QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR THE ITALIAN EMISSION INVENTORY YEAR 2025

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NATIONAL AIR EMISSION INVENTORY: GENERAL OVERVIEW

Objective

This document summarizes the specific Quality Assurance (QA) Quality Control (QC) activities and different verification procedures which are applied thoroughly the current inventory compilation as part of the estimation process.
In addition to a description of the current activities applied and the documentation, archiving and reporting processes, a specific section illustrates the main findings of the latest review process together with the actions undertaken by the inventory team.
Further improvements and planned QA activities identified during the preparation of the National Inventory and National Inventory Report 2022 are also presented.
A summary of previous QA/QC procedures which helped to understand the improvement of the inventory over the years concludes the general part of the report.
Sector specific QA/QC and verification documentation are explained in the relevant chapters.

Review process recommendations

In 2022, the Italian inventory was submitted to a UNFCCC review; also, the European annual review of GHG emission inventories of Member States took place in 2023. The main critical points raised during the review processes were addressed in the current inventory compilation and different improvements have been carried out.
Specific issues are described in the relevant sectoral chapters and there were no important problems concerning the general and cross cutting activities.

QA/QC activities and verification

Quality control checks and quality assurance procedures together with some verification activities are applied both to the national inventory as a whole and at sectoral level.
Specific QA/QC procedures are described in the manual 'Quality Assurance/Quality Control Plan for the Italian Inventory'[1]. Verification activities are also part of the overall QA/QC program. These activities have the ultimate objective of increasing the confidence and reliability of the inventory estimates.
Feedbacks for the Italian inventory derive from communication of data to different institutions and/or at local level. For instance, the communication of the inventory to the European Community result in a pre-check of the GHG values before the submission to the UNFCCC and relevant inconsistencies may be highlighted.
Results and suggestions from expert peer reviews of the national inventory within the UNFCCC process can provide valuable feedback on areas where the inventories can be improved.

An official independent review of the entire Italian greenhouse gas inventory was undertaken by the Aether consultants in 2013. Main findings and recommendations are reported in a final document, and regard mostly the transparency in the NIR, the improvement of QA/QC documentation and some pending issues in the LULUCF sector. In the same year, also an in depth UNECE review was undertaken in the context of the CLTRAP convention. In the same context, in 2017, an in depth review was done focusing on the main atmospheric pollutants to verify the compliance with the national emission ceiling directive (NECD).

[1] ISPRA, 2013.*Quality Assurance/Quality Control plan for the Italian Emission Inventor: Procedures Manual*

Also a bilateral independent review between Italy and Spain, with a focus on the revision of the GHG and air pollutant inventories of both the Parties was established in 2012. The Italian team revised part of the energy sector of Spain, specifically the categories public power plants, petroleum refining plants, road transport and off-road, whereas the Spanish team revised the industrial processes and solvent and other product use, and the LULUCF sectors of Italy. Results of these analyses are reported in a technical report[2]. Aim of the review was to carry out a general quality assurance analysis of the inventories in terms of the methodologies, the EFs and the references used, as well as analysing critical cross cutting issues such as the details of the national energy balances and comparison with international data (Eurostat and IEA), and use of plant specific information.
Moreover feedbacks occur once the inventory, the inventory related publications and the national inventory reports are posted on the website, specifically http://www.isprambiente.gov.it. Additional comments derive from the communication of data to different institutions and/or at local level.
The inventory is presented every year to the Ministry for Ecological Transition, and shared with the relevant Ministries and local authorities. Moreover a national conference is organised every year to share the main results and press news are communicated.
From 2011, a report concerning the state of implementation of commitments to reduce greenhouse gases emissions, and describing emission trend and projections, is prepared by the Ministry for Ecological Transition in consultation with other relevant Ministers. The report is annexed to the economy and financial document (DEF) to be annually approved by the Government.
Expert peer reviews of the national inventory also occur annually within the UNFCCC process; results and suggestions can provide valuable feedback on areas where the inventory should be improved. Specifically, the last in country review of the Italian GHG inventory by the UNFCC Secretariat occurred in October 2019, whereas the last review occurred in September 2021. Final results and recommendations of the reviews are available on the UNFCCC website at https://unfccc.int/sites/default/files/resource/arr2021_ITA.pdf.
Responses and actions to the review processes are described in detail in section IV.

With regard emissions projections and policies and measures, an official review was performed by Ecofys, in 2000, in order to verify of the effectiveness of policies and measures undertaken by Italy to reduce greenhouse gas emissions to the levels established by the Kyoto Protocol. In this framework, an independent review and checks on emission levels were carried out as well as controls on the transparency and consistency of methodological approaches[3]. In 2008, VITO, Öko-Institut and the Institute for European Environmental Policy, for DG Environment, undertook a review on the methodologies and EU Member States best practices used for GHG projections to identify possible ways to improve GHG projections and ensure consistency across the EU. The results were presented at the Workshop 'Assessing and improving methodologies for GHG projections'. Further analyses were presented in the Workshop on 'Quantification of the effects on greenhouse gas emissions of policies and measures'.

The preparation of environmental reports, where data are needed at different aggregation levels or refer to different contexts, such as environmental and economic accountings, is also a verification for emission trends. At national level, for instance, emission time series are reported in the Environmental Data Yearbook published by the Institute[4]. Emission data are also published by the Ministry for Ecological Transition in the Reports on the State of the Environment[5], the National Communications[6] as well as in the Demonstrable Progress

[2] AED, 2013. *Italy-Spain bilateral QA*
[3] Ecofys, 2001. *Evaluation of national climate change policies in EU member states. Country report on Italy*
[4] ISPRA, several years. *Environmental Data Yearbook*. ISPRA. http://www.isprambiente.gov.it/it/pubblicazioni/stato-dellambiente.
[5] MATT, several years. *RSA-Report on the State of the Environment*. Ministero dell'Ambiente. http://www.minambiente.it/biblioteca/relazione-sullo-stato-dellambiente-2009-sintesi
[6] MATT, several years. *National Communication under the UN Framework Convention on Climate Change*. Ministero dell'Ambiente. http://unfccc.int/files/national_reports/annex_i_natcom

report[7]. Moreover, figures are communicated to the National Institute of Statistics to be published in the relevant Environmental Statistics Yearbooks[8] as well as used in the framework of the EUROSTAT NAMEA accounting[9].
Comparisons between national activity data and data from international databases are usually carried out in order to find out the main differences and an explanation to them[10]. Emission intensity indicators among countries (e.g. emissions per capita, industrial emissions per unit of added value, transport emissions per car, emissions from power generation per kWh of electricity produced, emissions from dairy ruminants per tonne of milk produced) can also be useful to provide a preliminary check and verification of the order of magnitude of the emissions. This is carried out at European and international level by considering the annual reports compiled by the EC and the UNFCCC as well as related documentation available from international databases and outcome of relevant workshops.
Additional comparisons between emission estimates from industrial sectors and those published by the industry in the relevant Environmental reports are carried out annually in order to assess the quality and the uncertainty of the estimates.
The quality of the inventory has also improved by the organization and participation in sector specific workshops. Follow-up processes are also set up in the framework of the WGI under the EC Monitoring Mechanism, which address to the improvement of different inventory sectors. In 2008 and in 2014, workshops were held, on the implications of the implementation of the 2006 IPCC Guidelines for national GHG inventories. Other workshops addressed: the use of European emissions trading scheme data in the national greenhouse gas inventories, management of uncertainty in national inventories, methodologies to estimate emissions from the agriculture and LULUCF sectors, involving the Joint Research Centre, from the waste sector, involving the European Topic Center on Resource and Waste Management, as well as from international bunkers, involving the International Energy Agency and EUROCONTROL. Presentations and documentation of the workshops are available at the address: http://air-climate.eionet.europa.eu/meetings/past_html.
A national conference on the Italian emission inventory was organized by APAT in October 2006. Methodologies used to carry out national figures and results of time series from 1990 to 2004 were presented detailing explanations for each sector.
In 2007, in the framework of the National Conference on Climate Change, an event previous to the Conference presented the National GHG emission Inventory and specifically the time series of emission estimates from 1990 to 2005; besides a specific session of the Conference was dedicated to the National and local Inventories focusing on methodological issues and policies and measures to be adopted to reduce GHG emissions. In 2010, the time series 1990-2008 was presented in a specific national Kyoto Protocol event. In 2014, emission time series and figure for the compliance with the Kyoto Protocol were presented to the stakeholders and the press.
A specific procedure undertaken for improving the inventory regards the establishment of national expert panels (specifically, in the sectors of road transport, land use change and forestry and energy) which involve, on a voluntary basis, different institutions, local agencies and industrial associations cooperating for improving activity data and emission factors accuracy. Specifically, for the LULUCF sector, following the election of the 3.3 and 3.4 activities and on account of an in-depth analysis on the information needed to report LULUCF under the Kyoto Protocol, a Scientific Committee, constituted by the relevant national experts has been established by the Ministry for Ecological Transition in cooperation with the Ministry of Agriculture, Food and Forest Policies.

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[7] MATT, 2006. *Italian report on demonstrable progress under article 3.2 of the Kyoto Protocol*. Ministero dell'Ambiente. http://unfccc.int/resource/docs/dpr/ita1.pdf
[8] ISTAT, several years. *Annuario Statistico Italiano* . Istituto Nazionale di Statistica, Roma ,Italia
[9] ISTAT, 2006. *La NAMEA: conti economici nazionali integrati con i conti ambientali*. Istituto Nazionale di Statistica. http://www.istat.it/dati/dataset/20060301_00/.
[10] ENEA/MAP/APAT, 2004. *Energy data harmonization for CO_2 emission calculations: the Italian case*. Rome 23/02/04. EUROSTAT file n. 200245501004

In addition to these expert panels, ISPRA participates in technical working groups within the National Statistical System (Sistan). These groups, named *Circoli di qualità*, coordinated by the National Institute of Statistics, are constituted by both producers and users of statistical information with the aim of improving and monitoring statistical information in specific sectors such as transport, industry, agriculture, forest and fishing. These activities improve the quality and details of basic data, as well as enable a more organized and timely communication.

QC procedures are also undertaken on the calculations of uncertainties in order to confirm the correctness of the estimates and that there is sufficient documentation to duplicate the analysis.
The assumptions, which uncertainty estimations are based on, are documented for each category. Figures to draw up uncertainty analysis are checked with the relevant analyst experts and literature references and they are consistent with the IPCC Good Practice Guidance[11] and IPCC Guidelines[12].
Quantitative estimates of the uncertainties for the Italian GHG inventory are calculated using Approach 1 as defined in the IPCC 2006 Guidelines, which provides a calculation based on the error propagation equations. In addition, Approach 2, corresponding to the application of Monte Carlo analysis, has been applied to specific categories of the inventory but the results show that, with the information available at present, applying methods higher than Approach 1 does not make a significant difference in figures. The results of the study, 'Evaluating uncertainty in the Italian GHG inventory', were presented at an EU workshop on Uncertainties in Greenhouse Gas Inventories, held in Finland in September 2005, and they are also available on website at the address:
http://air-climate.eionet.europa.eu/docs/meetings/050905_EU_GHG_Uncert_WS/meeting050905.html.
A further research on uncertainty, specifically on the comparison of different methodologies to evaluate emissions uncertainty, was also carried out[13].
In the last years, Monte Carlo analysis was applied to some key categories of the Italian inventory and it is planned to extend the study to other inventory categories.

In point of fact, the annual QA/QC plan includes all the improvements planned to the inventory and references to the relevant documentation and information supporting the modifications at sectoral and general level. Changes are based on the observations of the different inventory review stages (internal and external evaluations by third parties involved in inventory issues), the review feedbacks received from the UNFCCC Secretariat on the previous inventory or from the European internal review, and other collected information.
Whenever relevant changes in methodologies and emission estimates for key categories are planned, new methodologies and emission factors are chosen after consultation with the national experts also in the framework of the national sectoral expert panels. Internal reviews are also undertaken, comparing different methodologies, before changes are included in the inventory.
The QA/QC plan is updated every year to re-evaluate the quality objectives of the inventory.
All the material and documents used for the inventory preparation are stored at the Institute.
Information relating to the planning, preparation, and management of inventory activities are documented and archived. The archive is organised so that any skilled analyst could obtain relevant data sources and spreadsheets, reproduce the inventory and review all decisions about assumptions and methodologies undertaken. A master documentation catalogue is generated for each inventory year and it is possible to track changes in data and methodologies over time. Specifically, the documentation includes:

[11] IPCC, 2000. *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*. IPCC National Greenhouse Gas Inventories Programme, Technical Support Unit, Hayama, Kanagawa, Japan
[12] IPCC 2006, *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan
[13] Romano D., Bernetti A., De Lauretis R., 2004. *Different methodologies to quantify uncertainties of air emissions*. Environment International vol 30 pp 1099-1107

- electronic copies of each of the draft and final inventory report, electronic copies of the draft and final CRF tables;
- electronic copies of all the final, linked source category spreadsheets for the inventory estimates (including all spreadsheets that feed the emission spreadsheets);
- results of the reviews and, in general, all documentation related to the corresponding inventory year submission.

After each reporting cycle, all database files, spreadsheets and electronic documents are archived as 'read-only' mode.
A 'reference' database is also compiled every year to increase the transparency of the inventory. This database consists of a number of records that references all documentation used during the inventory compilation, for each sector and submission year, the link to electronically available documents and the place where they are stored as well as internal documentation on QA/QC procedures.

Major QA/QC activities over the past years

Energy Balance Verification. A task force made up of energy and inventory experts (Ministry of Production Activities, ENEA and APAT) established to examine differences in basic data between the CRF and the joint EUROSTAT/IEA/UNECE questionnaire submissions and to improve the details of the National Energy Balance finalised its study and reported the results in the document "Energy data harmonization for CO_2 emission calculations: the Italian case"[14].

