Environment and energy

The analysis of the natural and environmental contexts of our country can count on very old historical records (observations on rainfall, temperature, water levels, forests, etc.), while other aspects are covered by more recent information, usually running from the second half of the last century.
Official statistics made a leap in quality in this area in particular during the last decades of the 20th century, including new measurements aimed at describing the environmental effects of human activity alongside atmospheric and geological observations. Thanks to the estimates deriving from Environmental accounting – also developed thanks to the intervention of the European Commission in the early 1990s – the processing of more and more detailed records of the interaction between the general state of the environment and the overall development of productive activities became possible.
In the evolution of this national and international information snapshot, energy sector has taken on an incresing importance and weight due both to the close correlation with the economic system in general and to the sector's direct impact on environmental conditions.
The modernisation and perfecting of the methods used to estimate polluting emissions and the contemporary accounting in the national energy balance of renewable energy sources reflect the high level of awareness and attention to the issues relating to environmental protection in the last decades of the 20th century. these issues likely appear to take on an ever more important role in the years to come. The development of renewable sources has in fact become one of the pillars of Eu energy policy in the new millennium, setting binding targets for each member state. In 2005, with the ratification of the Kyoto Protocol, Italy undertook to develop, publish and regularly update national emission inventories, in addition to formulate and implement emission reduction programs. In 2014, six years before the Europe deadline of 2020, Italy achieved the goal of gross final consumption of energy covered by renewable sources (17 percent).

Weather statistics

In Italy, the first certain documents that evidence a systematic observation of meteorological phenomena date back to the first half of the 18th century, thanks to the activities carried out by universities, colleges and academies.
After the constitution of the Kingdom of Italy, the *Divisione della statistica generale of the Ministero di agricoltura, industria e commercio* (Division for general statistics of the Ministry for agriculture, industry and trade) took over these activities and, in 1865, established a centralised *Servizio meteorologico centrale* (Central meteorological service) with the task of collecting figures from astronomical observatories, schools and other institutions who held the proper equipment, and of setting up new measurement stations.
The first publications on weather statistics relating to the entire national territory started in 1865 and continued until 1878. In particular, the volumes entitled "*La Meteorologia Italiana",* published firstly every 10 days and later on a monthly basis, by the Servizio meteorologico centrale, are well known. From 1879 to 1935, with the exception of the interruption due to the first world war, the publications of figures and reports on the weather continued in the *Annali,* published by the *Regio ufficio centrale di meteorologia*, established in November 1876 and directed by the *Divisione della statistica generale del Ministero di agricoltura, industria e commercio*. From 1907 to 1920 and from 1926 to 1935, however, scientific work and reports only were published rather than the usual tables of meteorological figures. Furthermore, from 30th November 1879 the *Regio ufficio centrale* published a "*Bollettino meteorico giornaliero"* containing the figures from the main Italian observatories and selected foreign ones, including up to 122 stations in 1914.
After the establishment of the *Ufficio idrografico del magistrato delle acque a Venezia* (1907) and the

Ufficio idrografico del Po a Parma (1912), in 1912 *Bollettini mensili* began to be published, with particular attention to rainfall figures. Later, in 1917, when the *Servizio Idrografico Centrale* was established under the supervision of the *Consiglio Superiore delle Acque* at the *Ministero dei lavori pubblici*, it began the publication of *Annali Idrologici* edited by the various territorial departments.
In 1925, the *Sezione presagi del Regio ufficio centrale di meteorologia* merged with the Aerological Office in the *Direzione superiore del genio e delle costruzioni aeronautiche* into one single *Ufficio Presagi*, under the direction of the *Commissariato per l'Aeronautica*. Within a few years the actual *Servizio Meteorologico dell'Aeronautica Militare* was founded, together with the publication of the *Bollettino giornaliero*, legacy of the one previously published by the *Ufficio centrale di meteorologia*. The publication of weather figures later were discontinued, also due to the commencement of the Second World War.
Since 1926, the Central Institute of Statistics has been in charge of publishing weather data from approximately 60 stations, distributed over the entire national territory, in detailed tables in the *Annuario statistico italiano* and in *Bollettini di statistica*.
In response to the growing interest for recording meteorological phenomena and for ensuring the necessary historical continuity of the publication of these information, from 1959 to 2005 Istat published a specific series of Special yearbooks entitled *Annuario di statistiche meteorologiche* which was ideally linked with the volumes of the *La meteorologia italiana*.
Over time, the number of stations providing figures decreased. Currently, the Italian meteorological network is essentially based on:

- Agenzie regionali per l'ambiente (Arpa);
- Regioni e Province autonome, until the 80s they were mainly part of the Ministero dei lavori pubblici, Servizio idrografico;
- Ufficio centrale di ecologia agraria;
- Ministero della difesa aeronautica, Servizio meteorologico;
- Ente nazionale di assistenza al volo (Enav).

Many other stations also exist, established and managed by public, cultural, religious and private bodies such as universities, school institutions, private centres and companies.
It should be specified that the meteorological-climate data recorded in individual stations depend on the specific geographical-morphological features of the area surrounding each measuring station. Therefore, the data from each station can represent the climatic conditions of that particular area and, with the appropriate caution, the climatic region to which they belong to.
Tables presented in this section show the annual and monthly data for the stations, some of which are located in the regional capitals. These have long time series and provide an overview, with precise territorial detail, of the main climatic phenomena linked to rainfall and temperature measurements. Here the months and years with the presence of 80% of valid data are considered; below this threshold, months and years are missing.

Warnings on time series comparisons

Stations used in the previous edition were replaced by the stations included in the Istat weather database to enable more time continuity.

National parks

National Parks constitute an important natural, historical and cultural heritage. Gran Paradiso Park in 1922, Abruzzo National Park in 1923, Circeo National Park in 1934 and Stelvio National Park in 1935 were the first parks established in Italy. More recently, the most well-known historical parks have been joined by many others, expanding the protected areas territory. In Italy, there are 24 National Parks, covering an area of approximately 1,500,000 hectares, about 5% of the National territory. In the State Protection Programme, Marine Parks are taking on increasing importance. They are intended to protect Mediterranean sea and coastal areas (often including entire islands or archipelagos), when presenting exceptional and typical environmental or scenic features in an integrated manner.
The National Parks, together with marine protected areas, marine nature reserves, national and regional

nature reserves are protected natural areas, which complement and complete land protection. Protected areas are rich territories not only for biodiversity, but also for archaeological, historical, architectural and artistic legacy of an historical relationship between man and nature that has granted the huge richness of biodiversity and landscapes.
The decree by *Ministero dell'Ambiente* creating the *Registro delle aree protette italiane* was published on 05th May 1991. This Register is composed by two sections: an administrative section collecting ministerial decrees and regional or state laws establishing the protection criteria for the individual protected areas; and a cartographical section, collecting the official maps showing the perimeter of each Protected Area and any zoning schemes created within them. The Register is managed by the *Servizio conservazione della natura del Ministero dell'ambiente*, which takes care of processing the existing data on National Protected Areas. Some indications, including those related to area management, are provided by the *Lista Ufficiale delle Aree Protette* (EUAP), in compliance with Law no. 394/1991, drawn up and periodically updated by the *Ministero dell'Ambiente*. The list currently in force is related to the 6th update, approved on 27th April 2010 and published in Ordinary Supplement no. 115 to the *Gazzetta ufficiale* n. 125 of 31st May 2010.

