBPo).
AEEG (2010) Indagine Conoscitiva Sulla Strategia Energetica Nazionale (Italian). In: Rome: Autorità per l'energia elettrica e il gas.
Barbetti T. (2009) Certificati Verdi. Cosa accadrà? (Italian). Rete Ambiente.
Bertoldi, P. and Huld, T. (2006) Tradable certificates for renewable electricity and energy savings. Energy Policy 34(2): 212.
Dugan, P. and Allison, E. H. Water: act now to restore river health. Nature 468(7321): 173.
ENEA (2011) Indagine conoscitiva sulla strategia energetica nazionale. Audizione al Senato della Repubblica Italiana. (Italian). In: Agenzia Nazionale per le Nuove Tecnologie, L'energia e Lo Sviluppo Economico Sostenibile.
Giles, J. (2006) Methane quashes green credentials of hydropower. Nature 444(7119): 524.
GSE (2010a) Idroelettrico 2009, Rapporto statistico 2009. In: Gestore dei Servizi Energetici.
GSE (2010b) Guida agli incentivi per la produzione di energia elettrica da fonti rinnovabili. In: Gestore dei Servizi Energetici.
GSE (2010c) Indagine conoscitiva sulla strategia energetica nazionale. Audizione al Senato della Repubblica Italiana. (Italian). In: Gestore Servizi Energetici.

GSE (2011) Incentivazione delle fonti rinnovabili: Certificati Verdi e Tariffe Onnicomprensive. Bollettino aggiornato al 31 dicembre 2010. In: Gestore dei Servizi Energetici.
IAPS (2010) Un movimento dal basso vicnente per la vita delle nostre acque. In: Sondrio: Intergruppo Acque Provincia di Sondrio.
Kramer, G. J. and Haigh, M. (2009) No quick switch to low-carbon energy. Nature 462(7273): 568.
Markandya A.; Bigano A.; Porchia R. (2010) The social cost of electricity. Scenarios and policy implication.
Provincia di Sondrio (2008a) Relazione tecnica, Bilancio Idrico della Provincia di Sondrio. In.
Regione Piemonte (2003) Bacini Imbriferi Montani: Gestione dei sovracanoni provenientiagli impianti idroelettrici. In.
Repubblica Italiana (2007) Legge n. 244 del 24/12/2007: Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato (Legge finanziaria 2008). In.
Ringel, M. (2006) Fostering the use of renewable energies in the European Union: the race between feed-in tariffs and green certificates. Renew. Energy 31(1): 1-17.
Schiermeier, Q., Tollefson, J., Scully, T., Witze, A. and Morton, O. (2008) Electricity without carbon. Nature 454(7206): 816-823.
Terna (2010) Dati Statistici sull'energia elettrica in Italia 1997-2010. In.
Tollefson, J. (2011) Worth a dam? Nature 474(7352): 430-430.
Verbunt M.; Zwaaftink M.G. and Gurtz J. (2005) The hydrologic impact of land cover changes and hydropower stations in the Alpine Rhine basin. Ecological modelling 187(1): p.71–84.
Walter, R. C. and Merritts, D. J. (2008) Natural Streams and the Legacy of Water-Powered Mills. Science 319(5861): 299-304.
APER, 2011: Dossier "Energie senza bugie": costi e benefici delle fonti rinnovabili.
Environmental Agency, 2011: Report on 2010 EU Emissions Trading System emissions data.
GSE, 2010: Idroelettrico, Rapporto statistico 2009.
International Energy Agency, 2011: CO2 emissions from fuel combustion.
IAPS (2010). Un movimento dal basso vicnente per la vita delle nostre acque. Sondrio, Intergruppo Acque Provincia di Sondrio.
Regione Piemonte (2003). Bacini Imbriferi Montani: Gestione dei sovracanoni provenientiagli impianti idroelettrici.
Ups (2006). Visita in Provincia di Sondrio della Commissione Ambiente del Senato della Repubblica. Lettera della Commissione Ambiente del Senato della Repubblica in occasione della Visita in Provincia di Sondrio, Unione Pesca Sportiva della Provincia di Sondrio.

6 Data Sources

7 Annexes

Annex I: Development of hydroelectricity in Italy 1983-2010

From the early phase of industrialisation in the 1880s until the 1960s, hydropower was the most important electricity's source in Italy (**Errore. L'origine riferimento non è stata trovata.**). In 1960s, the almost six-fold growth of thermoelectric production, from about 8.000 GWh to more than 48.000 GWh, had outpaced the importance of hydropower. From then till 2010, the thermoelectric production grew up to over 231.000 GWh (in 2010) whereas the hydroelectricity production increased only slightly up to 54.407 GWh.

The total national gross production of electricity in 2010 amounts to some 302.062 GWh, while the national demand (consumption) is 330.455 GWh. The energy deficit of around 30.000 GWh per year is covered by imports (Terna 2010). Actually hydropower accounts for 18% of the total national production and remains the second most important source of electricity (**Errore. L'origine riferimento non è stata trovata.**). The third most important electricity's source, solar and wind power, account for some 11.000 GWh (less than 4%) of national production.