Carbon Emission Factors Review. A sampling and measurement campaign was carried out jointly with the Stazione Sperimentale Combustibili in order to check the CO_2 emission factors used for emission estimation in the energy sector, specifically the road transport and residential and commercial sector. Representative samples of Italian fuels, specifically gasoline, diesel oil and LPG, were collected and analysed from September 2000 - August 2001. Measurements were compared with default CO_2 emission factors proposed by the IPCC in the 1996 Revised Guidelines and those proposed by the EEA and used in COPERT III methodology. Values of national emission factors resulted higher than the default ones for gasoline and LPG, while those of diesel were lower. Emission factors have been substituted for the years 2000 onwards. The study and the results are described in detail in the APAT report[15]. The analysis was repeated in 2013 with the same methodology by Innovhub (former Stazione Sperimentale Combustibili) and carbon content and main characteristic of coal and natural gas have been added. The methodology, data sources and main results are reported in a final technical paper[16].

Road Transport Emissions Review. The Italian Expert Panel on Transport, which comprises experts from Research Institutes, Universities, Industrial Associations, Local Authorities, Ministries and Public Authorities, continues its work on the improvement and assessment of emission estimations from road transport. There has been a considerable improvement on the details of basic data to be used within the COPERT model, both in terms of availability and timeliness. Studies of the expert panel group as well as presentations held in different meetings can be found on the website http://groupware.sinanet.isprambiente.it/expert_panel.
Other Off-road Emissions Review. The whole time series of aviation emissions was recalculated as a consequence of a specific sectoral study which considered most recent trends in civil aviation both in terms of modelling between domestic and international flights and technological progress of the fleet. The methodology

[14] ENEA/MAP/APAT, 2004. *Energy data harmonization for CO_2 emission calculations: the Italian case*. Rome 23/02/04. EUROSTAT file n°200245501004
[15] APAT 2003. *Analisi dei fattori di emissione di CO_2 dal settore dei trasporti*. Ilacqua M., Contaldi M., Rapporti n°28/2003
[16] Innovhub, 2013. *Caratterizzazione chimico-fisica dei combustibili utilizzati in Italia*. Rapporto finale dicembre 2013.Innovhub-Stazione Sperimentale per i combustibili.

was applied at national and airport level and the results shared with national experts in the framework of an ad hoc working group instituted by the National Aviation Authority (ENAC). There was also a revision of the methodology to estimate emissions from the maritime sector from 2004, on account of a national study which considered most recent trends in terms of modelling between domestic and international consumptions and improvements in operational activities in harbour. Also in this case, results were presented to a working group on local air emission inventories, formed by local authorities, sectoral experts, the Ministry for Ecological Transition, and air quality model experts. In 2014 submission, a verification of activity data from different sources was undertaken. For aviation EUROCONTROL data, methodology and results for Italy have been included in the inventory from 2016 submission.

Energy – Industrial processes Review. A specific activity relating to improvements of the inventory and QA/QC practices in the last year regarded the progress on the building of a database where information collected in the framework of different European legislation, Large Combustion Plant, INES/PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. The actual figures are considered in an overall approach and used in the compilation of the inventory and resulted in verification and updated of the emission factors for many categories and gases.

F-gases Review. A review with industrial associations and the electrical company ENEL was undertaken in order to improve the quality of estimates by implementing the use of the Tier2 methodology. SF_6 estimates improved with the cooperation of the national electrical company ENEL and the main electrical associations. Specifically, for PFC emissions from aluminium production, the estimates were carried out jointly with the only national producer. A revision has also concerned HFC emissions on account of major information on the leakages made available by the European Association of Responsible Use of HFCs in Fire Fighting. In 2013, in response to the UNFCCC review process, the industrial associations have been contacted to verify f-gases emission factors from refrigeration and air conditioning in the different phases of the process from the production to the end of life of gases and appliances. A detailed analysis at sectoral level was carried out in 2017 and 2018 contacting the relevant operators to study the effect on the market of the implementation of the EU F-gases regulation and in this context additional technical information including past and new emission factors has been collected.

Agriculture Review. Since 2006 submission, the main improvements regard the results from the MeditAIRaneo project which have been included in the preparation of the Agriculture emission inventory (GHG/CLRTAP) with effect especially on CH_4, N_2O and NH_3 emissions. Besides, studies on NH_3 and PM10 emissions from swine and poultry within the convention signed between APAT and the Ministry for Ecological Transition, were carried out by CRPA[17] and University of Milan[18]. At the end of 2009 another research study related to land spreading estimations and scenario was completed[19].

LULUCF Review. The ongoing work of the established expert group and the analysis of data from the new national inventory forest allowed continuous improvements of LULUCF emission and removal estimates. In particular the land use assessment has been carried out on the basis of new set of data (i.e. outcomes of Inventory of Land Use (IUTI) and areas assessment resulting from the ongoing National Forest Inventory

[17] CRPA, 2006[b]. *Predisposizione di scenari di emissione finalizzati alla progettazione di interventi per la riduzione delle emissioni nazionali di ammoniaca ed alla valutazione di misure e di progetti per la tutela della qualità dell'aria a livello regionale*. Final report. Reggio Emilia - Italy

[18] University of Milan, 2008. *Valutazione dei fattori di emissione di particolato e dei gas serra (protossido d'azoto, anidride carbonica, metano) ed ammoniaca, in relazione alle tecniche di abbattimento di inquinanti atmosferici*. Rapporto finale gennaio 2008. L'Università degli Studi di Milano - Dipartimento di Scienze e tecnologie Veterinarie per la Sicurezza Alimentare di Milano

[19] CRPA. 2009. *Valutazione dell'entità delle emissioni ammoniacali derivanti dall'applicazione al suolo dei fertilizzanti, delle loro possibilità di riduzione e individuazione degli elementi per un monitoraggio statistico delle tecniche di applicazione utilizzate*. Rapporto finale. Reggio Emilia – Italia.

(NFI). The coefficients used in the estimation process for the litter pool in the relevant categories were updated following the inclusion of latest NFI's outcomes. Activity data related to organic soils, in cropland category, has been updated and plantations have been excluded from cropland and have been allocated in forest land category. Recalculations also occurred in fires estimates, due to the implementation of the new methodology and to the use of updated activity data.

Waste Review. In 2013 a database of incinerators has been built with data collected from different sources resulting in update of previous sectoral estimates. The analysis regarding incineration plants has been conducted through verifications and comparisons with data reported in E-PRTR registry, Emissions Trading Scheme and data collected directly from the operators updating data of waste amount and pollutants emissions at plant level. On the basis of the recent ESD reviews some insights have been made on country specific conditions regarding solid waste disposal, composting and anaerobic digestion sites.

MeditAIRaneo Project. A three years project involving the Inventory Reference Centres of the European Mediterranean Countries (Italy, Spain, France, Greece, Portugal) started at the end of the year 2000. The aim was to examine in details emissions that are specific and/or typical of the Mediterranean Countries. Four different studies on air emissions from vegetation, agriculture, solvent use and urban road transport in Mediterranean areas were funded by APAT. Common objectives are analysis of methodologies and emission factors used by Mediterranean countries for estimating emissions, individuation of Mediterranean peculiarities, in comparison with other European countries, such as climate, technologies, industrial management, identification of methodological points which need in-depth examination and uncertainty assessment. An Italian case study has been developed for each of the four projects. In 2006, all the projects concluded and the results have been used in the national inventory to improve country-specific emission factors.

Emissions Trading Scheme. Analyses of sectoral industrial data from the Italian Emission Trading Scheme database are used to develop country-specific emission factors and check activity data levels. ETS data have been used together with additional information collected by the industrial association to assess CO_2 emissions abatement resulting from the implementation of the II phase EU ETS in Italy as well as for the definition of the benchmark in the III phase of EU ETS and the final communication to the EU for benchmark and carbon leakage for the years 2009 and 2013. In this context, additional information has been elaborated data provided by the industry to assess the sectors subjected to potential carbon leakage and relevant benchmarks.

European Pollutant Release and Transfer Register (E-PRTR). Data from the Italian Pollutant Emission Register from some industrial sectors are used in the inventory compilation or as a check with the estimates carried out at national level. In particular, this regards the production of non-ferrous metals, chemical productions, cement and lime productions and the production of iron and steel.

Local inventories. A study on the top-down approach to the preparation of local inventories was conducted and Italian emissions for different local areas were derived. In 2013, ISPRA finalised the provincial inventory at local scale for the years 1990, 1995, 2000, 2005, 2010[20]. The results were checked out by regional and local environmental agencies and authorities in order to find out the main weak points and contribute with information available to characterise the local environment, this contributing as well as a feedback to the improvement of the national inventory. Final estimates and the detailed methodologies followed for each SNAP sector to carry out emission figures are published in technical reports[21]. In 2021, the provincial inventory

[20] ISPRA, 2013. *Database della disaggregazione a livello provinciale dell'Inventario nazionale delle emissioni:1990-1995-2000-2005-2010*. Istituto Superiore per la Protezione e la Ricerca Ambientale, ISPRA

[21] Liburdi R., De Lauretis R., Corrado C., Di Cristofaro E., Gonella B., Romano D., Napolitani G., Fossati G., Angelino E., Peroni E., 2004. *La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni*. Rapporto APAT CTN-ACE 2004

at local scale for the years 1990, 1995, 2000, 2005, 2010, 2015 and 2019 was finalized[22] and the report is under finalization.

Planned improvements

Specific improvements are identified in the relevant chapters of the QA/QC plan; and they can be summarized in the following.

For the energy and industrial sectors, the database where information collected in the framework of different EU legislation, Large Combustion Plant, E-PRTR and Emissions Trading, is annually updated and improved. The database has helped highlighting the main discrepancies in information and detecting potential errors leading to a better use of these data in the national inventory.
Improvements for road transport sector will be connected to the availability of information regarding activity data, calculation factors and parameters, development of the methodology and update of the software. In particular, an improvement is planned regarding a general review of mileages and speed values with reference to a better distribution between the vehicles categories and driving conditions, subject to the total fuel balance between the sales of national fuels and the estimated total consumption.
For the agriculture and waste sectors, improvements will be related to the availability of new information on emission factors, activity data as well as parameters necessary to carry out the estimates; specifically, for agriculture, further improvements are expected for the grazing, housing, storage systems and land spreading, while for waste sector the availability of additional information on waste composition.
The improvement of the waste production and management database, handled by another unit of ISPRA, is ongoing, facilitating the extrapolation and elaboration of the huge amount of information contained in the database and facilitating the analysis of information useful for the inventory compilation (e.g. waste composition).
For the LULUCF, final results of the third NFI will allow using of IPCC carbon stock change method to estimate emissions and removals for forest land remaining forest land category.

Additional studies will regard the comparison between local inventories and national inventory and exchange of information with the 'local inventories' national expert group.
Further analyses will concern the collection of statistical data and information to estimate uncertainty in specific sectors by implementing Approach 2 of the IPCC guidelines. In this regard, we plan to reassess the uncertainty for the same categories reported in the annex of the NIR because these are the main categories for which the analysis makes sense in consideration of the information available on parameters and underlying distributions. We will try to extend the analysis to some other key categories in the IPPU sector (chemical and mineral).

APAT/ARPA, 2006. *Confronto tra l'Inventario Nazionale e gli Inventari Locali*. Realizzato nell'ambito del tavolo interagenziale "Inventari delle emissioni e piani di risanamento della qualità dell'aria"
ISPRA, 2009. *La disaggregazione a livello provinciale dell'inventario nazionale delle emissioni*. Anni 1990-1995-2000-2005. ISPRA, 92/2009
[22] http://emissioni.sina.isprambiente.it/serie-storiche-emissioni/

QA/QC ENERGY
2024 ACTIVITIES AND FUTURE IMPROVEMENTS

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NATIONAL AIR EMISSION INVENTORY: ENERGY

Objective

The improvements carried out during the preparation of the 2024 national inventory submission for the energy sector and those expected for the next future are summarised in the following.

Review process recommendations

In the following table, the issue raised and responses provided to the recommendations, for the Energy sector, during the last UNFCCC review process (as described in the report of the individual review of the annual submission of Italy submitted in 2022[23]), then implemented, are reported.

Table 1. *Issue raised for the Energy sector during the UNFCCC review in 2023*

CRT category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
1.B.2.a Oil – liquid fuels – CH4	During the review, the ERT noted a significant inter-annual change between 2015 and 2016 of –60.13 per cent for CH4 emissions from oil production (CRF table 1.B.2.a) due to recalculation of the emissions. The ERT welcomes the Party's detailed explanation and recommends that the Party include in its NIR information provided during the review that explains why updating CH4 EFs for oil production would not reflect the actual state of emissions prior to 2016.	E.4	Additional information has been included in the NIR.	Chapter 3
1.B.2.a Oil – natural gas liquids – CH4 1.A(a) - – natural gas	During the review, the ERT noted that for 2020, IEA has reported natural gas liquid consumption of about 412 TJ, while the CRF tables 1.A(b) and 1.A(d) report no apparent consumption for this fuel, leading to a 100 per cent difference between the two data sets. ... The ERT recommends that the Party investigate production and use of natural gas liquids in Italy and if the activity does occur, report activity data and emissions, both for fugitive as well as for combustion emissions, with respect to refinery operations.	E.5	Natural gas liquid has been made explicit among fuels reported in the reference approach since 2020. In previous years it was included in the crude oil. As concern this category we verified that the amount of natural gas liquid is already included in the activity data so that no changes are due.	Chapter 3

During last ESD technical review process, in 2022, 5 issues have been raised during step 1 for Energy and no unresolved issues have been forwarded to step 2, no revised estimates or technical corrections were deemed necessary[24]. Anyway, issues identified during the review have been taken into account as much as possible to improve the current submission.

Under the European National Emission Ceiling Directive (NECD), an in-depth review has been conducted since 2017. The main resulting findings and how the recommendations were addressed for Energy sector in 2024 review process are reported in **Errore. L'origine riferimento non è stata trovata.**[25].