Forest area

The first large-scale survey of wooded areas took place in 1868 and is known as the "1870 forest statistics", after the year in which the survey results were published, or also as the "Castagnola survey" after the name of the Minister of Agriculture who wanted it. From 1871 to 1926, before the foundation of the Central Statistical Institute, various "general" and "special" surveys were carried out on "forests". However they provided just a limited amount of information on the subject. Surveys had generally the aim of ascertaining the *extension* of the stocked area, distinguished by type of government, tree species and property category, and the *production,* intended as extraction of timber form the forests, or more often as "use", usually considering both "timber" and "non-timber" products, in particular "chestnuts".
Among the special surveys of stocked areas, the survey initiated in 1922 and concluded in 1924 of the land owned by municipalities and other public institutions is particularly noteworthy. The survey ascertained the extension of forests and, at the same time, the land belonging to other types of cultivation, divided into "crops" and "pasture". The survey distinguished different forms of forest managements and included chestnut orchards. From 1927 to 1945 records and measurements progressively improved, to the point of creating the first *Italian forest registry,* although incomplete, and a *forest statistics service* which employed new methods in surveys and a greater quantity of resources to those used in the past.
When the Central institute of statistics was created, and the responsibility for agriculture and forest statistics passed to it (by the Royal Decree no. 1035 dated 02nd June 1927), the need for an organisation of the registry complying with technical criteria, was already clear. The direct measurement of all elements, regarding both extension and production, was crucial for the quality of the Italian forest registry. This survey was performed independently of the agriculture registry, although the two sources remained linked by the common use of distinctive features of individual types of cultivation, in order to allow checking of any discrepancies in results. The principle of direct measurements was not always applied with the same procedures; the instructions given to operators in 1928 were applied up until 1939, but different methods were used from 1939 to 1945.
With regard to definitions, in 1928 the Central institute of statistics defined "forests" as land covered in timber forest plants, trees or bushes, covering more than 50 per cent of the surface and whose production was higher than that of uncultivated productive areas. In that period, moreover, the Forestry administration gave an important contribution to the statistical system, both directly contributing to the collection and transmission of administrative data and carrying out direct and independent surveys, such as those performed in the 1930s for the compilation of the "Italian forests map" created with reference to year 1935. The "map" could not entirely replace the registry, although it provided a useful guide for the size estimation, types of forests and their geographical distribution at the time. Also the map, despite it did not show particularly detailed territorial data and immediate link with the other statistical information on the same subject, was a reference for the subsequent updating of the annual statistics on the matter.
A genuine programme of forest statistical surveys, in any case, was created and initiated only in the early 1930s, following the issue of the first and fundamental legislative text, still in force today, for the forestry sector – Royal Legislative Decree no. 3267/1923 – coupled with the effect of Royal Decree no.

1035/1927 which resulted in the foundation of a forest statistics service at the Kingdom's Central institute of statistics.
The period running from 1946 to 1956 saw an intense activity regarding forest statistics. From 1949, in order to improve and align the survey data, the number of observed factors was enlarged, measurements were perfected, records simplified (without damaging results) and a more rapid and efficient critical exam on data from the provincial Commissioner was carried out, in synergy with Istat. All these operations allowed for the construction of annual time series of surface data, divided by type of forest and production, with a satisfactory degree of accuracy and articulation, also thanks to the combination of more adequate methods and means.
A good estimate of the areas corresponding to different types of forest, for a total of 29 types was provided by means of the special general survey – of surface and production – performed to record the situation as at 30th June 1947. It was carried out in response to a specific request from the Food and Agriculture Organisation (FAO). This same typing system has been adopted by modern statistics since 1948. The classification of types has undergone a few variations over time, reducing the number of types from 29 to 25: 14 types of high forest system, 6 coppices with standard systems and 5 simple coppice systems.
During the following decades, *Forest statistics* were revised several times to adapt them to the requirements and characteristics of a sector that has progressively transformed in line with the economic development, the changes in sectorial policy and the transferral of responsibility: from the State to Regions, on one hand and from the State to the European union and United Nations on the other.
The time series presented here start from 1861, however up until 1949 they report total forest areas only, homogeneous and comparable data on types of forest are available from 2004 onwards.
The survey of stocked woodland areas ascertained, with reference to 31st December each year for each individual municipality, the areas on which at least half a hectare of forests were replanted, according to their size, type of forest, property category and altitude zone. The unit of measurement was the forest area undergoing replanting or deforestation. In this way, the balance of forest areas was calculated by the difference between the increase (replanting of land previously used for cultivation other than forest) and the decrease (authorised deforestation, abusive deforestation, failed replanting, avalanche, landslides, etc.). Variations due to changes in administrative circumstances or variations for changes in rural district resulted from adjustments to the balance, as well as changes to areas previously reported. It should be noted that the definition of forest area adopted by Istat up until 2004 and used for the national time series specified a minimum coverage of 50 per cent of tree cover, compared with a minimum of 10 per cent accepted by recently introduced international definitions.
The "Forest statistics" stopped in 2004. Since 2005 onwards the estimate of stocked wooden areas, their size, the type of forest, property category and altitude zone have been updated, in variable periods, starting with the "National forest and forest carbon stock inventory" (INFC) performed by the State Forestry Department in 2005, with the collaboration of the Ministry of the Environment, the National Statistical Institute and the scientific supervision of the Agricultural research council, in order to comply with the requirements of international commitments, in particular the "Kyoto Protocol", the operational tool of the United Nations Framework convention on climate change (UNFCCC, 1992), but also to meet to the need of a modern information tool for Italian forestry[1]. The 2005 edition of the INFC is the last inventory to have been made on a national level. An update is planned within the next ten years.

Warnings for time series comparisons

The time series for forest areas is affected by the different definitions and inventories or cartographic surveys performed in specific base years:

- the 1922-1942 series is affected by the revision performed following the 1933 forest areas survey;
- the 1943-1984 series is affected by the revision performed following the forest areas survey performed between 1947-1949.
- Extraordinary replanting was performed during the 1960s.

[1] The first "National forest INVENTORY" (IFNI, 1985) was performed in the mid-1980s, the first post-war inventory of Italian forests. An interesting precedent was set by the old Forest militia map of the 1930s.

- Since 1977 figures have referred to the solar year rather than the forestry statistical year (01st April to 31st March).
- Since 1985 onwards the total forest areas have also included areas dedicated to Mediterranean brush;
- Up until 2004, the definition of forest area referred to a minimum tree coverage of 50 per cent. In 2005 this changed to 10 per cent, in compliance with recent international definitions, implemented by the "National forest and forest carbon stock inventory" (INFC) performed by the State Forestry Department.

Forest fires

Statistics of the forest fires phenomenon started in the seventies, when their environmental severity began to be perceived in a more concrete manner. The climate change conditions, with long periods of drought, and the progressive urbanization in recent decades have led to increase abandoned areas intensifying the problem of forest fires, and increasing the severity of both number and damaged surfaces.
Data collection activities on forest fires, due to national importance and originality of the information provided by organized sources (such as the operating unit of the Corpo Forestale dello Stato and the Regions and Autonomous Provinces) were historically included in the Programma Statistico Nazionale activities (PSN), and more precisely in the industry surveys "Agriculture forestry and fishing".
Istat processes part of these data and publishes them through its own publications, including the "Annuario Statistico Italiano". Since 1996, with reference to the 15 regions under ordinary government, the Corpo Forestale dello Stato (Cfs) has developed an accurate computerized system for collecting data on forest fires. It is known as the Sistema Informativo della Montagna (SIM), and provides detailed and reliable information. This system allowed the Cfs to acquire a solid experience in the use of Geographic Information Systems (GIS), an important support for the institutional role of talking and prevent environmental crimes.
Since 2008, moreover, the new "Fascicolo evento incendi" (FEI), available within the information system, has allowed the local administrations to have, in a single electronic file, descriptive statistics data on each single event and the delimitation of the fire area through the geographic coordinates of the points that define it.
The Regional operating Centres of Cfs indirectly activate the procedure through a program for the management of emergencies, by inserting the first information received when the fire is reported and by assigning FEI to the local Command station in charge. Then, the Command station fills out the FEI, collects data and enters the information into the system, according to pre-established time schedule. The Provincial Command coordinates the process activities, checks the information and ensures quality by means of a final validation. Only the data contained in the FEI final report are used to calculate National Forest Fire Statistics, published by the Cfs.
Regions and Autonomous Provinces, working with forestry bodies at the local level, establish their own collection and cataloguing of data procedures and periodically transmit them to the Cfs to be included in national statistics.