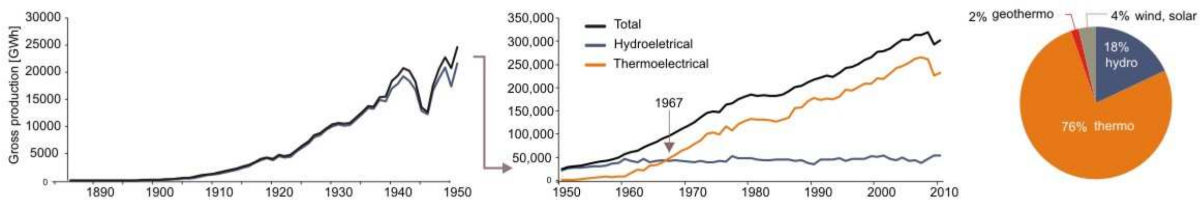

Figure: Gross national electricity production in 1883-1950 (left) and 1950-2009 (middle) in real terms. Share of the different energy sources as in 2010 (right). Own elaboration based on Terna 2010)

Between 1900 and 1960, Italy's hydroelectric power capacity had been constantly increasing. The period from 1946 to 1960 had witnessed a boost hydropower development, triggered by energy demand for economic growth.

Table 7 - National gross hydropower production, gross installed capacity, and the variation of both compared to the previous period. Production and capacity refer to the last year of the period. Source: Terna S.p.A.

1883-1959	**1960-1992**	**1992-1997**	**1998-2010**

GWh	MW	GWh	Δ%	MW	Δ%	GWh	Δ%	MW	Δ%	GWh	Δ%	MW	Δ%
38,398	10,822	45,786	19.2	19,552	80.7	46,552	1.7	20,146	3.0	54,407	16.9	21,893	8.7

After 1960, the hydropower development was constrained by a host of economic, environmental and social factors. Figure 9 shows the key pieces of legislations that had influenced the hydropower development.

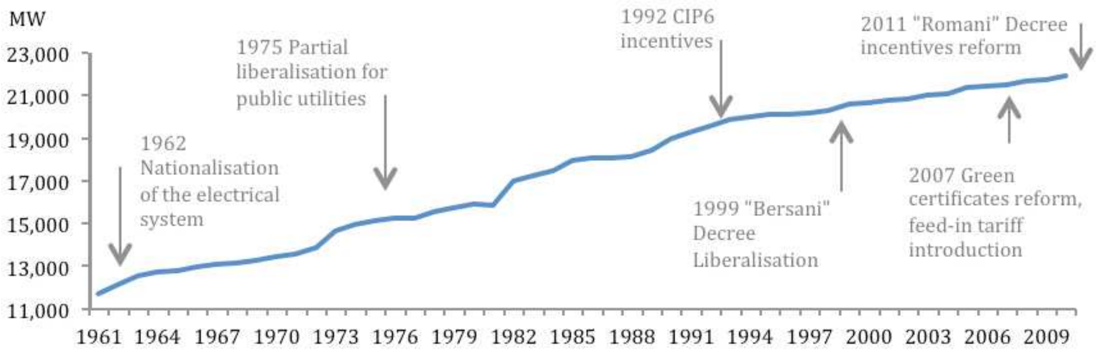

Figure 11 - Annual hydropower gross capacity (1961-2010). Source: own elaboration on Terna S.p.A.

The hydropower system's annual production is variability due to its strong dependency on water availability. The national hydroelectric production intensified steeply from 1946 to 1960. After then, it continued to increase, if to a lesser extent and affected by strong inter-annual variability.

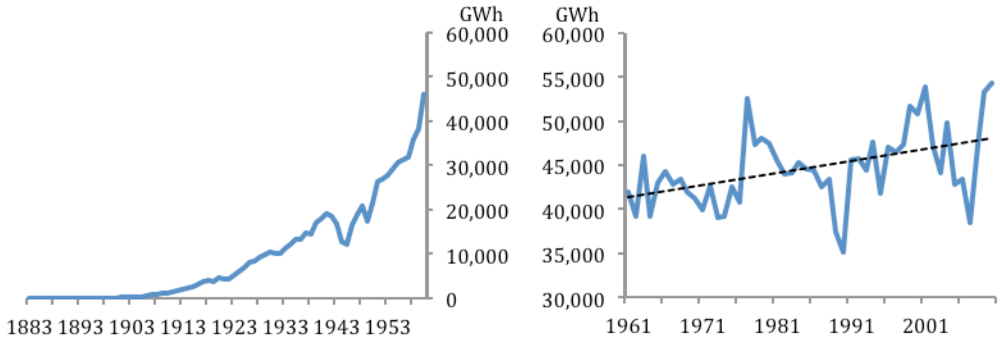

Figure 12 - Annual gross hydropower production from 1883 to 2010. Source: own elaboration on Terna S.p.A.

Annex II: Pedigree matrix

Table A1 Pedigree Analysis for data used in this case study

Assessment criteria	Value	Proxy	Empirical	Method
Hydroelectricity generated	Section 3.1 and Annex 1	4	4	4
Environmental impacts	Section 3.1	2	1	1
GEC Market turnover	Section 3.2	4	4	4
Transaction costs	Section 3.6	4	2	2

Annex III: Contributors to the report/Acknowledgments

This report has been written by the team of FEEM, led by Jaroslav Mysiak. The team includes (in alphabetical order) Margaretha Breil, Fabio Farinosi, Lorenzo Carrera, Antonio Massaruto, and Francesca Testella,