[23] UNFCCC, 2022. Report on the individual review of the annual submission of Italy submitted in 2022. Note by the expert review team. https://unfccc.int/documents

[24] EEA 2022, Final Review Report, 2022 annual review of national greenhouse gas inventory data pursuant to Article 19(2) of Regulation (EU) No 525/2013

[25] UNECE 2024, Final Review Report 2024, Review of National Air Pollutant Emission Inventory Data 2024 under Directive (EU) 2016/2284 (National Emission reduction Commitments Directive)

Table 1. *Response to the NECD review process recommendations in 2024*

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE, TC, or UPTC in 2024	Implementation
IT-1A3bii-2024-0001	Yes	1A3bii Road transport: Light duty vehicles, NO_X, 2021	For category 1A3bii Road Transport: Light Duty Vehicles, NOX, 2021, the TERT notes that significant recalculations have been applied (>10% change) and there is a lack of transparency in the IIR, specifically in section 3.5.6 Recalculation (pg. 101). In response to a question raised during the review, Italy explained that the time series of road transport emissions has been revised based on the upgrade of COPERT model version, from version 5.6.1 to 5.7.3, in the 2024 submission. Among the various updates, a rebalancing of mileage between light duty vehicles and heavy-duty vehicles has occurred due to availability of revised road freight transport data. This update has entailed a reduction in light duty vehicles and the recalculation in NOX emissions. **The TERT recommends that Italy include detailed description of the recalculations and the implications for light duty vehicles in the next IIR submission to improve transparency.**	NO	Implemented, more info in the IIR
IT-1A3di(i)-2023-0003	No	1A3di(i) International maritime navigation - Memo Item, PM2.5, SO2, 2021	For category 1A3di(i) International maritime navigation - Memo, PM2.5, SO2, 2021 and 2022, the TERT notes that there is a lack of transparency regarding the changes in sulphur content in fuels over time to estimate emissions from maritime activities in the 2024 IIR Guidebook, specifically in 3.7.2 Methodological issues (pg 104). This was raised during the 2023 NECD inventory review. In response to a question raised during the review, Italy explained that fuel oil represents 98% of the total international fuel consumption along the time series, and that this information has been added to the IIR. In addition, Italy points out that the sulphur content has been erroneously reported equal to 0.3% (IIR, pg 105, states 'For international navigation 0.3% of sulphur content in fuel oil has been assumed for the whole time series'). The correct sulphur content value is 3%. **The TERT reiterates the recommendation that Italy improve the description on how the sulphur content in fuels for maritime activities changes over time.**	NO	Implemented, more info in the IIR

In 2024, under the UNECE LRTAP Convention, a stage 3 ad-hoc review of emission inventories has been carried out, which resulted neither a revision of estimates nor technical corrections for Energy sector, being focused on 'industrial processes and product use – solvents' sector[26].

The NIR and IIR report additional information about the last review processes (e.g UNFCCC[23] and UNECE[25,**Errore. Il segnalibro non è definito.**]), addressing the recommendations of the review teams.

Inventory improvements and QA activities

Documentation collected in the framework of the different European Directives, and Regulations (E-PRTR, Large Combustion plants and the Emissions Trading scheme) has been completely integrated in a unique

[26] UNECE 2024, Report for the Stage 3 ad-hoc review of emission inventories submitted under the UNECE LRTAP Convention: 2024 Italy FINAL REPORT

informative system, with the aim to verify emissions and activity data reported for the same year under different reporting obligations and identify possible improvements in emission estimations. A further use of this database has regarded the calculation at plant level of emission estimates of other pollutants than greenhouse gases. This activity has been implemented also in view of the submission of national emission figures of other pollutants which have to be communicated in the framework of the EMEP-CLRTAP Convention at 0.1°×0.1° degree scale. Emissions at point source level have been therefore derived for the energy and industrial sectors, refining figures previously attributed at local level by a top-down approach. In the framework of CLRTAP, every five years (four from 2015) emissions are disaggregated at regional and provincial level; for 2019 and previous years data collected from point sources have been analysed and elaborated allowing the distribution of emissions at local level. Results are compared with those obtained by regional bottom-up inventories. Emissions disaggregated at local level are also used as input for air quality modelling. Final results are useful to highlight the most critical areas in the Italian Regions.
In 2025 submission, recalculations affected the years 2021 and 2022 because of the update of non ferrous metal activity data and lime production. CH_4 and N_2O emissions from charcoal production from 1A1 have been included considering the methodology in the 2019 IPCC refinements.
For 1.A.2 category some recalculations in 2022 are due to the update of activity data reported in the National Energy Balance or in production activity data. Recalculations greater than 1% occurred in 2022 for NO_X (-7.8%) and NH_3 (-14.1%) because of the update of the relevant emission factors from cement production; for PM10 (+1.0%) because of the update of lime production activity data; for Hg (-1.1%) and Pb (+2.6%) because of the update of the emission factor from lead and zinc production. As regards lead and zinc production in Italy there is a sole integrated plant for the primary productions and the consultation of environmental permits and data declared in the EPRTR framework led to a gap filling operation and therefore to minor recalculations for the years 2014-2018 and 2020-2022.
As regards aviation, no recalculations have been carried out in 2025 submission; over the years verification and comparison activities covered aviation activity data and emission factors. In particular, number of flights have been compared considering different sources: ENAC, ASSAEROPORTI, ISTAT, EUROCONTROL and verification activities have been performed on the basis of the updated EUROCONTROL data on fuel consumption and emission factors resulting in an update and improving of the national inventory.
The whole time series of road transport emissions has been recalculated mainly as a result of the upgrade of COPERT model version used, from version 5.7.3 in last submission to 5.8.1 in submission 2025 (EMISIA, 2024). Main methodological innovations introduced in version 5.8.1 respect to version 5.7.3 , used in last submission, relate: the introduction of Euro 7 vehicles; the introduction of Euro VI CNG & LNG HDVs; the revision of CO, EC, SPN23, NOx of Euro 6 HEV/PHEV; the revision of VOCs speciation of Euro 5/6 petrol & diesel LDVs; the revision of EC of BEVs; the revision of cold PM & BC of Euro 5/6 petrol, diesel & CNG LDVs; the revision of EC of Euro 6 LPG cars; the revision of Euro 5 motorcycles. As regards the software, revisions relate: the extension of the functionalities of the Command Line Interface regarding ability to point to an existing .cop file, all pollutants, mileage degradation; the Energy Consumption from A/C for battery electric cars. In addition, the following bugs have been solved: share of cold CH_4 and NMVOC over VOC for Euro 6 LDVs; hot CH_4 emission factors of LPG cars; PM, PN emission factor of CNG/LPG Euro 5 & 6 vehicles; minor issues. With respect to the last submission, the following vehicle categories have been introduced: Battery electric Light Commercial Vehicles, CNG and LNG Heavy Duty Trucks, Battery electric Buses.
Over the years, an inventory improvement process in the road transport sector was activated as part of the activities of the Transport expert panel, at national and international level, in order to improve the activity data and the accuracy of the emission factors. Besides, over time recalculations of transport time series estimates have been discussed with national experts in the framework of an *ad hoc* working group on air emissions inventories, chaired by ISPRA.
For 1A3c Railways, recalculations occurred in 2025 submission because of the updating of PM10 and PM2.5 emission factors for 2021 and 2022.
As regards navigation, recalculations respect to the previous submission occurred: ISTAT reviewed the number of ships arriving in Italian ports in 2022; therefore, emissions have been updated accordingly.
In 2025 submission, some recalculations affected 1A4 category. Recalculations occur in 2021 and 2022 because of the update of activity data for incineration with energy recovery resulting in a variation of -0.03% in 2022 for CO_2 in 1A4; minor recalculations occur in 1A4a because of the update of historic data for one incineration plant with energy recovery resulting in some negligible changes for the years 2002, 2008-2010

(always < 0.1% for CO_2, CH_4 and N_2O). Major differences have been found in 2022 because of the update of activity data resulting in -16% for HCB and -10% for PCB emissions, for other pollutants recalculations are less than ±0.5%. Minor recalculations have occurred throughout the time series because of the update of historical data of a single plant in the years 2002 and 2006-2010. More, the reconstruction of old info about the other plant led to recalculations on dioxins emission in the years 1995-2000, 2002, 2005-2010 with differences from -3% in 1995 to -43% in 2007, year for which a bug was fixed.
As regards feedstock and non-energy use of fuels, in 2025 recalculations occur because of the implementation of the updated national energy balance data.
With regard to fugitive emissions, minor recalculation occurred in 2022 due to the update of amount of distributed natural gas (source 1.B.2.b); recalculations affect CO_2 and CH_4 emissions, with 0.1 Mg and 3 Mg respectively more emissions compared to the previous submission. The recalculations affect total CO_2eq emissions by +0.0017% in 2022 compared to the previous submission. Recalculations occured for NMVOC emissions in 2022 from liquid fuel distribution because of the update of activity data resulting in a variation equal to +1.9%.

Planned improvements

In this paragraph further improvements identified during the preparation of the National Inventory, National Inventory Report 2025 and of the Informative Inventory Report 2025 are presented.
For the energy sector, a major progress regards the management of the information system where data collected in the framework of different obligations, Large Combustion Plant, E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors. Moreover, the complete use of the energy data provided by the Ministry of Environment to the Joint Questionnaire IEA/OECD/EUROSTAT is planned in substitution of the national energy balances used in the past; liquid, gaseous and solid fuel are now aligned for the whole time series and it is in plan for next submission to update as possible renewable fuels and biomass. With respect to PM10 and heavy metals emissions from Public Electricity and Heat Production category (1A1a) while PM10 emissions are updated every year on the basis of data submitted by the plants in the framework of the EPRTR registry, Large Combustion Plants Directive and Environmental Reports, heavy metals emission factors time series have been reconstructed from 1990 to 2001 on the basis of a study conducted by ENEL (major company in Italy) which reports heavy metals emissions measurements by fuel and technology (with or without PM10 abatement technologies) of relevant national plants. From 2001 these emission factors have not been updated. Heavy metals emission data in the EPRTR registry refer only to few not representative plants and are not sufficient to calculate average emission factors. Further work is planned to update/change emission factors for those pollutants where figures reported in the EPRTR lead to average values significantly different from those actually used. As regards 1.A.2, following the update of lead and zinc production the reconstruction of the time series ante 2014 is planned to ensure the consistency. For the energy sector, a major progress regards the management of the information system where data collected in the framework of different obligations, Large Combustion Plant, E-PRTR and Emissions Trading, are gathered together thus highlighting the main discrepancies in information and detecting potential errors.
Improvements consist also of the use of data and country specific emission factors collected in national research involving road transport and biomass consumption in residential sector.
As regards 1.A.3.a, improvements for next submissions are planned on the basis of the outcome of the ongoing quality assurance and quality control activities, in particular with regard to the results of investigation about data and information deriving from different sources, in particular further assessment of EUROCONTROL data, and comparison with information provided by the national institute of statistics, ISTAT, on the number of flights.
Improvements regarding 1.A.3.b for next submission will be connected to the possible new availability of data and information regarding activity data, calculation factors and parameters, new developments of the methodology and the update of the software.
No specific improvements for 1A3c are planned for next submission.
As regards maritime activities, improvements will regard a verification of activity data on ship movements and emission estimates with the National Institute of Statistics. In particular it is in plan to build an emission estimation database calculating every year emissions at harbour level taking into account the information officially provided by Italy to Eurostat per type of ship, class of tonnage and movement statistics.

The updating of average emission factors for 1A4 will continue in future submissions on the basis of the surveys on wood consumption and combustion technologies planned by ISTAT on fuel consumptions as well as from the results of an emission factor measurements campaign realized in Italy (ALTROCONSUMO, 2018), and the measurements campaign on advanced stoves completed by Innovhub. An in-depth analysis of emission factors resulting from these experimental studies and their comparison with the values suggested by the last version of the EMEP/EEA Guidebook (EMEP/EEA, 2023) will be carried out and emission factors will be updated as needed.
No specific improvements are planned for 1.B.

Table 2. Planned improvements

Category	Subcategory	Parameter	Gas	Description	Timing
Cross-cutting	Energy balance	AD		A working group of ISPRA and Ministry of Industry is investigating about the consistency and validation of the consumption data time series reported in the national energy balance in Eurostat format.	2024 - 2025
1.A.1a	Public electricity and heat production	EFs	HMs	Further work is planned to update/change emission factors for those pollutants, as zinc, where figures reported in the EPRTR lead to average EFs significantly different from those used.	2024 - 2025
1.A.3.b	Road transport	EFs	GHG and air pollutants	An in-depth analysis of emission factors resulting from national studies about road transport is planned, and the comparison with the values suggested by the last version of the EMEP/EEA Guidebook is in plan, so to update emission factors as needed.	2023 - 2025
1.A.3.d	Maritime Navigation	EFs	NOx, HC, CO, PM	Improvements will regard a verification of activity data on ship movements and emission estimates with the National Institute of Statistics. In particular it is in plan to build an emission estimation database calculating every year emissions at harbour level taking into account the information officially provided by Italy to EUROSTAT per type of ship, class of tonnage and movement statistics.	2023 - 2025
1.A.4.b	Biomass consumption in residential	AD and EFs	GHG and air pollutants	An in-depth analysis of activity data and emission factors resulting from national studies about biomass consumption in residential is planned, and the comparison with the values suggested by the last version of the EMEP/EEA Guidebook is in plan, so to update emission factors as needed.	2023 - 2025

QA/QC INDUSTRIAL PROCESSES AND PRODUCT USE
2024 ACTIVITIES AND FUTURE IMPROVEMENTS

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NATIONAL AIR EMISSION INVENTORY: INDUSTRIAL PROCESSES AND PRODUCT USE

Objective

The improvements carried out during the preparation of the 2025 national inventory submission for the industrial processes sector and those expected for the next future are summarised in the following.

Review process recommendations

In the following tables, issues raised during the last review processes and related to the industrial processes sector are reported; improvements implemented for each subject are also included.
Table 1 describes the responses to the recommendations under the UNFCCC review process; reported recommendations are those included in the last review report for Italy by UNFCCC in 2023.