Main river outflow

The river flow is a crucial component of the hydrological cycle. The water course, besides of being determined by natural factors, namely climate, vegetation, and the geomorphological and hydrogeological features of the water basin, is also strongly influenced by several anthropic factors, such as water abstraction and derivations for various uses and soil use. The river flow is, therefore, an important indicator of the overall state of water resources.
Differently from the main European Countries, from a hydrological point of view, Italy is characterised by an extremely variable range of situations. The large river network in the North, flowing into the Adriatic Sea (such as Po, Adige, Piave, Tagliamento, Brenta-Bacchiglione and Isonzo rivers) and the large rivers of the Italian mainland (Tever, Arno, Liri-Garigliano and Volturno rivers), are countered by rivers with limited hydrographical basins and a more irregular flow along the whole length of the Apennine ridge, in Sicilia and in Sardegna.

The river basin is the reference area for water flow analysis, representing the area in which rainwater or melting snow and glaciers, flowing on the surface, gather through a series of creeks, rivers and sometimes lakes before flowing into the sea by a single mouth, estuary or delta. The amount of water flowing through a specific section of a stream is usually calculated by the hydrometric level, defined as the elevation of the water surface above an established level (hydrometric zero). In general, hydrometric zero is placed in correspondence with the possible minimum level for the water course, to avoid negative readings. The measurement of the hydrometric level is then converted into a flow value using a function known as "flow scale" or "discharge table", experimentally calculated by measuring the flow speed and the geometry of the section of riverbed. Measurement of the hydrometric level can be calculated using systematic manual readings of hydrometers, or by hydrometrographs or tele-hydrometers which automatically record data, and can transmit to a default collection centre.
Not all Italian rivers, and less those from minor river basins, are monitored by means of measuring stations.
In Italy, the first observations of rainfall and the first systematic readings of the levels of certain water courses date back to the beginning of the 19th century. After the first world war, the Ministero dei Lavori Pubblici established the Servizio idrografico Nazionale, with the specific task to standardize, organize and make available thermometric, pluviometric and hydrometric information through the regular publication of "Annali idrologici". The Servizio idrografico nazionale was structured in fourteen departments distributed over the territory, based on the hydrographical basins of the main Italian rivers and the particular administrative nature of the various areas. The Servizio Idrografico Nazionale has collected information on hydrological phenomenon for the whole 20th century, based on approximately four thousand thermo-pluviometric stations distributed over the entire national territory, developing analyses and studies on the overflow of Italian water streams.
Knowledge, through a systematic data-collection, of the hydrological phenomena occurred in the past is still the fundamental basis for designing hydraulic defence works, for estimating hydraulic risk factors and proper planning.
In 1989 by Law no. 183 dated 18th May titled "Conferimento di funzioni e compiti amministrativi dello Stato alle regioni ed agli enti locali" the *Servizio idrografico e mareografico nazionale* was founded within the technical services of the Presidency of the Councilof Ministers of Italy. By responsibility transfer from State to Regions, even the *Servizio Idrografico e mareografico italiano* changed.
Legislative Decree no. 112 dated 31st March 1998 ", in implementation of Law no. 59 dated 15th March 1997 and the Presidential Decree dated 24th July 2002 provided that the *Uffici compartimentali* had to be transferred to Regions, while the Direction of the Servizio idrografico nazionale became part of the then *Agenzia per la protezione dell'ambiente e per i servizi tecnici* (Apat), now *Istituto superiore per la protezione e la ricerca ambientale* (Ispra).
Following these changes, some hydrographical offices were placed under the supervision of *Agenzie regionali per la protezione dell'ambiente* (Arpa), while others were placed in regional civil protection structures, commissions and agencies for soil protection. As a consequence the publication of the "Annali idrogologici", was no longer carried out and regional bodies took on the responsibility for publishing their own data.
Framework Directive 2000/60/EC on waters, issued by the European Parliament and EU Council[2] introduced the main units for managing river basins: the "River basin district". This is formed by one or more neighbouring river basins and their respective underground or coastal waters. Article 64 of Legislative Decree no. 152 dated 03rd April 2006 divides the national territory into eight river basin districts: Padano, Eastern Alps, Northern Apennines, River Serchio basin, Central Apennines, Southern Apennines, Sicilia and Sardegna.

Seismic events

Seismic activity is a territory physical feature just like climate, mountain ranges and water streams. Italy is one of the Mediterranean countries with the highest seismic risk, both in frequency and intensity of earthquakes that affect it.
From the 19th century, academics have been working on a seismic history of Italy, drawing from the

[2] Directive 2000/60/EC by the European Parliament and Council dated 23rd October 2000 which establishes a framework for community action regarding water management, published in the Official Gazette of the European Union dated 22nd December 2000.

chronicles of the time. One of the first problems to be solved in order to perform this task was classifying seismic events. To this purpose the macroseismic scales were introduced, and adapted to synthesize the critical effects of earthquakes in each area by a numerical value measuring the macroseismic intensity. From the collection and systematic classification of seismic events the first catalogues of earthquakes were created, although affected by the uncertainties inherent to the sources, they still are an irreplaceable tool to describe the seismicity of an area. As of the end of the sixties, this information were computerized and is currently stored at the *Istituto Nazionale di Geofisica e Vulcanologia* (INGV).
In 1935, Charles Francis Richter introduced "magnitude" as a measure of earthquakes. Itt represents an estimate of the quantity of energy released, based on amplitude and duration of seismic waves.
Guglielmo Marconi in 1936 founded in Italy the *Istituto Nazionale di Geofisica* it was in charge of monitoring and analysing seismic events. As a result of the destructive earthquake in Friuli, in 1976, and in Irpinia, in 1980, this sector received a major boost resulting in the creation of the National central seismic network, which still collects and publishes data on seismic activity. From the early eighties the signals from the seismic network have been systematically analysed in digital format. Seismic monitoring has become therefore available 24 hours on 24. It provides location and magnitude of any Italian earthquakes within two minutes from its occurrence.
Today, the Network is managed by INGV, officially responsible for seismic monitoring in Italy (Legislative Decree no. 381 dated 29th September 1999). Seismic events are continuously detected by the centralized national seismic network, and are transmitted in real time to the earthquakes National Center, at the headquarters in Rome. The network consists of some 350 stations located throughout the whole national territory. The collected data are disseminated by the "Bollettino Sismico" that since 2015 has been published every four months and is available for download on the INGV website. In addition to the "Bollettino Sismico", as for historical earthquakes the Ingv updates the Italian macrosismic database and the "Catalogo Parametrico dei Terremoti Italiani".