Table 1. *Response to the UNFCCC review process recommendations*

CRF category /issue	Review recommendation	Review report /paragraph	MS response / status of implementation	Chapter/section in the NIR
IPPU 2.B.1 Ammonia production CO_2 Transparency	The ERT recommends that Italy investigate the reasons for the difference between apparent consumption and the amount of urea used in the inventory and include the results of this investigation in the NIR.	I.1	Resolved. The Party reported in its NIR that it is continuing to investigate the final uses of urea in Italy and the amount of urea used in the inventory against apparent consumption. The ERT notes that information about final markets of urea in Italy is updated and emissions sources (selective catalyst reduction engines; nitrogen oxides abatement systems and fertilizers) are clearly described in the NIR.	Chapter 4 paragraph 3
IPPU 2.D.3 Other non-energy products from fuels and solvent use – CO_2 Convention reporting adherence	Present national totals with and without indirect CO2 emissions in CRF table summary 2.	I.2	The national totals have been reported both with and without indirect emissions in the NIR and relevant information has been added to improve the transparency.	Chapter 2
2.D.3 Other (non-energy products from fuels and solvent use) – CO_2 Convention reporting adherence	The ERT recommends that the Party report indirect CO_2 emissions in CRF table 6 as “IE” instead of “NO”.	I.3	The notation key has been changed	

Conclusions from step 1 of the 2022 annual ESD review did not identify any significant issues, consequently Italy has not been subject to a second step of the 2022 annual ESD review.

Table 2 reports responses to the recommendations under the review of the European National Emission Ceiling Directive (NECD) conducted in 2023.

Table 2. *Response to the NECD review process recommendations*

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-2D3b-2022-0001	No	2D3b Road paving with asphalt, NMVOC, 1990-2021	For 2D3b Road paving with asphalt and NMVOC for all years, the TERT notes that there is a lack of transparency regarding the methodology used to estimate emissions. This was raised in the 2022 NECD inventory review. In response to a question raised during the review Italy stated that there was still discussion about the emission factor and did not provide a revised estimate. The TERT decided to calculate a technical correction for the 2005 and 2019-2021, which was accepted by Italy. The estimates demonstrate that the issue is above the threshold of significance. The TERT recommends that Italy include a revised emission calculation in the 2024 submission.	TC	Implemented
IT-2A5a-2017-0001	No	2A5a Quarrying and mining of minerals other than coal, PM2.5, PM10, 1990-2021	For 2A5a Quarrying and mining of minerals other than coal PM2.5 and PM10 for all years, the TERT identified a potential under-estimate exceeding the threshold of significance. This was also raised during the 2017, 2018, 2019, 2020, 2021 and 2022 NECD inventory review. The TERT noted that Italy had partly implemented the estimate that was the outcome of a recommendation in the 2022 NECD review, but also noted that the reported PM2.5 emissions were higher than the PM10 emissions. In response to a question raised during the review, Italy acknowledged that there was a factor 1000 error. Italy provided a revised estimate for 1990-2021, and stated that it will be included in the 2024 submission. The TERT agreed with the revised estimate provided by Italy. The TERT recommends that Italy include the revised estimate in the next submission.	RE	Implemented
IT-2D-2023-0001	No	2D Non energy products from fuels and solvent uses, NMVOC, 2017, 2021	For 2D3e Degreasing and NMVOC for 2017 and 2021, the TERT notes that there is a lack of transparency regarding the activity data (AD) and EFs reported in the IIR, and activity data and NMVOC emissions reported in NFR tables. The values of AD reported in the IIR on p.147 for 2017 and 2021 are the same (2,248,707 Mg product) and the value for 2021 differs to that reported in the NFR table (2,602.385 kt), also EF for 2021 in the IIR	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			Table 5.6 p.148 (1,000,000 g/Mg solvents) differ from the IEF (700,000 g/Mg solvents) calculated from values of AD and NMVOC emission reported in NFR tables. In response to a question raised during the review, Italy explained that there was a mistake in the two tables reported in the IIR, and that emission estimates and AD in the NFR table are correct, and as a proof they sent an Excel file. The TERT notes that this issue is related to a lack of transparency regarding activity data and EFs reported in the IIR. The TERT recommends that Italy correct the errors identified in the IIR and ensures consistency between the information presented in the IIR and the data reported in the NFR in the next submission.		
IT-2D3a-2023-0002	Yes	2D3a Domestic solvent use including fungicides, NMVOC, 2016-2021	For 2D3a Domestic solvent use including fungicides and NMVOC for 2016-2021, the TERT notes that there is a lack of transparency regarding activity data and EFs reported in the IIR and activity data and NMVOC emissions reported in NFR tables. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that there has been an error in the tables reported in the IIR and sent corrected activity data set and used EFs. The TERT recommends that Italy correct the errors identified in the IIR and ensures that the information provided in the IIR is correct and consistent with the information in the NFR of the next submission.	No	Implemented
IT-2D3a-2023-0001	Yes	2D3a Domestic solvent use including fungicides, NMVOC, 2020	For 2D3a Domestic solvent use including fungicides and NMVOC for 2020, the TERT notes that there is a lack of transparency regarding significant recalculations that took place (e.g. -33.2 %; from 126.84 kt to 84.77 kt in 2020 for NMVOC) in the IIR for this key category. In response to a question raised during the review, Italy explained that there has been an update of the activity data for domestic solvent use, sum of cleaning and cosmetics products (the update refers to the data on the production of cosmetics), and by mistake, the description of this recalculation had not been included in the IIR. This does not relate to an over- or under-estimate of emissions. The TERT recommends that Italy identify and explain any recalculations in the IIR of the next submission.	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-2D3d-2023-0002	Yes	2D3d Coating applications, NMVOC, 1990-2021	For 2D3d Coating applications and NMVOC for 1990-2021, the TERT notes a potential over/under-estimate due to differences in reporting activity data and emission factors in the IIR and in NFR tables. The TERT checked NMVOC emission estimations from the AD and EFs reported in the IIR for a few years and got the following differences when data in the IIR with emissions reported in the NFR tables: for 2005 the difference is -23.45 kt, for 2015 there is no difference, for 2016 the difference is -24.86 kt, for 2020 the difference is -4.74 kt, for 2021 the difference is -26.42 kt. In response to a question raised during the review, Italy explained that there has been an error in the tables reported in the IIR and sent corrected activity data sets and used EFs, documenting that the emissions reported in the NFR tables are correct. This does not relate to an over- or under-estimate of emissions. The TERT recommends that Italy correct the errors identified in the IIR and ensures that the information provided in the IIR of the next submission is correct and consistent with the data reported in the NFR tables.	No	Implemented
IT-2D3d-2023-0001	Yes	2D3d Coating applications, NMVOC, 2020	For 2D3d Coating applications and NMVOC for 2020, the TERT notes that there is a lack of transparency regarding not providing an explanation for significant recalculations that took place (e.g. -12.9 %; from 134.87kt to 117.54 kt in 2020 for NMVOC) in the IIR for this key category. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that the recalculations occurred on account of an update of activity data for vehicles production, and by mistake, the description of this recalculation has not been included in the IIR. The TERT recommends that Italy identify all recalculations and provides explanations in the IIR of the next submission.	No	Implemented
IT-2D3i-2023-0002	Yes	2D3i Other solvent use, NMVOC, 1990-2021	For 2D3i Other solvent use and NMVOC for 1990-2021, the TERT notes that there is a lack of transparency regarding the activity data and EFs reported in the IIR, and activity data reported in the NFR tables. The TERT notes that Italy reports the same value of 9,000 with no activity units in the NFR table, but in the IIR on p. 147 there are time	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			series of 7 different activities that do not sum to 9,000. The TERT also notes that the numerical value for Application of glues and adhesives, Domestic solvent use (other than paint application), Vehicles dewaxing are exactly the same in the year 2017 and 2021. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that the value 9,000 refers to the activity data of one single category (kt creosote oil consumption) and not to all the categories. Emissions are estimated under 2D3i for application of glues and adhesives, glass wool enduction, fat oil extraction, preservation of wood and vehicle dewaxing. Italy stated its intent to provide information on methods and activity data and EFs in the IIR of the next submission. The TERT recommends that Italy include information on activity data and emission factors and ensures that there are no inconsistencies between data reported in the NFR tables and the IIR of the next submission.		
IT-2G-2023-0001	Yes	2G Other product use, SO2, NOX, NH3, NMVOC, PM2.5, PAHs, Cd, Pb, PCDD/F, PM10, CO, TSP, 1990-2021	For 2G Other product use and all pollutants for all years, the TERT notes that there is a lack of transparency regarding reporting of activity data and emission factors used for the emission estimations. In the NFR tables AD is reported with notation key 'NA' (Not applicable), in the IIR Italy reports that emissions occurring from use of lubricants, tobacco and fireworks but without time series for these activities. In the IIR there is no information on the use of shoes, which is included in 2G. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that these activity data cannot be summed, and that emissions from the use of shoes are included in 2D3i Other solvent use (use of glues and adhesives). Italy provided the TERT with the activity data and emissions for each activity included in 2G, and stated that it would be included in the IIR in the future. The TERT recommends that Italy include this information on activity data and emission factors in the IIR of the next submission.	No	Implemented

Inventory improvements and QA activities

Other improvements not identified during the review process have been carried out.

CO_2 emissions have been checked with the relevant industrial associations. Both activity data and average emission factors are also compared every year with data reported in the national EPER/E-PRTR registry and in the European emissions trading scheme (EU-ETS). Under the EU-ETS, operators are requested to report activity data and CO_2 emissions as information verified and certified by auditors who check for consistency to the reporting criteria. Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared to the information provided by the industrial associations. In particular, comparisons have been carried out for cement, lime, limestone and dolomite, and glass sectors. The general outcome of this verification step shows consistency among the information collected under different legislative framework and the information provided by the relevant industrial associations. Information reported under the EU-ETS has allowed for estimating CO_2 emissions from other uses of soda ash, the whole time series is included in the present submission and allocated under the "Other processes use of carbonates" category. Emissions from adipic acid, nitric acid, ammonia and other chemical industry production have been checked with the relevant process operators and with data reported to the national EPER/E-PRTR registry. Emissions and activity data for adipic acid, nitric acid and ammonia productions have also been checked against the relevant information reported by operator to the national competent authority for the ETS, the resulting consistency of both emissions and activity data for those sectors is the outcome of this control. Emissions from fluorochemical production have been checked with data reported to the national EPER/EPRTR registry.

Also, emissions from the metal sector are checked with the relevant process operators. Emissions from magnesium foundries are annually compared with those reported in the national EPER/E-PRTR registry while for the iron and steel sector emissions reported in the national EPER/E-PRTR registry and for the Emissions Trading Scheme are compared and checked.

To solve the issue of the allocation of emissions of the integrated Pb and Zn plant (not only about combustion and process but also about the different productions of different metals in the same factory) a depth investigation of the integrated facility has been started on the basis of E-PRTR and IPPC permits. The first result of this investigation has been the update of the emissions since 2014 up to now and the EFs. The analysis of IEAs (Integrated Environmental Authorization) and the comparison with other sources of activity data and emissions and EMEP/EEA Guidebook, has allowed the identification of any inconsistency and the production of estimates.

Air conditioning category, as well as refrigeration, foam blowing, fire extinguishers and aerosols has been analyzed with experts of the national associations, in the framework of the study planned by the agreements with the Ministry of Environment for a survey, about HFCs alternative substances with low GWP, natural refrigerants and alternative technologies. Besides, a continuous sharing of information between the experts of the national association and the Inventory team is ongoing by enabling both the collection of new data and the verification and updating of those used to date.

In January 2019 the new National Telematic Registry of fluorinated greenhouse gases and equipment containing fluorinated gases that has been instituted by the DPR 146/2018, entered in force. ISPRA started to check data of the Registry and, from a first analysis, it emerged that the information contained is not always in the form and at the level of detail useful for estimating of the Inventory. ISPRA is working with the Responsible of the Registry to try to overcome some of the issues that have emerged after an initial check of the database.

For that regard the use of solvent categories in the framework of the MeditAIRaneo project, ISPRA commissioned to Techne Consulting S.r.l. a survey to collect national information on emission factors in the solvent sector. The results, published in the report "*Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*"[27] have been used to verify and validate the emission estimates.

ISPRA commissioned to Techne Consulting S.r.l. another survey to compare emission factors with the last update published in the EMEP/EEA guidebook[28]. The results are reported in "*Fattori di emissione per l'utilizzo*

27 TECHNE, 2004. *Progetto MeditAiraneo. Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*. Rapporto Finale, novembre 2004

28 EMEP/EEA, 2009. *Air Pollutant Emission Inventory Guidebook*. EEA. Technical report No 9/2009

di solventi"[29]) and have been used to update emission factors for polyurethane and polystyrene foam processing activities.
In addition, for paint application, data communicated from the industries in the framework of the EU Directive 2004/42, implemented by the Italian Legislative Decree 161/2006, on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products have been used as a verification of emission estimates. These data refer to the composition of the total amount of paints and varnishes (water and solvent contents) in different subcategories for interior and exterior use and the total amount of products used for vehicle refinishing and they are available from the year 2007.

Planned improvements

In the following, specific improvements and remarks to be taken into account in the next submission of the national air inventory for IP sector are reported. Planned improvements include also the findings identified in the CLRTAP/UNECE review process.
Periodically, further improvements can result from the analysis of the different databases. The inventory team integrates the documentation collected in the framework of the different pieces of European legislation (EPER-E PRTR, Large Combustion Plants and Emission Trading Scheme) with the aim to verify emissions and activity data reported for the same year under different reporting obligations and to identify possible improvements in emission estimations. In the framework of EU-ETS, CO_2 emissions are checked with the relevant industrial associations at national level.
Both activity data and average emission factors are also compared every year with data reported in the national EPER/E-PRTR registry and in the European emissions trading scheme. Under the EU-ETS, operators are requested to report activity data and CO_2 emissions as information verified and certified by auditors who check for consistency to the reporting criteria.
Every year activity data and emissions reported under EU-ETS and EPER/EPRTR are also compared to the information provided by the industrial associations. As previously reported, the general outcome of this verification step shows consistency among the information collected under different sources (pieces of legislations; relevant industrial associations). Further investigations regarding completeness of CO_2 emissions sources from the activities of this sector are planned, as well as additional checks will be carried out on account of information from new entrance installations included in the ETS from 2013.
Concerning the integrated production of Zn and Pb this year the data and information of the IEAs (Integrated Environmental Authorization) have been used. This information will be used, for the next submission, to carry out the right allocation for all pollutants and all categories and to improve the accuracy of the estimates.
For what concern F-gases,
Improvements should be also obtained by consulting the new National Telematic Registry of fluorinated greenhouse gases and equipment containing fluorinated gases that has been instituted by the DPR 146/2018, entered in force in January 2019.

A new activity of QA/QC is ongoing based on the results of the test of the new IPCC SOFTWARE for estimating F-gas emissions, developed by the Task Force on National Greenhouse Gas Inventories.
Moreover, ISPRA is in contact with Department of Pure and Applied Sciences of the University of Urbino where a research group deals with continuous atmospheric measurements of halogenated GHGs in order to estimate emissions using the top-down approach: a comparison of measures from the research and emissions from estimation is planned.

29 TECHNE, 2008. *Fattori di emissione per l'utilizzo di solventi*. Rapporto Finale, marzo 2008

In Table 3, the planned improvements are synthesized; for each topic, the reference to the UNFCCC category, which the improvement is focussed, is reported.

Table 3. *Planned improvements*

Category	Subcategory	Parameter	Gas	Description	Timing
General	-	-	-	Implementation of a quantitative uncertainty analysis for air pollutants	2020-2025
Mineral products	Cement and lime production	Activity data	CO_2	Further investigations concerning the replacement of natural raw material in lime production are planned.	2020-2024
	Building industry	Emission estimates	PM_{10}	Estimate and report emissions from categories 2A7a, "Quarrying and mining of minerals other than coal" and 2A7b, "Construction and demolition"	2020-2024
Chemical industry	Other chemical industry	Activity data	CO_2	A detailed balance of the natural gas reported in the Energy Balance, as no energy fuel consumption, and the fuel used for the production processes in the petrochemical sector is planned.	2020-2024
Metal production	Lead and zinc production	Allocation	All	Combustion vs process for air pollutants. Possibility to split up between zinc and lead production	2020 - 2024
Consumption of halocarbons and SF_6	Consumption of halocarbons and SF_6	Activity data, emissions parameters	F-gases	Investigations are planned in order to gather further data on emissions from the use of heat transfer fluids. We are constantly in contact with the national experts and Associations in order to collect any new information that gradually become available by taking into account changes in the market both in terms of the entry of new refrigerants and technological advances in equipment, and also considering good practices in gas management that affect the emission factors. Improvements should be obtained by consulting the new National Telematic Registry of fluorinated greenhouse gases and equipment containing fluorinated gases that has been instituted by the DPR 146/2018, entered in force in January 2019. We have already started to check data of the Registry and, from a first analysis, it emerged that the information contained is not always in the form and at the level of detail useful for estimating of the Inventory. In recent months we have been working with the Responsible of the Registry to try to overcome some of the issues that have emerged after an	2023-2025

Category	Subcategory	Parameter	Gas	Description	Timing
				initial check of the database. Although some gaps were overcome, there are still critical on data.	

Mineral products

Further investigations concerning the replacement of natural raw material in lime production are planned to improve the knowledge on the process and the accuracy of the estimations. The same investigations concerning clinker production were carried out in the past years, information on the replacement of natural raw materials with secondary raw materials is provided by the national cement and clinker industrial association and it has been included in the last NIR editions. Further investigations concerning the use of carbonates other than limestone in the source category "other processes uses of carbonates" are planned.

Chemical products

A detailed balance of the natural gas reported in the Energy Balance, as no energy fuel consumption, and the fuel used for the production processes in the petrochemical sector is planned.

Metal production

CO_2 emissions from lead and zinc production have been subdivided in combustion (reported in 1.A.2) and processes (reported in 2.C.6) on the basis of ETS data. The whole time series has been reconstructed but only for CO_2 emissions, the disaggregation for other gases planned in the previous years has allowed new estimates for CO, NMVOC, NOx, SO_2, PM, Pb, Zn and Cd. Investigation about the possibility to split up between zinc and lead production for integrated plants.

Consumption of halocarbons and SF_6

To improve our estimation in all the sectors described above we are constantly in contact with the national experts and Associations in order to collect any new information that gradually become available by taking into account changes in the market both in terms of the entry of new refrigerants and technological advances in equipment, and also considering good practices in gas management that affect emission factors. Concerning the recovery of gas at the end of life of equipment, Erion, the largest Italian system of extended producer responsibility for the management of waste associated with electronic products, is finalizing a study on stationary conditioning appliances end-of-life. Improvements should be also obtained by consulting the new National Telematic Registry of fluorinated greenhouse gases and equipment containing fluorinated gases that has been instituted by the DPR 146/2018, entered in force in January 2019. Compared to the previous National F-gas Data Bank (established by Presidential Decree 43/2012), which includes refrigeration, air conditioning and fire protection systems, the new Registry also contains data on electrical switches and cold rooms in refrigerated trucks or trailers. Therefore, it will be possible to investigate these types of systems as well. We have already started to check data of the Registry and, from a first analysis, it emerged that the information contained is not always in the form and at the level of detail useful for estimating of the Inventory. Although some gaps were overcome, there are still critical issues on data. For this reason, we have decided not to use the information contained in the registry yet. Also, a new collaboration with Assofrigoristi has been initiated to improve the Data Bank collection system and obtain more precise information on emission factors, gas recovery percentage and frequency of equipment topping up. In detail, Assofrigoristi launched an initial survey

among the Association by requesting data and information. The data collected at the moment does not yet have statistical value and therefore cannot be used. For this reason, this survey will be carried out in the coming months, with the aim of involving a greater number of members and also including other sectors such as refrigeration. Through this collaboration, we expect to be able to continue to verify and update the data we use..
Finally, thanks to the fruitful collaboration with the Department of Pure and Applied Sciences of the University of Urbino Carlo Bò within the PARIS Project (Process Attribution of Regional Emissions), HFC-134a emissions have been deeply investigated, representing at the moment the best available estimates. The Horizon Europe research project aims to significantly increase knowledge on the emissions of climate "forces" from eight European countries (including F-gas and Italy), focusing on the interface between bottom-up and top-down approaches and aiming to strengthen collaboration between scientists and teams that deal with the preparation of national inventories in order to calibrate the results deriving from atmospheric models (Inverse model) that use measurement data recorded by 4 existing stations in Europe (one of which is present in Italy on Monte Cimone) and 5 of future installation and those deriving from the estimates of the inventories.

Categories 2D3a_d_e and 2G

In the following table, the specific planned improvements and remarks to be taken into account in future submissions of the national air inventory for the solvent and other product use sector are reported with the information on the weight of the category on total NMVOC emissions of the sector.

Table 2. *Planned improvements*

Category	Sub-category	NMVOC Emission	Description	Timing
Cross cutting	Paint application for construction and building; Polyester processing; Polyurethane processing	-	Assess the possibility to obtaining information to derive the apparent consumption to be used instead of production data as activity data	2020-2025
Paint application	Other industrial paint application	8%	Assess the possibility to split non industrial application according to the Guidebook EMEP/EEA	2020-2025
Degreasing, dry cleaning and electronics	Metal degreasing	4%	Update information, from the national chemical industrial association (Federchimica), on activity data and emission factor	2020-2025
Chemical products manufacturing and processing	Leather production	5%	Update emission factor for the last years on the basis of the information collected by the industrial association and EPRTR registry and local emission inventories	2020-2025

Category	Sub-category	NMVOC Emission	Description	Timing
Other use of solvents	Printing industry	4%	Update emission factor for the last years on the basis of the information collected by the industrial association	2020-2025
Other use of solvents	Application of glues and adhesives	5%	Update emission factor for the last years on the basis of the information collected by the industrial association	2020-2025

QA/QC AGRICULTURE
2024 ACTIVITIES AND FUTURE IMPROVEMENTS

Prepared by: Eleonora Di Cristofaro

April, 2025

NATIONAL EMISSION INVENTORY: AGRICULTURE

Objective

This report describes activities and improvements carried out during the preparation of the 2025 national inventory submission for the agriculture sector.

Review process recommendations

During the last UNFCCC Greenhouse gases review process in 2022 no findings for the agriculture sector additional to those included in Table 3 were made by the ERT during the review. In 2024, there was no UNFCCC review.

Table 1. *Table 3 Status of implementation of recommendations included in the previous review report for Italy*

CRF category / issue	Recommendation from previous review report	ERT assessment and rationale
3.A.1 Cattle – CH4 (A.16, 2021) Accuracy	Conduct further verification of country-specific Ym values, as indicated by Italy during the review, and include in the NIR the results of the verification to demonstrate that country-specific values better represent Italy's national circumstances, in addition to a justification.	Resolved. The Party revised its Ym values for dairy cattle for 2004–2019 and reported in its NIR (p.208) country-specific Ym values used for CH4 estimation for cattle and the results of their verification (p.212). Adequate justification for Italy's values based on national circumstances has also been provided in the NIR (p.208). Detailed information on parameters used to determine the Ym values was also provided (section 5.2.2, pp.205–212, section 5.2.6, p.213, and annex 7, section A7.1, p.495).
3.A.2 Sheep – CH4 (A.1, 2021) (A.4, 2019) Transparency	Improve the transparency of reporting on the enteric fermentation of sheep by providing information on the assumptions used to adjust the feed digestibility percentage values for mature ewes and other mature sheep.	Resolved. The Party reported in its NIR (section 5.2.2, pp.210–211, and section 5.2.6, p.213) the assumptions underlying the adjustment to the feed digestibility percentage values for mature ewes and other sheep. Italy however stated in its NIR (section 5.2.6, p.213) that it plans to collect additional data and information to improve the estimation of CH4 emissions from sheep, in particular the feed digestibility parameter for mature ewes and other mature sheep.
3.B Manure management – CH4 (A.17, 2021) Transparency	Provide in the NIR the values used for conversions from volume to mass unit for slurry and solid manure when estimating CH4 emissions from cattle and buffalo manure management.	Resolved. The Party reported in its NIR (section 5.3.2, p.215) the values used for conversions from volume to mass unit as multiplying the slurry and solid manure values which were converted from volume to weight by 1 t/m3 and 0.75 t/m3 to obtain the values in mass by factors proposed in the study by Husted (1994).
3.B Manure management – CH4 (A.18, 2021) Accuracy	Revise the CH4 EFs used to estimate emissions from pasture, paddock and range for cattle (dairy and non-dairy) and buffalo by correcting the allocation of the methane conversion factor and manure handled by climate zone, in line with equation 10.23 of the 2006 IPCC Guidelines (vol. 4, chap. 10), and recalculate CH4 emissions for this subcategory.	Resolved. The Party recalculated the CH4 EFs for cattle and buffalo for the entire time series and reported in its NIR (section 5.3.2, pp.214–226) the recalculated CH4 EFs used to estimate emissions from pasture, paddock and range for cattle and buffalo. Italy also corrected the EFs for the temperate and cool regions in line with equation 10.23 of the 2006 IPCC Guidelines (vol. 4, chap. 10) and recalculated CH4 emissions using the EFs for the respective climate zones. Additional information on implied EFs was provided in NIR table A.7.16 (p.510).

CRF category / issue	Recommendation from previous review report	ERT assessment and rationale
3.C Rice cultivation – CH4 (A.19, 2021) Transparency	Provide an explanation in the NIR of the increase in the share of rice cultivation area with single aeration, which is one of the key drivers for the decrease in CH4 emissions from rice cultivation.	Resolved. The Party explained the increase in the share of rice cultivation area with single aeration from 1.0 per cent in 1990 to 58.6 per cent in 2020 in its NIR (section 5.4.3, p.232).
3.B.4 Other livestock – N2O (A.20, 2021) Consistency	(a) Ensure that emissions from ostrich manure management are consistently reported between CRF tables 3.B(a) and 3.B(b), including the reporting of estimates or the appropriate notation key, together with a justification for excluding N2O emissions from ostrich manure management as an insignificant source in line with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines.	Resolved. The Party reported the inclusion of N2O emissions from ostrich manure management in its NIR (section 5.5.2, pp.237) reported under agricultural soils. Italy also reported consistent data in CRF tables 3.B(a) and 3.B(b) and corrected the notation key in CRF tables 3.B(a)s1 and 3.B(a)s2.
3.B.4 Other livestock – N2O (A.20, 2021) Consistency	Correct the MMS reported for ostriches in CRF table 3.B(a)s2.	Resolved. The Party has corrected the MMS in CRF table 3.B(a)s2 to pasture, range and paddock.
3.D.a.1 Inorganic N fertilizers – N2O (A.21, 2021) Transparency	Provide an explanation in the NIR (e.g. as a footnote to table 5.38) of the amount of fertilizer distributed (t/year), N content (%) and amount of N (t N/year) in the fertilizer for other nitrogenous fertilizers.	Resolved. The Party provided footnotes to table 5.38 in its NIR (p.235) explaining the fertilizer distributed and the composition of the various types of fertilizer distributed in 2020.

During the last ESR Greenhouse gases review process in 2024, no issue was raised.
During the last NECD review process[30] in 2024, no issue was raised.
During the last CLRTAP review process in 2024, no questions were sent by TERT on the agriculture sector as the focus of the review was on IPPU. Findings from the CLRTAP Stage 3 Review 2023 for the Sector Agriculture for Italy are reported in Table 2. All recommendations of CLRTAP review process have been implemented.

Table 2. *Findings from the CLRTAP Stage 3 Review 2023 for the Sector Agriculture for Italy*

NFR category / issue	Observation	Recommendation
3 – IT-2023-3-1	The ERT noted the need to enhance the quality of the IIR by including more diagrams of emission trends from the different categories. This issue was pointed out in the 2013 Stage 3 inventory review report for Italy and in the 2023 Stage 3 inventory review, the ERT noted that the Party has not included any diagram in the agriculture sector concerning emission trends. We appreciate that the Party has responded that is considering including such diagrams in the next submission.	In order to enhance the quality of the reporting in the IIR, we encourage the Party to include more diagrams of emission trends from subcategories, supported by explanations on emission trends, which will add transparency to the report.
3B3 – IT-2023-3B3-1	The ERT noted discrepancies between the number of swine reported in the IIR and those in the CRF tables (population livestock) used as activity data behind emissions submitted to	The ERT recommends that Italy pursues consistency in the activity data regarding the population of swine behind emissions submitted to UNECE/CLRTAP and UNFCCC. The ERT

[30] The review of the air pollution emission data submitted by Member States under the European Union's Directive on the Reduction of National Emissions of Certain Atmospheric Pollutants (Directive (EU) 2016/2284) (NECD) defined in Article 10(3).