Energy

National Energy Balance

The theme of energy, due to its close links to the economic system and its environmental impact, has taken on a growing importance over time. The characteristics of this sector are well known thanks to the wide range of data available. Data are collected and processed by some sector operators: the *Ministero dello sviluppo economico* (Mise - Ministry of Economic Development), regarding the statistics on the National Energy Balance, collected from the 1970s; the *Terna* society and *Rete elettrica nazionale Spa* company for statistics on the electricity sector.
The Energy Balance is the accounting tool used to quantify flows of each primary energy source derived, in all phases, from production or importation of energy sources right up to the final uses in each economic sector. In the Italian National energy balance (BEN) the quantity of energy produced, imported, transformed and consumed in a year is calculated for each energy source on the national territory. The BEN is drawn up and published on a yearly basis by the current *Ministero dello sviluppo economico* (Ministry of Economic Development) according to the methodology set down by European regulations on energy statistics. The data accounted in the BEN are the result of processes performed partly on the basis of the direct measurements by the Ministry on oil, carbon and gas sector operators, and partly on the basis of the measurements performed by the Terna – *Rete elettrica nazionale Spa* statistical office, which is in charge, within the National statistical system, of publishing official statistics on the electric power system.
The BEN was published for the first time in 1971. Since then, a few important changes have been introduced with the aim of highlighting different details in the energy sources to be used. Some obsolete sources, such as "Nuclear fuels", have been eliminated from the balance, while since 1994 "Renewable energy sources" have been introduced, systematically entering under that label those sources that, although already present in the BEN to some extent, were previously grouped under other labels.
The Ministry of Economic Development processes the Energy balance in an extended and synthetic format. In the summary version, the individual energy sources are aggregated into five homogeneous classes (solid fuel, oil products, gas fuels, renewable fuels and electric energy), taken into consideration in the extended version of the balance, and eliminating duplications due to energy transformation activities. The fundamental identity of the energy balance has to be checked for both the extended and

the summary versions. The identity is equality between availability (offer) and use (demand) of energy.
The most commonly used units of measurement for processing energy balances are the tonne of oil equivalent (TEP - TOE) and its multiples. In order to aggregate quantitative data from the various energy sources, a conversion operation is performed where the units of measurement for the various energy sources are replaced by a common unit, allowing their aggregation at a global level. The Ministry of Economic Development, in the "Energy statistics" section of its website (http://dgerm.sviluppoeconomico.gov.it/dgerm/) has been publishing national energy balances both in their extended and summary versions since 1998, in addition to specific statistics including the natural gas balance, the prices of certain petrol products, carbon, natural gas and electricity and some statistics relating to the petrol market. In addition to Italian National energy balances, regional energy balances prepared by ENEA since 1990 are also available. These balances are constructed using the same method as the Italian National energy balance and offer an exhaustive overview of the regional energy situation.
The National Agency for New Technology, Energy and Sustainable Economic Development (ENEA) has published the Energy and environment report on its website (http://www.enea.it/it/pubblicazioni/rapporto-energia-e-ambiente) since 1999. It contians data form the National and regional energy balances. The Energy and environment report offers a periodic and in depth analysis on the energy situation at national and regional levels, in relation to the economic and social context and technological and environmental development.

Electricity Balance

The first data on electricity date back to 1883, the year in which this source of energy first began to be used in Italy. Only data relating to energy production were recorded at the time, while since 1931 those relating to demand for electricity together with the characteristics of generation plants and the electric network have began to be collected. Up until 1962, these statistics were under the responsibility of Anidel (Italian National Association of Electricity Distribution Companies).
On 06th December 1962 Enel (National Electricity Authority) was founded with the task of producing, importing, exporting, transporting, transforming, distributing and selling electric power. Enel started its activities in 1963 gradually absorbing the existing electricity companies. By the end of 1995, 1,270 companies had been absorbed. Since1963, therefore, Enel has been responsible for providing data on traditional thermoelectric generation, divided according to the type of fuel used, and those relating to consumption of electricity, structured by sector of use. Enel took care of collecting and processing data relating to the electricity sector up until 1998, recording some important phenomena linked to national economic history.
In 1992, nearly thirty years after its foundation, ENEL became a joint stock company, the first step towards privatisation, with the Italian Treasury as sole shareholder. In 1999 *Enel Produzione*, *Terna* and *Enel Distribuzione* were born. At the same time new operators entered the market together with other figures including the National Grid Operator (GRTN), responsible for electricity transmission and distribution and the collection and publication of sector statistics up until 2005. Since 2005, official statistics relating to the national electricity sector have been produced by the statistical office of *Terna - Rete elettrica nazionale Spa*. This company was founded in 1999 within the Enel group implementing the Legislative Decree no. 79 dated 01st November 2005, and following the unification of the ownership and management of the national electricity grid operator.
The figures collected by Terna cover, in 2009, the whole range of approximately 1,800 operators in the electricity sector, such as producers, distributors and wholesalers, and provide a complete overview of the electricity sector in Italy. This information is contained in various publications made available by *Terna*, including the "*Electricity balances"* drawn up from 1947 onwards. The balance reports data relating to the production of electricity divided by energy source used and the figures relating to the use of energy in the various sectors of use. Today all the figures relating to the electricity sector are available at the http://www.terna.it/default/Home/SISTEMA_ELETTRICO/statistiche.aspx website, from where the "Electricity statistics" section may be accessed, where "historical data" are stored together with other figures relating to the electricity system.

Electricity from renewable sources

The development of renewable energy sources is one of the pillars of Eu energy policy over the last decade. Directive 2009/28/EC issued by the European Parliament and Council on 23rd April 2009, in substitution of Directive 2009/77/EC, entitled "Promotion of electricity produced from renewable energy sources", sets binding targets for each Member state; for Italy, the national target is of 17 per cent by 2020.
Energy from renewable sources is derived from non-fossil fuels and is classified into the following types: solar, wind, hydraulic, geothermal, biomass, tidal power (tides and currents). Renewable energy sources have been included in national energy balances since 1994, while data relating to geothermoelectricity has been available since 1916 and for gross electricity production from wind and solar power since 1992. Since 1999 the energy services provider has supplied an overview of the renewable energy sources used in Italy in the form of annual reports (*Statistics on renewable energy sources in Italy*). Since 1999 Enea (National Agency for New Technology, Energy and Sustainable Economic Development) has also presented an *Energy and the environment report* with a section dedicated to renewable energy sources.

Warnings for time series comparisons

- With regard to electricity balances, since 1983 in compliance with international methods, losses relating to plant transformation are included under the heading "energy consumption for auxiliary services", previously they were under transmission and distribution losses.
- Since 1994 some obsolete energy sources such as "Nuclear fuels", have been removed from the "National energy balance", while "Renewable energy sources" have been introduced. Some sources already present in the BEN but previously appearing under other headings have been shifted to this category.
- In 1996 the classification of economic activities for electric use was aligned with Istat ATECO91 and European Union NACE Rev.1 classifications. As a result, figures are no longer perfectly comparable to previous years.
- In 1998 the evaluation of the hydroelectric source net of pumping was modified in the "National energy balance", causing a difference in the new tables with respect to the past. In the new version only the quantity of energy effectively obtained from hydroelectric production is counted, while losses from pumping transformation are in any case considered in the total. The final result is that only approximately 70 per cent of the contribution from pumping is subtracted from total energy consumption, rather than 100 per cent.
- Since 2008 in the "National energy balance", natural gas has been estimated to have a calorific value of less than 8.190 kcal/m^3 rather than 8.250 kcal/m^3, in line with international and Eurostat statistics.

Atmospheric pollution

The method established during the European Coordination Information Air project (Corinair) and used to estimate pollution figures is presented in this section. It has the aim of harmonising, organising and developing information on atmospheric emissions, within the wider Eu programme entitled "Coordination of information on the environment" launched in 1985. The estimates previously drawn up by ENEA[3] in the context of the Corinair project considered three pollutants (SOx, NOx, volatile organic compounds - VOC- including methane) and 120 activities divided into eight groups (combustion in thermoelectric and heating plants, petrol refinery, industrial combustion, industrial processes, solvent evaporation, road transport, natural sources, other). An update and perfection of the method was subsequently performed as part of the European work programme Corinair90[4], which aimed to draw up an inventory of emissions,

[3] For a complete illustration of the calculation methods used in 1985, please refer to the Enea, Central Research Department for the Corinair Project, Inventory of polluting emissions in Italy in 1985 (edited by W. Boccola, M.C. Cirillo, D. Gaudioso, C. Trozzi, R. Vaccaio, C. Napoletano), Rome, 1989.