NFR category / issue	Observation	Recommendation
	UNFCCC. The Party explained that swine population activity data (3B3) reported in the IIR/NFR is different from that reported in the NIR/CRF. Hereby, piglets (swine less than 20 kg) are included in the swine population for the NIR/CRF for the estimation of CH4 emission from enteric fermentation, while they are not included in the number of the NFR because the NH3 EF used for sows considers the emissions from piglets.	acknowledges that the NH3 EF used for sows considers the emissions from piglets, however the ERT does not consider this an appropriate reason behind the inconsistent number of swine used for the estimates of GHGs and air pollutant emissions, as this leads to an inaccurate IEF to be calculated.
3B – Italy-2023-3B-2	The ERT noted that PM emissions from turkeys, sheep, goats, mules and asses and fur animals are estimated based on average EF per head. The IIR lacks description of the source of the EFs. The Party has provided a detailed description regarding the source of the EFs, which are the result of the product of the Guidebook emission factors and the ratio between the Guidebook average weights and those of the national inventory by animal category. The Party has expressed their plan to include the source of EF and details in the next IIR submission.	The ERT recommends Italy to fulfil their plans for improving the IIR reporting by adding the source of emission factors and the underlying assumptions.
GNFR-K&L – IT-2023-GRID-GL-1	The expert review team notes that the chapter on gridded emission data of the IIR only provides proxy data used for the compilation.	The expert review team recommends Italy to describe the methods used for gridding in more detail in its next submission.

Improvements and QA activities

Improvements for the agriculture sector developed in the last years are described in the following.

General aspects

An internal report of the UNFCCC/UNECE-CLRTAP national emission inventory of the agriculture sector has been updated. This report contains information on the procedures undertaken for preparing the national inventory *2025 submission*[31].

A detailed checklist of procedures for compiling the agriculture sector that is used as part of the QC system was included in the QA/QC Manual. A data flow chart for the agriculture sector was compiled and included in the file that already describe the inventory compilation procedures for the agriculture sector and archived in the reference database. The data flow chart describes the link to the working files used for the estimates.

National statistics

The Italian National Statistical System (SISTAN) revises every year the National Statistical Plan that covers a three year period. In this framework, the Agriculture, Forestry and Fishing Quality Panel (*Circolo Qualità Agricoltura, Foreste e Pesca*) has been established under the coordination of the Agriculture service of ISTAT. In the last years, through this process different improvements, at activity data level, have been reached. Moreover, ISPRA has established a direct contact with a network of sectoral experts useful for the verification of the time series.

[31] Di Cristofaro E., several years. *Procedura per la preparazione, caricamento e reporting dell'inventario nazionale delle emissioni 1990-2023, del settore Agricoltura. Rapporto interno VAL-ATM/ISPRA.* Roma – Italia.

ISPRA together with CRPA participated to the preparation of the instructions for specific queries (grazing, housing, storage and land spreading) of the 2010 and 2020 Agricultural Census, 2013 and 2016 Farm Structure Survey (FSS). This exercise provides useful information for improving the emission inventory.
As a part of QC activities and data verifications, the verification of statistics was carried out: the livestock number was compared between conjunctural (short-term) statistics used in the estimates and Agricultural census for the year 2010 and 2020.
Data on cow's milk collection from farms for dairy industry provided by the AGEA were compared to official statistics provided by ISTAT, for the years 2004-2015. Data from AGEA are on average higher by 6% in the years 2004-2007 and 3% in the years 2011-2013. In other years, the differences are negligible, in particular for the years 2014 and 2015.
Differences on sheep's milk collection data are found between FAOSTAT and national statistics. FAO data is 30% and 40% higher on average than ISTAT official statistics, for the period 1990-1994 and 1998-2003 respectively. In the following years, the data are practically the same and from 2009 the FAO data are equal to the quantity of milk collected at the farms, provided by ISTAT. The milk directly suckled by lambs is not considered. In the period 2009-2013, FAO data is only equal to the total of milk collected at the farms without the amount used on farms (of the ISTAT data).
Concerning compost data, from waste sector only data on compost production are available. Official statistics provided by ISTAT on compost used in agriculture sector (that is the green and mixed amendments) are compared to data on compost from waste sector. For the year 2015, the amount of compost used is 58.1% of the compost production only from plants that treat a selected waste.
During 2020, based on the comparison with Assofertilizzanti and ISTAT experts on the time series of synthetic fertiliser use, the nitrate data in the years 2009-2011 were revised. In addition, nitrate data (quantity and nitrogen content) were recalculated in the years 1990-2000 to include the estimated CAN fertiliser.
Data on national sales of synthetic nitrogen fertilizers (by type of fertilizers) as provided by Assofertilizzanti – Federchimica for the period 2011-2023 have been compared to official statistics provided by ISTAT and used to estimate the FSN amount. ISTAT simple mineral nitrogen fertilizers data are on average 11% lower than those of Assofertilizzanti, for the years 2011-2023 (with an up-and-down trend). These differences in recent years could be attributable to rising fertilizer prices. ISTAT statistics almost certainly do not take into account that farmers tend to anticipate purchases (and thus stockpile) when expectations of rising market prices are present. The 2022 data are lower than annual average (for nitrogen, phosphorus pentoxide, and potassium oxide) because they follow a two-year period in which quantities purchased increased and refer to a year in which high market prices prompted operators to delay purchases in anticipation of falling prices, an event, which actually occurred during 2023.
Data on the number of animals raised were compared with those of the National Livestock Registry Database (*Banca Dati Nazionale dell'Anagrafe Zootecnica* - BDN), for the period 2018-2023. The BDN, established by Presidential Decree 317/96, consists of a database containing data on livestock farms, number of animals and animal movements.

Estimation improvements

In 2010 data collection and verification of emission factors presented in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4 – Agriculture, Forestry and other land uses, *AFOLU*) was implemented. In particular, emission factors related to nitrous oxide emissions from agricultural soils were compared. Different local and European scientific publications were used for this verification. Different research groups that are working on soil emission measurements were contacted (University of Naples, University of Turin, University of Udine). In 2015, emission estimates have been updated on the basis of the 2006 IPCC Guidelines.
In 2010, N excretion in Italy has been evaluated through a N balance inter-regional project "Nitrogen balance in animal farms", funded by the Regional Governments of the most livestock-intensive Italian Regions. The

N-balance methodology has been applied in real case farms, monitoring their normal feeding practice, without specific diet adaptation. In the project the most relevant dairy cattle production systems in Italy has been considered. In contrast with what normally found in European milk production systems, poor correlation between the N excretion and milk production has been found. Probably there are two reasons for explaining the non-correlation: a) extreme heterogeneity in the protein content of the forage and in the use of the feed; b) the non-optimisation of the protein diet of less productive cattle[32,33].
In 2013, regarding uncertainty analysis applied to GHG estimates, Monte Carlo analysis has been extended to other key categories of the sector, the estimation of uncertainties is shown in the *NIR submission 2014*.
In November 2014 submission, revised CH_4 and N_2O emission estimates from manure management have been calculated using a country-specific methodology and MCF, that separate the manure used in anaerobic digesters from the manure treated as slurry/solid.
In 2014, the CH_4 emission factors used for the rice cultivation category in the Italian emissions inventory were presented at the 9th Expert Meeting on Data for the IPCC Emission Factor Database (EFDB) and the values were entered into the database. On the basis of the feedback received during the meeting, the daily emission factor for continuously flooded fields without organic amendments for multiple aeration regime have been updated.
In 2015 submission, as regards N_2O emissions from agriculture soils, data on crop residues and, in particular, on the relationship between crop residues and product were compared with studies and research provided by the Agricultural Research Council (CRA). However, these studies were conducted in different countries from Italy, so despite the differences, the values used in the inventory, based on national studies, have not been changed. Following the suggestion of the CRA experts, in the estimation of N_2O emissions from crop residues, the total amount of residues has been considered, without deducting the fraction removed for purposes such as feed, bedding and construction. Therefore, the data were corrected using the fixed residues/removable residues ratio for each crop considered, which is the same information used to estimate the emissions from category emission 3F.
In 2016 submission, some updates have been done: as regards CH_4 emissions from enteric fermentation, Tier 2 methodology has been applied for sheep category; data on biogas from digesters used for energy production provided by TERNA have been updated and biogas flared has been estimated in response to the 2016 UNFCCC review process; N_2O emissions from nitrogen leaching and run-off during manure management activities have been estimated; for liming category, additional information has been collected from the industry on the amount of dolomite and limestone applied and the weighted average emission factor has been used to estimate CO_2 emissions.
In 2017 submission, in response to the UNFCCC review process, the cross check of crop residues with the calculations of the amount of organic bedding materials added to animal manure available for application to soils has been done. The estimated amount of nitrogen in bedding materials is equal to 66% of the nitrogen contained in straw removed from wheat and barley crops, for the year 2015.
In 2018 submission, some updates have been done: on the basis of the 2010 General Agricultural Census data on housing distribution for dairy cattle category, the production of manure both liquid/slurry and solid has been updated, involving a change in the methane emission factors. Based on the 2010 General Agricultural Census and the 2013 Farm Structure Survey data on manure management systems, NH_3 emission factors for cattle, buffalo, swine and poultry categories and CH_4 emission factors on manure storage for swine category have been updated. NO_x emissions from storage have been updated according to the Tier2 methodology reported in the last version of the EMEP/EEA Guidebook (EMEP/EEA, 2016). NH_3 emissions from digesters biogas facilities have been estimated and subtracted from manure management category (cattle and swine) and

[32] *De Roest and Speroni, 2005. Il bilancio dell'azoto negli allevamenti di latte. Agricoltura. Marzo 2005. pag 112-114*

[33] CRPA, 2010. *Personal communication - experts Laura Valli and Maria Teresa Pacchioli from Centro Ricerche Produzioni Animali (expert consultation on N excretion and natinal production systems).* Reggio Emilia, Italy.

allocated in the anaerobic digestion at biogas facilities (5B2 of the waste sector in the NFR classification under UNECE/LRTAP Convention). N_2O emissions have been recalculated according to the update of the average value of $Frac_{LEACH-(H)}$ for the entire national territory based on a country specific methodology.
In 2019 submission, some updates have been done: CH_4 emissions have been recalculated because of the update of the values of some parameters for estimating the manure sent to the digesters[34] (such as data related to the percentages of the different substrates that feed the anaerobic digesters and data relative to the average content of volatile solids by type of substrates). As a result of these changes, the amount of manure sent to the digesters decreases considerably and CH_4 losses of the biogas recovery plants become greater than the methane emissions avoided due to the storage of manure in the digesters. Compared to the previous submission, CH_4 emissions from manure management for cattle and swine are increased throughout the time series. Based on the update of parameters for estimating the manure sent to the digesters described above, also the amount of nitrogen contained in the manure has been updated and has remarkably decreased, leading to an increase in total N_2O direct emissions from manure management. N_2O emissions have been recalculated according to the update of $Frac_{LossMS}$ that now includes the losses of N_2, consequently the amount of managed manure nitrogen available for application to managed soils has decreased.
In 2020 submission, some updates have been done. CH_4 emissions have been recalculated because of the data updating on manure production for cattle and buffalo from the year 2016 based on Ministerial decree of 25 February 2016 on criteria, and general technical standards, for the regional regulation of the agronomic use of farmed effluents and wastewater, as well as for the production and agronomic use of digestate (GU, 2016)[35]. The number of laying hens and broilers has been updated from the year 2011 based on 2010 Agricultural Census and 2013 Farm Structure Survey. CH_4 emitted during grazing for cattle and buffaloes and CH_4 from manure management for ostriches have been included, as requested during the 2019 UNFCCC review. N_2O emissions have been also recalculated because of the updating of the N excreted for dairy cattle from the year 1990 based on the 2019 UNFCCC review and calculated using equations 31-33 of the 2006 IPCC Guidelines. Besides, the number of laying hens and broilers has been updated from the year 2011 based on 2010 Agricultural Census and 2013 Farm Structure Survey. Moreover, the N excreted for other poultry has been updated from the year 2005 based on ISTAT statistics, such as 2010 Agricultural Census, 2005, 2007 and 2013 Farm Structure Survey. The N excreted for calves, buffalo, turkeys and other poultry has also been updated from the year 2016 based on Ministerial decree of 25 February 2016 on criteria, and general technical standards, for the regional regulation of the agronomic use of farmed effluents and wastewater, as well as for the production and agronomic use of digestate (GU, 2016).
In 2021 submission, some updates have been done. The main changes are described. CH_4 emissions from enteric fermentation have been recalculated because of the data updating from 2004 of DE and Ym parameters used to estimate CH_4 emissions for dairy cattle category. CH_4 emissions from manure management have been recalculated because of the following data updating: the average monthly temperatures; the coefficients of cattle and buffalo manure production for the years 2007-2015; the weight of the category other poultry (which affects the coefficient of manure produced) for the years 2007-2015; the number of broilers and laying hens in the period 2001-2009 and since 2011. On the basis of updated temperatures, cattle and pig allocation rates in temperate zones and MCF were recalculated. N_2O emissions from manure management and from agricultural soils have been recalculated because of the updating of the N excreted for dairy cattle from the year 2000. Following the update of the gross energy intake (GE), based on the estimation of the parameters digestibility (DE) of diet and methane conversion factor (Ym), the excreted nitrogen value of dairy cows was updated from

[34] On the basis of the recent study for the evaluation of the effects on emissions of livestock management practices carried out by CRPA - CRPA, 2018. *Studio per la valutazione degli effetti sulle emissioni delle trasformazioni in corso nel settore degli allevamenti*
[35] Gazzetta Ufficiale della Repubblica Italiana (G.U.), 2016. Attuazione della legge 3 maggio n. 79 in materia di ratifica ed esecuzione dell'Emendamento di Doha al Protocollo di Kyoto (G.U. n. 298 del 22 dicembre 2016).

the year 2004. Excreted nitrogen is in fact calculated from GE using equations 10.31-10.33 of the 2006 IPCC Guidelines. In addition, the percentage for protein in diet has been updated from the year 2000 respect to the previous submission. This parameter is used with GE in the estimation of excreted nitrogen.
In 2022 submission, some updates have been done. The main changes are described. CH_4 emissions from enteric fermentation of dairy cattle since 2004 have been updated, considering weighted average of Ym for lactating and dry cows, as indicated in the 2019 IPCC Refinement; emissions of sheep have been updated for the whole time series, considering weighted average of Ca parameter for time spent on pasture and housing.
As regards for CH_4 emissions from manure management, the changes were: recalculated EF CH_4 for grazing for cattle and buffalo since 1990 with average MCF value for cool and temperate zones, based on the distribution of livestock between these zones (as required by 2021 UNFCCC review); EF CH_4 update from equines and sheep/goat manure management since 1990 (EFs are weighted averages of the 2006 IPCC cool and temperate EFs, with updated values assigned to provinces consistent with the update of provincial mean temperatures based on SCIA data); corrected the provincial distribution of methane emissions from manure management with data from the 2010 census, this resulted in a slight change in the EFs from manure management of sheep, goats and horses.
As regards for N_2O emissions from manure management, the changes were: updated equine and sheep and goat housing NH_3 emission factors for the whole time series; modified the formula for estimating NH_3 emissions from storage for cattle, pigs and poultry by subtracting from N at housing also the amount of N at digesters before multiplying by the emission factor; included in storage estimates NH_3 emission factors for equine and sheep and goat for the whole time series.
As regards for N_2O emissions from agricultural soils, the changes were: correction of estimated amount of nitrogen from crop residues (Fcr) as requested during the 2022 ESD review in January/February 2022; correction of estimated runoff and leached nitrogen (Fracleach) with new data based on the hydrological balance of the national territory; change in estimate of emissions from N synthetic fertilisers, because estimate of N_2O from rice cultivation for the whole time series has been included; modification of N at spreading as a result of the changes described in reference to N_2O emissions from manure management, related to NH_3 emissions in housing and storage; for the estimation of N at spreading, the percentages of N remaining after emissions in the housing, storage and after other losses during storage (NO_2, N_2O, N_2, N leached in manure management, NH_3 from digesters) were recalculated and N bedding was added; updated the estimate of straw use for dairy cattle, non-dairy cattle and buffaloes to take into account sheltered animals only (removing grazing animals); included estimate of direct and indirect N_2O emissions for ostriches, where manure management system is grazing (as required by UNFCCC 2021 review).
In 2023 submission, some updates have been done. The main changes are described.
The recalculation of the entire time series is due to an update of the dry matter intake (DMI) and methane conversion factors (Ym) values of the subcategories of the non-dairy cattle category. The recalculation was done in collaboration with experts from CRPA who, based on a large database, recalculated the percentage of DMI to the average weight of the animal. The Ym values of the different subcategories were calculated using the formula of Ellis et al 2007 based on the DMI and the percentage of forages in the ration.
As regards for CH_4 emissions from manure management, since 2011, emissions have changed because data on average monthly temperatures, which is a parameter used in the country-specific methodology, have been updated. These data refer to average temperatures for the 30-year period 1991-2020. In addition, data provided by SNAM, the national pipeline operator, on the amount of biomethane fed into the grid, from 2017, were considered. This data was used to estimate the national biogas produced. Based on this estimate, the amount of livestock manure sent to anaerobic digestion was calculated, which was useful for estimating the methane emissions, from manure management, avoided.
In 2024 submission, some updates have been done. The main changes are described.
The recalculation is due to updating the NH_3 emission factors of synthetic fertilizers, which affects the indirect emissions of N_2O. Fracleach value from 1990 was updated, which involved recalculation of indirect emissions

from leaching/runoff. Emission factors of rice cultivation were updated from 2008; the percentage of straw incorporated versus straw burned was changed from 2001; the IPCC value for CFOA to estimate SFo was changed from 2001 to 2007, from 1 to 0.29, related to the period in which straw is incorporated (before or after 30 days of tillage).
In 2025 submission, some updates have been done. The main changes are described.
The percentages of dairy cows on pasture were changed from 2007, based on data from the 2020 Agriculture Census (whose data were made available by ISTAT in 2024). This change resulted in the updating of GE.
In 2020, the share at grazing of non-dairy cattle increases from 3 to 19%; that of dairy cattle from 5 to 7%. The previous percentages are derived from a 2006 study. For the years 2007 to 2020, data were interpolated to estimate a linear change in grazing percentages over the years. Modification of these percentages resulted in an increase in CH_4 for dairy cattle and non-dairy cattle from 2007.
Based on updated percentages of livestock housing by type from the 2020 Agriculture Census, liquid and solid manure production coefficients for dairy cattle have been updated since 2011. The Census data show that the number of stables where only slurry is produced increased and those where slurry and solid manure are produced decreased. This has resulted in a greater reduction in solid manure than an increase in slurry production. This has resulted in a reduction in EF CH_4 since 2011.
Updating the EF of swine storage facilities, based on the 2020 Agriculture Census, resulted in an increase in closed storage facilities from 2020, which resulted in an increase in EF.
Based on GSE (Energy Services Manager) data of biomethane production, disaggregated by production source (organic substrate of agricultural origin), the amount of livestock manure sent to anaerobic digestion from 2017-2022 has been updated. This change only affects cattle emissions (as the methodology is set up).
As regards N_2O emissions from manure management, the largest recalculations involved direct N_2O emissions. These recalculations were due to the update of N excreted at pasture since 2007 for cattle, based on the 2020 Agriculture Census. Direct N_2O emissions decrease because, when total excreted N is considered fixed, the share excreted to pasture (whose emissions are reported in the Agricultural soils category) increases, and consequently emissions from liquid and solid systems fall. The share of livestock manure sent to digesters also falls, leading to an increase in N_2O emissions. Overall, emissions are decreasing.
Changes related to indirect N_2O emissions are due to changes in estimates of NH_3 and NOx. Based on the 2020 Agriculture Census, livestock housing, manure storage and spreading were updated by animal category. These upgrades have changed the emissions of NH_3 and NOx.

Planned improvements

In the following table, improvements for the Agriculture emission inventory (UNFCCC/UNECE-CLRTAP) are reported.

Table 2. *Planned improvements*

Category	Subcategory	Parameter	Gas	Description	Timing
Enteric fermentation	Cattle, sheep, and buffaloes	Emissions	CH4	Implementation of the 2019 IPCC guidelines for enteric emissions from cattle, sheep, and buffaloes	2025
Manure management	Livestock categories	CH_4, N_2O EFs	CH_4, N_2O	Based on regional livestock management data, the collection of which began a few years ago, checks will be made on the data used to estimate national emissions on livestock manure management	2025

National statistics

Data on livestock farms collected through the Farm and structure survey (FSS) survey and the census of agriculture are crucial for improving the preparation of the national agriculture emission inventory (UNFCCC/UNECE-CLRTAP). Detailed data such as animal grazing information, animal housing and storage systems characteristics, and use of manure/slurry for land application information were collected. Data from 2010 and 2020 Agricultural Census, FSS 2013 and 2016 were analysed and the emission factors of ammonia, the values of nitrogen excreted between liquid and solid manure of some categories of livestock and methane emission factors of dairy cattle and swine categories were updated based on the results of the calculations.

Estimation improvements

Improvements will be related to the availability of new information on emission factors, activity data (for example, census data and regional livestock management data), as well as parameters necessary to carry out the estimates.

QA/QC LULUCF
2024ACTIVITIES AND FUTURE IMPROVEMENTS

Prepared by: Marina Vitullo and Guido Pellis

April, 2025

NATIONAL AIR EMISSION INVENTORY: LULUCF

Objective

The report summarizes the improvements and remarks, which have been identified during the preparation of the 2025 inventory submission for the LULUCF sector.

Review process recommendations

In Table 1, responses to the main questions raised during the last UNFCCC review process, related to the national inventory submitted in 2022, are described.

Table 1

1.a) *Response to the UNFCCC review process recommendations*

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
4.A Forest land – CO_2	Resolved. Italy reports this year significant recalculation in the category 4.A.1 and 4.A.2 for the year 2018. As compared the previous submission, in the current inventory the categories show same trends and values, except for few years since 2013 onwards. But it is for the year 2018 for which the category shows a significant recalculation. Could you please provide an explanation on reasons for the recalculations and the drivers for the trends? Please, remember to also include information on this matter on you next NIR submission.? The information will be used to complete the EU NIR 2023.		Recalculation driven by new NFI's data released in late 2022. The recommendation has been addressed in the 2024 submission
4.B.2 Land converted to Cropland – CO_2	Resolved. The EU 2022 (draft) UN ARR raised an (reiterated) issue on the need to move to higher Tier methods in Italy for reporting E/R from LcCL (4.B.2). The ERT argued that this category is key. We noted that Italy´s GHGI 2022 for 4.B.2 provides quantitative estimates restricted to LB and SOC in GLcCL (4.B.2.2). Bearing, also in mind the 2006 IPCC GL (table 4.1. of the Vol.1 of the IPCC 2006 GL): "if this category is key, the inventory compiler should determine which pools and subcategories are significant." Could you please (i) inform us on if is there any plan to enhance the reporting of information on this category? And, (ii) if ITA has performed the analysis to retrieved which is, if any, the key pool (in terms of its significant to the net value) within the category 4.B.2?		Italy applied T1 for the estimation of living biomass (LB) and dead organic matter (DOM), while T2 for soil organic carbon pool. Organic carbon stocks in mineral soil are estimated at a regional level by means of equation 2.25 of the 2006 IPCC GLs, using IPCC default SOC_{REF} values considering the percentage of IPCC soil classes and climate zones in each region; F factors (F_{LU}, F_{MG} and F_I) adapted to the national circumstances. Therefore, Italy considers this solution as a Tier 2 method. The soil pool is the most significative, in the land converted to cropland subcategory (97% in the whole time series). Italy is planning a revision of soil organic carbon stock and their changes, based on peer-review studies on the national territory.
4.C.1 Grassland remaining Grassland – CO_2	Resolved. Grassland remaining grassland is a key category according to table 7 in the CRF and mineral soil contribute with more that 25% to this land use category. According to the NIR 2022 this pool is estimated using a tier 1/2 method. As an initial assessment this is possible not in compliance with Regulation (EU) 2018/841, which states in Article 18 (4) that "for emissions and removals for a carbon pool that accounts for at least 25-30 % of emissions or removals in a source or sink category which is prioritized within a MS's national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level of emissions and removals, the trend in emissions and removals, or the uncertainty in emissions and removals in the land-use categories, at least Tier 2 methodology in accordance with the IPCC 2006 Guidelines should be used".		Italy applied T2 for the estimation of soil carbon pool in mineral soil, while T1 is applied for living biomass and dead organic matter for grazing land. For other wooded land Italy applies T3 and T2 for living biomass and dead organic matter, respectively. Organic carbon stocks in mineral soil are estimated at a regional level by means of equation 2.25 of the 2006 IPCC GLs. IPCC default SOC_{REF} values considering the percentage of IPCC soil classes and climate zones in each region; F factors (F_{LU}, F_{MG} and F_I) adapted to the national circumstances. Therefore, Italy

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
			considers this solution as a Tier 2 method. A further improvement is planned in the next years considering peer-review studies based on the national territory.
4.E.2 Land converted to settlements – CO_2	Partially resolved. Based on the values it seems the assumption is that all soil carbon is assumed to be lost in the year of the conversion. The IPCC 2006 guidelines chapter 8 on settlement section 8.3.31 refers for a Tier 1 approach to equation 2.25 in chapter 2, which assumes a default of 20 years to reach a new equilibrium. According to information provided in the NIR2022, section 6.5.3, parks and human settlements are part of the settlement land use category and the assumption that all soil carbon is lost when converting cropland or grassland to settlement is likely an overestimation of emissions for such conversions. Can Italy please confirm the approach used and the rationale if different from the IPCC guidance?		As reported in the NIR (section 6.6.4) for the land converted to settlements, the 20-years transition period has been applied to determine the area in conversion. However, due to the characteristics of the final land use category (settlements), it is assumed that, for each carbon pool, all C stocks of the area subjected to an annual conversion are completely lost in the same conversion year, while the related CO2 emissions are assigned to the first year the conversion has occurred.
4.G Harvested wood products	Partially resolved. Italy reports gains-losses in the same column (column B) in table 4Gs1, this can be understood as the net influx after the loss has been taken into account. These values deviate however significantly from the net value in column E (taking into account the units) for all years of the time series. Can Italy please clarify? Italy has also for the year 2019 reported a significant increase in removals from HWP compared to the previous years. This increase is also partly due to a recalculation from last years inventory. Can Italy please check whether this is correct and provide the rationale in the NIR?		In column B of table 4Gs1, the Inflow (HWPj) (in tC) is reported, while in column E of the same table the carbon stock change, in term of CO2, is reported (equal to C(i+1)-C(i)), as for eq. 12.2 of the 2019 Refinement (correspondent to the eq. 2.8.5 of PCC KP Supplement). The recalculation of the 2019 data is due to the updated activity data (i.e., FAOSTAT) for wood based panels for the years 2017-2020. The 2019 increase is due to a remarkable increase in harvesting due to the severe forest damages after Vaia storm in late 2018. Destroyed or intensely damaged forest stands amounted to about 42.500 ha; the growing stock volume of fallen trees was about 8.5 million m3.

Responses to the main questions raised during the last European review process, related to the national inventory submitted in 2024, are described.

Table 1

1.b) *Response to the European review process recommendations*

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
4	Resolved. Italy reports in table 4(V) CO2, CH4 and N2O emissions from wildfires in the cropland and grassland categories as also explained in the NIR. It is however not clear how Italy takes into account the IPCC 2006 guidance, Ch.2, section 2.4 Non-CO2 emissions, which states that: "CO2 net emissions should be reported where the CO2 emissions and removals for the biomass pool are not equivalent in the inventory year and for grassland biomass burning and burning of agriculture residues, the assumption of equivalence is generally reasonable." Do the approach used by Italy to estimate these CO2 emissions, consider only emissions from the part of the biomass pool which are not equivalent in the inventory year such as woody vegetation? Alternatively, there is a risk that emissions are		The reported wildfire emissions in cropland and grassland come from woody crops (e.g., orchards) and other wooded land within the grassland category. As explained in the NIR, IPCC default values (Table 2.4, Vol. 4, Ch. 2) were used to estimate fuel mass. Burned annual crops and grazing land were excluded from GHG emission estimates, in line with IPCC guidance.