[4] The Corinair90 system was developed in compliance with the EMEP programme (Evaluation and monitoring of long range transmission in Europe of air Pollutants) aimed at dealing with transboundary atmospheric pollution issues, and with the Ipcc/Oecd (Intergovernmental Panel on Climate change/Organization for the economic cooperation and development).

in the context of the Convention on transboundary atmospheric pollution and the Framework Convention on climate change, ratified by the Italian Parliament in January 1994.
The main innovations introduced by Corinair90 were:

1) an extension of the range of the considered pollutants, passing from three to eight, including sulphuric oxides, nitric oxides, volatile non-methane organic compounds, methane, carbon monoxide, carbon dioxide, nitrous oxide and ammonia, i.e. all types directly or indirectly linked to the greenhouse effect;
2) a more detailed and differently structured classification of activities and sources of pollution, covering more than 260 activities;
3) an increase in the number of countries involved.

In 1994, the Corinair90 method was reviewed again by the European Environment Agency, which launched the Corinair94[5] project and developed a group of methodological proposals for estimating emissions, to be implemented on an annual basis.
In December 1997 the Kyoto Protocol was signed, representing the implementation of the United Nations Framework Convention on Climate Change, approved in New York on 09th May 1992, with the aim of combating and minimising the negative effects of climate change on our planet. According to the Convention and the Kyoto Protocol, which entered into force in Italy on 16th February 2005, Italy undertook to develop, publish and regularly update national emissions inventories, in addition to formulating and implementing programmes to reduce emissions.
For each of the pollutants analysed,[6] the annual updating of time series was performed by the Higher Institute for Environmental Protection and Research (ISPRA), using the EMEP-EEA (European Environment Agency) methodology in compliance with the indications provided by Corinair94. It was specified that, when necessary, the methodology would be updated by technical groups coordinated by the EMEP programme in collaboration with the EEA, and the entire time series would be revised in order to ensure coherence and comparability of data over time. The time series produced are the result of the national inventory of emissions. The values relating to emissions and absorption from natural sources are excluded. The totals obtained coincide with the official figure communicated by Italy as part of the United Nations Framework Convention on Climate Change (UNFCCC) – regarding carbon dioxide, methane and nitrous oxide[7] - and the United Nations Economic commission for Europe convention on long range transboundary air pollution for the remaining pollutants.

Interaction between economy and environment in the satellite account system in national accounts

In the early 1990s Istat initiated a programme for developing environmental accounting, an integrated information system on economy and environment based on the satellite accounts in national accounts. The system was linked with the information traditionally produced in national economic accounts. In the same period Eurostat, the European Union statistical office, following the first projects in environmental expenditure initiated at the end of the 1980s, launched a wide-ranging development programme for environmental accounting. Furthermore, studies promoted by the Un following the 1992 Rio Conference on environment and development led to the definition of the first version of the SEEA environmental accounting manual. The SEEA was revised and the current version – the System of Environmental-Economic Accounting 2012 — Central Framework – was adopted as International Statistical Standard by the United Nations Statistical Commission. The methodological basis developed at this stage on an international level, which also saw a contribution by Istat, has been the foundation for the calculations produced by the Institute from the 1990s onwards. The further extension of environmental accounts by Istat was performed in line with the methodological developments at the international level, prioritising the creation of parts of the accounting system dealing with the most important aspects for the European political agenda.
The environmental accounting series correspond to themes of top priority in a European context: material

[5] See European environment agency “Review of Corinair90 Proposals for air emissions 94”, 1995.
[6] In 1999 the responsibility for calculating national emissions passed from ENEA to ANPA, currently known as ISPRA.
[7] These totals are net of Lulufcf (*land use, land use change and forestry*).

flows, use of energy resources, products and residuals, atmospheric emissions, environmental expenditure and taxation. The described phenomena relate to the overall potential pressure of the human system on the natural system (material and energy flows), pressure on the environment by specific economic sectors in terms of flows of pollutants (air emissions in environmental accounting), responses to environmental problems - created by the economic system. All this by means of "economic" toolsa available to environmental policy (environmental taxation) and actions and activities aimed at protecting the environment (environmental expenditure). From 2011 onwards, due to the high level of priority given to these themes, and thanks to the good availability of basic data, the construction of the accounts on Air emission by activity, on Environmental taxes by activity and on Economy-wide material flows have been included in the Regulation of the European Parliament and of the Council n. 691/2011 on European Environmental Accounts. Moreover, from 2014 onwards, also the accounts on Environment protection expenditure, on the Environmental goods and services sector and on Physical Energy Flows have been covered by this Regulation[8].
Environmental accounting calculations are based, among other things, on environmental data which are produced and used in relation firstly to the typical dimensions of the natural system, and not with reference to the economic system. A specific difference between environmental accounts to numerous base statistics used for their construction lies in the adoption in the accounts – as satellite accounts in National Accounts – of the *residence principle:* "A unit is a resident unit of a country when it has a centre of predominant economic interest on the economic territory of that country — that is, when it engages for an extended period (one year or more) in economic activities on this territory". (Esa2010 § 1.61). This entails, for example that atmospheric emissions in environmental accounting include flows of pollutants that are not necessarily generated within national boundaries, where on the other hand the original data produced with the emission inventory (defined within the European Corinair project) refer to the natural system within the national territory.

Use of material resources

The accounts concerning the use of material resources (material flows) relating to the entire socio-economic system (economy-wide) are calculated by Istat in National Accounts and, in particular, the satellite economic-environmental accounts in physical terms. These accounts began to be part of official Italian statistics in the early years of this century only, thanks to financing granted by Eurostat. Eurostat coordinated the pilot applications, performed on the basis of a methodological guide drafted by a European *task force*, in which Italy took active participation. In the past the system was in the field of economic-environmental research, especially in Germany, as a tool to respond to new information requirements deriving from the ever increasing need to promote ecological sustainability of socio-economic processes. In 2011 the yearly compilation and transmission to Eurostat of Economy-wide Material Flow Accounts, with no more than two years delay from the end of the last reference year became mandatory under regulation 691/2011. Italy regularly publishes the data approximately 14 months after the end of the last reference year.
Material flow accounts record withdrawal, use, apparent consumption and overall requirements for materials activated by production and final national use of goods and services. The accounts comply with international methods and, in particular, with those codified by Eurostat in the methodological above-mentioned guide[9]. So far figures deriving from this source have been constructed and published only for the years after 1980. The first issue covered the period from 1980 to 1998, and the series have been revised several times, in compliance with the most recent methodological indications by Eurostat.
For the series presented here, *ad hoc* calculations were made, allowing for the drafting of time series running from 1951 to 1979. This extension – also performed in compliance with European methodology – provides the necessary elements for an initial historical assessment of the implications for the natural environment of the large changes in Italian production and consumption, starting in the years following the Second World War. The construction of the material flow accounts, which sourced the indicators used here, requires the use of a vast and diversified range of data, auxiliary information and estimation

[8] The three new accounts were introduced by the Regulation of the European Parliament and of the Council n. 538/2014, which modified the preexisting Regulation 691/2011.

[9] The methodology requires recording, in units of weight, of all the materials that cross the boundaries of the national socio-economic system, excluding water and air when used as such and not incorporated into products (for example, water used for irrigation in agriculture or air used to cool industrial plants are excluded).

models. The calculations performed on these sources are aimed at ensuring coherence in the physical aggregates of the material flow accounts with the monetary accounts in national accounts, both from the point of view of respecting the *residence principle* – for which, for example, fuels purchased abroad by Italians are included in the account of national fuel use – and from that of completeness of the estimates and exhaustiveness of the aggregates.
The calculation of the *Domestic extraction* (of material resources used and unused) relies on the following sources:

– for the extraction of *biomasses,* on figures from Istat statistics on agricultural cultivations, forests and fishing in addition to agronomic coefficients relating to sub-products and waste which accompany the extractions recorded by these statistics;
– for the extraction of *energy minerals*, on information deriving from Istat statistics on the quantities extracted, communications from the competent Ministry (of Industry, Productive Activities, Economic Development, etc.), in addition to technical coefficients for the unused amounts;
– for the extraction of *non-energy minerals* from quarries and mines, on Istat statistics on extraction industries (PRODCOM survey), on administrative sources (regional archives on mining and quarrying activity permits and type and quantity of extracted materials), on the joint Istat-Ministry of Industry survey of quarries and peat bogs (up until 1997), on the annual statistical survey on industrial production (from 1997 onwards), on Istat statistics on construction permits, on *ad hoc* communications by ANAS and Italian State railways, in addition to technical coefficients and estimation models constructed *ad hoc* for certain parts both of used and of unused materials.

No estimation on quantities of extracted but not used materials has been performed in recent years, so the present publication only reports those referred to pre-2009 years. Knowledge of these quantities is not considered a priority at European level, although according to the quoted regulation, more disaggregated data on the flows by kind of material is necessary (this level of detail is not provided here, but is available at dati.istat.it).
The calculation of materials' *Use,* of *Apparent consumption* and of *Overall requirements* are based, in addition to the above listed domestic sources, on figures on the flows of goods from or to other countries and their indirect demand, i.e. on Istat foreign trade figures, Istat transport statistics and on coefficients relating to indirect flows (of both used and unused materials together), provided by a specialised Institute.
The calculation of *Overall requirements* is based upon the estimation:

- of quantities of materials (used and unused) extracted abroad, necessary to meet the Italian demand for imported goods
- of the quantities of materials extracted at a global level (in Italy or abroad), necessary to meet the foreign demand for Italian goods.

These flows are relevant from an environmental point of view, as the resources used in the corresponding production processes, not physically embodied in traded goods remain in the producing countries, and transformed in waste and emissions. These flows, however, have not been estimated in recent years, therefore we publish here figures on pre-2009 data only. This is due not only to the above-mentioned European priorities, but also to the not yet updated methodology for their calculation. At the international level, similarly to domestic flows, an orientation emerged to privilege the separate estimation of used materials' flows only, also for indirect flows. Istat could not apply the available methodologies for this separate estimation due to their relatively high processing cost in terms of human resources.

Warnings for time series comparisons

- Since 1990 indicators have incorporated the estimates of direct foreign purchases made by units resident in Italy and of those made directly in Italy by non-resident units, which increase imports and exports respectively resulting in the *to and from abroad* headings. As the additional quantities represent less than 2 per cent of those already present, the readability of the data as series is only partially altered. Furthermore, the influence on the balance of direct flows to/from abroad is very limited, while indirect requirements are not affected at all, since direct purchases do not contribute to their calculation.
- As for the years where the corresponding elaborations were made, the quality of the estimates of indirect requirements is higher for more recent years, thanks to the availability of ever more

complete data bases, allowing for calculations on a progressively more detailed level. For the years before 1980, estimates were made using 13 groups of goods for imports and 14 for exports. From 1980 onwards the groups have been several hundreds. This ensures a substantial homogeneity within each group regarding the flows activated "upstream," i.e the direct necessary withdrawals from the natural environment, on a global level, for the production of goods actually imported or exported. These are important withdrawals from an environmental point of view, because the part of resources used in the corresponding productive processes which are not physically incorporated in the goods traded remain in the producer's country, transformed into waste and emissions. The simulations performed in years for which it was possible to operate on both levels of detail indicate a difference of not more than 5 per cent between the results obtained using the two methods. Moreover, from the reference year 1991 onwards the country of origin was also taken into account for some imported products characterised by a high level of variability in the intensity of indirect flows. All the estimates relating to this type of flows, such as those relating to flows of unused materials from domestic extraction, are in any case considered as prudential, i.e. they are indicating minimum values and trends of flows rather than complete assessment.

- The estimates of material flows have been constantly improved. From time to time Istat has revised published data several times, even-though the reference methodology remained substantially unchanged, as for the finding and use of ever more precise and detailed information sources – also with reference to far past years - and for the use of tools able to identify and correct computation errors in or to complete previously incomplete estimates. It is for example the case of a joint use of administrative and survey data in the case of quarries and mines extraction.
- The 1951-2008 time series were calculated and published for the first time on the occasion of the 150th anniversary of the Italian Unity, on the basis of the methodologies and with the tools in use at that moment. In the present occasion, more up-to-date series are used only for the 1990-2014 period, while it has not been possible to revise the series for 1951-1989. Considering the above mentioned warnings, however the methodological "jump" has not been to the extent of preventing the use of the time series for the entire period 1951-2014. Discontinuities are indeed of little relevance and in any case short-term changes of Economy-wide Material Flow indicators are of very limited importance in terms of practical relevance, as the represented phenomena have to be evaluated in their long- and very long-run evolution.

Energy use

In the 1980s Istat constructed and published data on energy uses in Italy on the years 1975, 1980, 1982, 1985 and 1988 in connection with the construction of the Input/Output Tables for the Italian economy. These figures, expressed in physical units, described the use of energy products broken down by economic activity (classified according to NACE70) and households. For each of the 25 products considered, data were split by purpose or type of use (transport, heating, non-energy use, other energy use) and by origin of supply (domestic output, imports).

After that the construction of an energy account in physical units describing the resources (domestic output, imports) and uses (intermediate uses, households' final consumption, changes in inventories and exports) of energy products has been annually carried out as part of the construction of the estimates for National Accounts in monetary terms (in particular for GDP estimates).For each product, intermediate uses were disaggregated by branch of economic activity (according to NACE Rev.1). The matrix of uses "product x branch" has never been published. With respect to the energy use data constructed in the 1980s, those produced after that date presented differences both in the methodology applied and in their structure. They were indeed not only classified according to the different version of NACE, but the total energy uses included some components which were previously excluded (use of fuel for military transport, for agriculture, livestock and forestry, for industrial removals and for gardening). Last this matrix did not provide a disaggregation of intermediate uses of production activities broken down by use. Only the figures relating to the household consumption of energy products were divided into "use for transport" and "other uses" (mainly heating).

From 1999 onwards, disaggregation exercises have been performed on the figures relating to energy uses by branch, by energy product and by function (heating, transport, other energy use, non-energy

use), with the aim of estimating atmospheric emissions for the Namea environmental accounting project and for the compilation of the pilot Eurostat Standard Table on energy consumption.
The integration of Environmental Accounting into National Accounts, which took place in 2010, implied that the construction of the Table of uses of energy products by type of use (TIPU) became an objective *per se* in Satellite Accounting, built in perfect coherence with the other National Accounting products, as for definitions, principle, classifications, reference manuals and, when appropriate, data sources. Thanks to this coherence, it is possible to ensure a meaningful relation between the physical data (energy uses) and other physical aggregates of environmental accounting (for example, Namea air emissions by economic activity) or the traditional monetary aggregates (output, value added, employment, households' consumption, etc.). The TIPU represents indeed an important basis for the construction of Physical energy flow accounts as well as of the Matrices of expenditures (final and intermediate) for energy products, realised within the GDP estimation process. Currently, TIPU data are constructed complying with the *residence principle*, and are expressed both in specific physical units for each product (tons, cubic meters, MWh) and in energy units (Terajoule), and are disaggregated by energy product, type of use and economic activity (28 energy products, 9 types of use and 99 economic activities, i.e. 98 production activities plus end users, i.e. households)[10] [11] .The main data sources used for the construction of the TIPU are:

- "National Energy Balance (BEN), "Quarterly Oil Bulletin", " Consumption of petroleum products" and "Survey on oil statistics", annually produced by the Ministry of Economic Development (MISE);
- surveys on "Foreign trade of Goods and Services"; "Air Transport"; "Sea Transport" and the "Industrial Producer Prices Survey", annually carried out by Istat;
- "Survey on energy consumption (COEN)", carried out in 2013 by Istat-MISE-ENEA (reference year 2011);
- the "Agriculture Economic accounts" and the 'Matrix of production at basic prices", annually produced by Istat;
- coefficients provided by ISPRA/ENEA for estimating consumption of some energy products in specific areas (household heating, industry off-road transport, ...);
- "Annual Report on Electricity in Italy" annually produced by TERNA;
- "Energy data. Economic, energy and environmental statistics", publication of Unione Petrolifera;
- fleet of vehicles, by power, owner, type of vehicle and prevalent use, microdata provided annually by ACI.

So far TIPU data have been published by Istat only in the previous edition of the Italian Historical Statistical Repository, issued in 2011 on the occasion of the 150th anniversary of Italian unity. In the present new edition of the Repository, we publish not only the energy use series, updated to 2014 (the entire series has been recalculated since 1990 as to profit from updated and revised basic data as well as from the introduction of methodological innovations), but we also publish for the first time the uses disaggregated by type of energy product[12].

[10] The 28 energy products considered by TIPU are: coal, lignite, coke oven coke, non-energy coal products, coke oven gas, crude oil, semi-finished oil products, motor gasoline, jet fuels, light oil and medium petroleum oils products, kerosene, diesel oil, fuel oil - low sulphur content, fuel oil - high sulphur content, LPG, refinery gas, petroleum coke, bitumen, lubricants, other refined petroleum derivatives n.e.c., electricity, by-products, natural gas, gas works gas, blast furnace gas, fuel wood, charcoal and waste incinerated used as fuel for the production of electricity/heat.
The 9 types of uses considered by TIPU are: heating buildings, road transport, off-road transport (rail, air and sea transport, as well as all the operations of ships, boats, tractors, construction machinery, lawnmowers, military and other equipment), transformation in electricity, transformation with combustion in energy products other than electricity, other energy use with combustion (typical processes of production, excluding the heating, transport and transformation), transformation without combustion in energy products, use of electricity, non-energy use. For the 3 uses related to the transformation, transformation losses are described too.
Economic activities are classified according to the NACE Rev. 2.

[11] The three-dimensional nature of TIPU (by energy product, type of use and economic activity) – and its layout (28 x 9 x 99) – ensures that no figure on the table is affected by double counting (which may occur when the energy incorporated in the products used to be transformed into other energy products is also counted in the different uses of derivative products); on the contrary, the aggregation of the figures by energy product, type of use and/or economic activity may result in the double counting of the same energy in different phases (substantially in the production/transformation phase or consumption phase).

[12] Data on household consumption, by type of energy product and type of use, are also published in the MISE report on 'National Energy Situation 2015' (ed. 2016).

Warnings on aggregations used in the tables

Considered as a whole, the figures on energy product use, presented separately for the household sector and for production activities, have the following shared features:

- the use of energy products is shown in aggregated form, i.e. totalling the uses of different products after converting all figures into a single *unit of measurement* (Terajoule);
- the considered *energy products* are: "solid" (coal, lignite, coke oven coke, non-energy coal products, fuel wood, charcoal, and incinerated waste used as fuel for the production of electricity or heat), "gaseous" (natural gas, coke oven gas, refinery gas, blast furnace gas, gas work gas, by-products), "crude oil and refined petroleum products" (crude oil, semi-finished oil products, motor gasoline, jet fuels, light and medium petroleum oils products, kerosene, diesel oil, fuel oil – low sulphur content, fuel oil – high sulphur content, lpg, petroleum coke, bitumen, lubricants, other refined petroleum derivatives n.e.c.), and "electricity";
- the division by *type of use* considers "energy use with combustion", "energy use without combustion" and "non-energy use".
  Energy use with combustion is then divided into use for "heating" (of homes, shops, offices, plants, enterprises, etc.), "transport" (road and off-road transport, including rail, air and sea, in addition to all the operations of ships, boats, tractors, construction machinery, lawnmowers, military and other equipment; for household, own account transport is considered; for production activities, transport is considered both as a principal, secondary and ancillary activity), "transformation in electricity", "other energy use with combustion" (transformation with combustion in energy products other than electricity, for example the transformation of coke into blast furnace gas; use of energy products by production activities in production processes in a strict sense, excluding heating, transport and transformation; use of energy products by households for cooking and hot water production).
  Energy use without combustion includes the transformation without combustion of energy products into other energy products (for example the transformation of crude oil into motor gasoline) and the use of electricity for any purpose.
  Non-energy use includes the transformation of energy products into non-energy producing products (for example, the transformation of crude oil into plastic) and the use of energy products for non-energy uses (degreasing, dry cleaning, lubrication, etc.);
- the figures presented are *gross of transformations*, in that the energy incorporated in the products used to be transformed into other energy products is also counted in the various uses of the derivative products. In principle, therefore, the "total use of energy products" is affected by double counting in that:
  a) the energy incorporated in the products used for the production of electricity is also counted in the phase in which the electricity itself is used;
  b) the energy incorporated in the products transformed by combustion into other energy products is also counted in the various uses for said derivative products;[13]
  c) the energy incorporated in the products transformed without combustion into other energy products is also counted in the various uses for the derivative products (for example, the energy counted in the crude oil used to produce motor gasoline is recounted in the use of petrol for transport).

On a practical level the above implies that the data for *production activities*, if we consider the individual types of use of energy products, do not present the phenomenon of double counting in the case of heating, transport, transformation into electricity and non-energy producing use, while the phenomenon does occur, marginally, in the case of the other energy use with combustion and energy use without combustion. The total use of energy products is, in contrast, strongly affected by the double count.
The data by *individual production activity* are affected by the same considerations as for production activities as a whole, but the disaggregation by activity considerably attenuates the phenomenon of double counting. The figures for *households* are not affected by double counting as households do not perform any type of transformation of energy products.

[13] In practice the only case in which this does take place is when the energy incorporated in coke used in blast furnaces to produce blast furnace gas, which in turn is used both for the production of electricity and for industrial steel-working processes and in cokeries.

Atmospheric emissions in Environmental Accounting

The figures relating to pressure caused by economic activities (industry and households) on the natural environment, in the form of air emissions, are provided by the Air emissions satellite account, which is mandatory under the Regulation of the European Parliament and the Council n. 691/2011 on European Environmental accounts. The early realisations of this satellite account are known as Namea (*National accounting matrix including environmental accounts*), after the name of the accounting system developed in the 1990's by the Netherlands Statistal Office for the representation of interactions between economy and environment in a way that ensures comparability of economic and social data (output, income, employment, etc.) with those on the stress that human activities put on the natural environment (environmental pressures). Although complete NAMEA matrices as such are not regularly compiled, this acronym, remains in current use as to identify environmental accounts having among their main characteristics the disaggregation of environmental pressures (or drivers) by economic activity (production branches and households), such as Air emission accounts[14].

The main source for the calculation of Air emission accounts is the national air emission inventory, which is produced on an annual basis by the Institute for Environmental Protection and Research (ISPRA), which produces the figures for the Italian Communications on an international level under the United Nations Framework Convention on Climate Change and the Convention on Long Range Transboundary Air Pollution[15] (see Atmospheric Pollution). However, the total emissions calculated using Air emission accounts methodology is different from both the total emissions according to the air emission inventory and that calculated as part of the main international conventions mentioned above. This difference is due to the adoption in the environmental account of the principles and standards used to calculate national economic accounts, established by the European system of national and regional accounts *European System of Accounts* (ESA210). With reference to the data presented here, it is important to point out the residence principle. For coherence with this principle, the emissions from resident units operating abroad (for transport activities) are added to the emission data calculated by Ispra, which refer to the national territory, and the emissions from non-resident units operating in the national territory (for transport activities) are subtracted. Furthermore, the satellite account for atmospheric emissions includes only emissions caused by human activity and not those associated with natural phenomena, which in contrast are included in the emission inventory.

Regarding production activities, the data of this satellite account include the emissions caused by production processes characteristic of the principal activity, those generated by any secondary activities and the emissions caused by ancillary activities such as in-house heating or transport processes[16]. With regard to households, the data are structured into three headings which are of particular interest for emissions: "transport" (including household emissions deriving from the use of fuel for private transport and gardening), "heating" (including cooking) and "other" (which includes household emissions caused mainly by the use of solvents).

The time series included here, both with reference to households and to production activities, cover the years 1990-2013. These are coherent with the 2015 version of the Corinair inventory and include emissions from nineteen atmospheric pollutants: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), nitrogen oxides (NOx), sulphur oxides (SOx), ammonia (NH_3), non-methane volatile organic compounds (NMVOCs), carbon monoxide (CO), particulates (PM_{10}), fine particulates ($PM_{2,5}$), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), selenium (Se) and zinc (Zn), in addition to the aggregate indices for "greenhouse", "acidification" and "tropospheric ozone" environmental issues.

The methodological coherence of the Air emission accounts data with the figures in the national economic accounts allows for the economic National Accounts data to be used to calculate indicators representing the efficiency of production activities such as emission intensity[17] (emissions/output, emissions/full time equivalent employees).

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[14] The same disaggregation and coherence with monetary supply-use tables characterises also other environmental accounts, such as those on Physical energy flows and of environmental taxes revenue.

[15] United nations - *Economic commission for Europe convention on long range transboundary air pollution*.

[16] For a given production unit, the primary activity is that whose value added is higher than any other activity performed in the same unit, a secondary activity is an activity performed in addition to the primary activity and an ancillary activity consists in a supporting activity (purchases, sales, marketing, data processing, transport, stocking, etc.) performed with the aim of creating suitable conditions for the performance of the primary or secondary activities.

[17] The higher the value of the indicator, the less efficient the production activity is.

Environmental taxes

The source of the figures on environmental taxes is the 'General Government aggregates and Accounts', calculated by National Accounts in compliance with the rules established by EU regulation no. 549/2013 (SEC2010).
A tax is defined as environmental if its base is 'a physical unit (possibly substituted by a proxy) of something which has a proven, specific negative impact on the environment[18].
Environmental taxes, as part of the overall group of taxes, constitute compulsory payments to the government, not directly linked to the benefits which the individual taxpayer receives from the activities of the General Government (GG).
On the other hand, payments to the GG provided for a service and which have a positive link with the volume of the service itself, even if compulsory, are defined as charges or fees . The revenue from charges and fees is excluded from the data on environmental taxes.
Some taxes are known as "earmarked taxes", the revenue from these taxes is used at least in part for financing environmental expenditure. They include, for example, the provincial tax for environmental protection and the special tax on landfill dumping[19].
The series published here are calculated from 1980 onwards and are divided into: energy taxes, transport taxes and pollution taxes. The first include taxes on energy products (independently from the product's intended use: transport, heating, etc.) and emission permits, regarded as equivalent to GHG taxes; the second include mainly taxes on property and vehicle use; the last relate to taxes on emissions (except GHGs), waste management and noise.
The revenue from environmental taxes is also calculated as a share of *total revenues from all taxes and social contributions* received by General Government, made up of the sum of the following four aggregates:

- direct taxes;
- indirect taxes;
- capital taxes;
- actual and imputed social contributions (since 1995)

Warning for time series comparisons

From the reference year 1995 onwards data are consistent with the 2014 revision of national accounts. Hence, the time series has a break in 1995 due to the introduced methodological changes.

Environmental expenditure

Aggregates on environmental expenditure related to waste management, wastewater management and use and management of water resources presented here are calculated by Istat according to SERIEE (*Système Européen de Rassemblement de l'Information Economique sur l'Environnement*) satellite accounts developed by Eurostat[20]. SERIEE accounts measure expenditure carried out by resident units of the national economy to protect the natural environment against pollution and degradation, as well as to manage and save the stock of natural resources against depletion.
SERIEE accounts, through a set of five interrelated accounting tables, describe: supply of environmental services; uses of environmental services; investments for production of environmental services; transfers between economic units to finance environmental activities; etc.. The economic transactions recorded in the accounting tables are consistent with fundamental concepts and schemes of European System of Accounts (ESA); therefore, environmental expenditure aggregates are comparable with the

[18] See *Environmental Taxes – A Statistical Guide*, European Union, Luxembourg: Publications Office of the European Union, 2013.

[19] For additional details on the use of revenue, see the following laws:
- for the Regional special tax on landfill dumping, Law no. 549 dated 28th December 1995, Art. 3;
- for the Provincial Tax for environmental protection, Legislative Decree no. 504 dated 30th December 1992, Art. 19;

[20] See Eurostat (1994): *SERIEE 1994 Version*, Luxembourg, and Eurostat (2002): *SERIEE Environmental Protection Expenditure Accounts – Compilation Guide*, Luxembourg.

corresponding aggregates of National Accounts.
The economic transaction recorded in SERIEE tables are broken down by institutional sectors - General Government, Corporations, Households, Non-profit Institutions Serving Households - and by the role played by the different economic units, i.e. producers, users, beneficiaries or financers of national environmental expenditure.
The series published in this section relate to the main aggregates produced within the SERIEE accounting tables with reference to waste management, wastewater management and use and management of water resources for the years 1997-2010. The series are consistent with National Accounts data calculated in compliance with the rules established by EU regulation no. 2223/96 (ESA95). The classification used for economic activities is Nace rev1.1.
The compilation of accounting tables concerning waste, wastewater and water resources management services relies on different data sources.
The main sources for the construction of the figures on production of environmental services are:

- National Accounts data, in particular data provided by production and generation of income accounts and supply and use tables with reference to the specific economic activities in which environmental services producers are included. Additional data sources have been used to break down National Accounts data and to estimate the environmental aggregates at the required level of detail;
- data on environmental protection expenditure by industry collected through the Survey on Economic and financial accounts of large enterprises and the sample Survey on the small and medium enterprises (SME) since 1998 in compliance with the Regulation (EC) on Structural Business Statistics (SBS)[21]. The Intermediate Census of Industries and Services is the data source used to produce estimates for 1997. Ad hoc methodologies have been implemented both to take into account differences in the various editions of the surveys (in terms of variables collected, breakdown by environmental domains), and to ensure consistency between data collected through surveys and National Accounts data.

With reference to the figures on uses of environmental services, the main sources are National Accounts data – *supply and use* tables, gross fixed capital formation by industry, General Government expenditure by function, final consumption expenditure by households – broken down on the basis of additional information to produce aggregates at the level of details required by environmental accounts.

[21] According to Regulation (EC) N. 295/2008 concerning long-term business statistics, National Statistical Institutes collect and transmit to Eurostat data on investment in equipment and plant for pollution control, and special antipollution accessories (mainly *end-of-pipe equipment*), investment in equipment and plant linked to cleaner technology (integrated technology) and total current expenditure on environmental protection, broken down by Nace code, 2-digit level, and by environmental domain according to the Classification of Environmental Protection Activities and expenditure Cepa2000.