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
	overestimated. Information on this in the NIR would improve transparency. Can you please check this?		
4 – Activity data	Resolved. Italy reports an inconsistency in the area of forest land in table 4.1 and 4.A for all years in the timeseries. Can you please check this?		An error was made in the compilation of CRF reporter. The values will be corrected for the final March submission
4.A Forest land – CO_2	Resolved. Italy reports CO2 emissions from biomass burning in forest land remaining forest land in table 4A which means this loss of biomass is mixed with losses due to harvest and tree mortality. Based on table 6.50 in NIR2023, it is clear that 2017 was a year with significant emissions from forest fires. Italy explains in detail how it estimates non-CO2 emissions from biomass burning but it is less clear how CO2 emissions are estimated. In the 2019 submission, Italy reports a burned area for 2017 forest land remaining forest land of 35456 ha in table 4(V) and a carbon stock loss in living biomass of -14935 ktC in table 4A and in the 2024 submission Italy reports for the year 2017, a burned area of 61177 ha and a carbon stock loss in living biomass of -14373 ktC (the reported area in the sub-category forest land remaining forest land in table 4A remained the same). In this case the area burned increases by 72% while at the same time the carbon loss decreased by 3.8%. These two numbers are not directly comparable because of the harvesting and natural mortality are also included in the loss, but it would increase transparency if Italy explains, how it treats CO2 emissions from the burning of living biomass, litter and dead wood in case of wildfires and controlled burnings, how salvaged wood from these burned areas are estimated e.g. based on reported quantity of wood extracted or based on standard fractions. Can you please provide an explanation on the issues raised above including also how and provide complete information on this in your next submission?		Fire losses are included in the For-est model, with details provided in Annex 13 of the NIR. Burned areas, based on Forest Service statistics, are assigned to forest inventory typologies proportionally to their area. Growing stock loss is estimated using average stock per hectare, assuming total biomass loss in burned areas, though not all biomass is oxidized. The annual burned growing stock is subtracted from the previous year's growing stock, following Annex 13 equations. Figure 6.3 of the NIR illustrates fire and harvest losses in relation to aboveground carbon, showing biomass loss as a percentage of total aboveground carbon stock in forest land. This explanation has been included in NIR 2024 and previous submissions. A reporting error affecting burned area data in the "forest land remaining forest land" subcategory was detected and corrected for the March 15 submission. It also appeared in previous submissions.
4.B.1 Cropland remaining Cropland – CO_2	Resolved. Italy reports a large recalculation for the full timeseries for cropland remaining cropland. It seems related to less removals in mineral soils for both annual and perennial crops. Could you please provide an explanation on reasons for the recalculations and the drivers for the trends? Please, remember to also include information on this matter in you next NIR submission.? The information will be used to complete the EU NIR 2024.		In the 2024 submission, Italy applied the 2019 IPCC Refinement SOCref and F factors for soil organic carbon in Cropland and Grassland. Using the IPCC equation, which includes FLU, FMG, and FI factors for management practices, the recalculated estimates differ by up to 10% for annual crops and up to 30% for perennial crops compared to 2006 IPCC default values. Variations depend on climate zones (moist/dry) and specific management changes in cropland remaining cropland. A detailed

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
			explanation will be provided in the 2024 NIR.
4.B.1 Cropland remaining Cropland – CO_2	Partially resolved. Regulation (EU) 2018/841 states in Article 18 (4) that "For emissions and removals for a carbon pool that accounts for at least 25-30 % of emissions or removals in a source or sink category which is prioritized within a Member State's national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level of emissions and removals, the trend in emissions and removals, or the uncertainty in emissions and removals in the land-use categories, at least Tier 2 methodology in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories." According with information included in the CRF tables 7 of the 2024 GHGI submission, the category Cropland remaining Cropland is a key categories, and within them the pools soil organic carbon in organic soils appears to be significant in the context of Art 18 (4). Information included in the NIR2023, indicates that "CO2 emissions from cultivated organic soils in cropland remaining cropland have been estimated, using default emission factor for warm temperate climate zone from Table 5.6 of the 2006 IPCC Guidelines". With a view to the comprehensive review which will take place in 2025, and which will assess reporting requirements in accordance with EU LULUCF Regulation, could you please provide information on any ongoing or improvement plan for the reporting of this pool in both categories using higher Tier methods?		Cropland accounts for 6.2% of total LULUCF emissions and removals. In 2022, within cropland remaining cropland, living biomass contributed 43%, mineral soils 38%, and organic soils 18% of CO_2 emissions and removals. IPCC Tier 2 is used for living biomass and mineral soils (covering 82% of the subcategory), while Tier 1 applies to the remaining 18%. There are no plans to adopt higher Tiers, mainly due to the small area of cultivated organic soils in Italy.
4.C.1 Grassland remaining Grassland – CO_2	Resolved. Italy reports in table 4C.1 grassland remaining grassland organic soils an annual removal of 2.5 tC/ha. This is by far the largest in the EU as all other MS have losses of soil carbon from organic soils grassland or zero in a few cases. Italy explains in the NIR that it uses default value from table 6.3 in Ch. 6 in the IPCC 2006 guidelines. It is our understanding that the reading of this table should be 2.5 tC/ha as an annual emission and not as an annual removal. This is also how Italy reads table 5.6 in Ch. 5 for cropland and this would bring the emissions at the same level as other EU Member States. Drained organic soil is one of the larger sources of CO2 emissions and it would not be logical that this would lead to a removal. Can you please check this?		An error was made in the compilation of CRF reporter. The values will be corrected for the final March submission
4.C.1 Grassland remaining Grassland – N_2O	Resolved. The GHGI 2024 introduces in the CRF table 4(III) and for the year 1990, the notation key NO for N2O emissions under the category grassland remaining grassland, although, losses of carbon from mineral soils are reported in CRF table 4.C. Chapter 11 in IPCC 2006 Guidelines provides equations and default emission factors, under its Tier 1 method, for estimating N2O emissions from N mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils (see equations 11.1, 11.2 and 11.8). Could you please check this issue and complete the reporting of the LULUCF information accordingly, or provide an explanation to understand the current reporting in CRF table 4 (III) for the years mentioned above?		N2O emissions under the subcategory grassland remaining grassland in the CRF table 4(III) will be included in the final March submission for 1990, since, as correctly noted, carbon losses have been estimated and reported in mineral soils of grassland remaining grassland (CRF table 4.C) for 1990
4.C - Grassland	Resolved. Italy reports inconsistency for final area in year X-1 and initial area in year X in table 4.1 for forest land and managed grassland for all years in the timeseries. Can you please check this?		An error was made in the compilation of CRF reporter. The values will be corrected for the final March submission

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation
4.E.2 Land converted to settlements – CO_2	Not resolved (yet). [Ref. number IT-4E2-2023-0001] Italy explained last year that when estimating emissions from soil in land converted to settlements, Italy assumes that all soil carbon is lost in the year of the conversion. In addition to the observation raised last year, we would like to also refer to the IPCC 2006 guidelines, Vol.4, Ch.8, section 8.3.3.2 for a Tier 1 method which suggest separating the area of settlements into paved area, turf grass, cultivated area and wooded to take into consideration the different treatment of soil carbon. The method used by Italy that doesn't take into account the different types of settlements are less accurate and as land converted to settlement is a key category for Italy according to CRF table 7, Italy should preferably use higher tier methods. Furthermore, the approach used by Italy results in very high emissions in the beginning of the timeseries. Can you please consider this together with IT-4E2-2023-0001 and provide complete information in the next submission?		For land converted to settlements (NIR2023, Sec. 6.6.4), a 20-year transition period is applied. However, all carbon stocks are assumed lost in the conversion year, with CO_2 emissions assigned to that year. A land classification revision is planned for the next submission, based on the Collect Earth implementation for Italy.
4.G Harvested wood products	Resolved. Italy reports a large recalculation in table 4Gs1 HWP for the period 2017-2021, resulting in less removals. Could you please provide an explanation on reasons for the recalculations and the drivers for the trends? Please, remember to also to include information on this matter in you next NIR submission? The information will be used to complete the EU NIR 2024.		The recalculation of the 2019 data is due to the updated activity data (i.e., FAOSTAT) for wood based panels for the years 2017-2021. In addition, also the 2021 FAOSTAT activity data for paper&paperboard have been updated. This explanation will be included in the NIR, section 6.13.5.
4.G Harvested wood products	Resolved. For the year 2022, CRF table 4.Gs.2 includes empty cells for information on activity data for HWP in the year 2022, and for the factors used to convert product units into carbon. The lack of this information does not lead to an incomplete reporting of the LULUCF budged, as fluxes in HWPs have been reported in 4.Gs.1, however, could you please check this issue and complete the information in your next submission?		The HWP activity data (for the background table 4.Gs2) will be included in the March submission, as well as the factors used to convert from product units to carbon

Inventory improvements and QA activities

Forest land (4A)

Several activities have been implemented and carried out. A specific Decree[36] was adopted by the Ministry for the Environment, Land and Sea to fulfil the requirements arising from the ratification of the Doha amendment to the Kyoto Protocol establishing the second commitment period. The technical annex to the abovementioned Decree includes a detailed list, for each reporting sector, of the needed data and timeframes; the relevant data providers have been identified and included in the same Decree. The abovementioned Decree will continue the data provision also in the Enhanced Transparency Framework under the Paris Agreement, facilitating the data collection, aiming to increase the quality and timeliness of the gathered data. A specific Annex is included in the NIR to provide detailed information on *For-est* model.

In the 2025 submission, Italy significantly revised the emission/removal estimates from Forest land remaining Forest land, and Land converted to Forest Land due to application of preliminary activity data from the ongoing fourth NFI (NFI2025).

In addition, as suggested by the European review process, the For-Fires model to estimate non-CO_2 emissions from wildfires now includes the necromass pool (dead wood and litter). During the revision of the model, a

[36] Decree of Ministry for the Environment, Land and Sea 9 december 2016 Attuazione della legge 3 maggio n. 79 in materia di ratifica ed esecuzione dell'Emendamento di Doha al Protocollo di Kyoto (GU, 2016).

few changes were applied: i) biomass and dead organic matter from the third NFI (NFI2015) have been used for the period 2019 onward; and ii) a few forest typology correspondence errors between the 2nd NFI and For-Fires model were corrected. Specifically, some NFI data on specific forest management practices (coppice and high forest) were incorrectly assigned to general forest typologies in the model, and vice versa. This information is included in the National Inventory Document (NID 2025), section 6.11.5 and Annex 12.

Cropland (4B)

In the framework of the abovementioned Decree related to the Doha amendment to the Kyoto Protocol, a technical working group, headed by ISPRA, has revised data and methods to estimate C stock changes for the living biomass pool, for perennial crops under cropland remaining cropland, and for the soil pool.

In the 2025 submission, Italy revised the Cropland remaining Cropland and Land converted to Cropland emission/removal estimates by applying several changes to the activity data for the last part of the time-series (2017 onward). These revisions were due to the updates in some activity data and to the correction of a few errors in the calculation spreadsheets and their links.

Considering the activity data update: i) the application of the preliminary NFI2025 surfaces (see previous section for Forest Land) slightly and indirectly impacted the estimation of national land-use change allocations at the regional level, including grassland converted to cropland; ii) the definitive 7th Agricultural Census data were applied, with an effect from 2017 onward; iii) a new system for collecting data on sustainable management practice was introduced with the new CAP and had an effect on several regions data from 2020 onward.

The error corrections involve: i) the incorrect classification of vineyard areas by age class from 2020 onward; ii) a spreadsheet linkage error for the activity data in one administrative region from 2017 onward; iii) the incorrect emission/removal estimates for set-aside management in 2022. All this information is detailed in the NID section 6.3.7.

A clarification of the CO_2 emissions from cropland wildfires has been included in the NID 2025 section 6.11 to improve transparency, as suggested by the European review process [Observation IT-4-2024-0002].

Finally, Italy has no plans to adopt higher tiers for organic soils under cropland due to the small area of these lands in the national territory. However, there is potential to explore recent national or Mediterranean climate zones literature to improve emission factors for organic soils in cropland remaining cropland.

Grassland (4C)

In the framework of the abovementioned Decree related to the Doha amendment to the Kyoto Protocol, a technical working group, headed by ISPRA, has revised data and methods to estimate soil C stock changes.

The application of preliminary data from the ongoing fourth NFI (NFI2025) significantly impacted the recalculation of the Grassland category, particularly due to updates in activity data related to other wooded land (included in grassland). This recalculation occurred only within the grassland remaining grassland subcategory but affected all carbon pools (biomass, dead organic matter and mineral soil) from 2016 onward.

As with cropland, a clarification of the CO_2 emissions from grassland wildfires has been included in the NID 2025 section 6.11 to enhance transparency, as suggested by the European review process [Observation IT-4-2024-0002].

Planned improvements

In the following, specific improvements and remarks to be considered in the next submission of the national GHG inventory for the LULUCF sector are reported.

In Table 2, the planned improvements are synthesized; for each topic, the reference to the UNFCCC category, which the improvement is focused on, is reported. No improvements are planned for the KP activities, since a third commitment period of the Kyoto Protocol has not been planned.

Table 2. *Planned improvements*

Category	Sub category	Parameter	Gas	Description	Timing
General		Activity data	All GHG	− Implementation of Open-Foris Collect Earth tool for land classification system and land-use change tracking. The results of this tool will be evaluated by comparing them with the available ancillary statistics and information.	2026
Forest land	FL-FL; L-FL	CO_2	GHG	− Explore the possibility of modifying the For-Est model to include CO_2 wildfire emissions only related to fuel mass effectively burned, calculated as the product of fuel mass and the combustion factor, as estimated in the For-Fire model.	2027
Cropland	CL		GHG	− Updated methodology for wildfire emissions from perennial crops; − Explore the possibility of finding country-specific emission factors for organic soils.	2027
Grassland	GL		GHG	− Updated methodology for wildfire emissions from other wooded land; − Explore the possibility of finding country-specific emission factors for organic soils.	2027

In the following, details related to the specific improvements are provided category by category.

Forest land (4A)

At present, the For-Est model assumes that CO_2 emissions from wildfires in forest land (both FL-FL and L-FL) result from the complete combustion of biomass. Accordingly, Italy accounts for these emissions under carbon stock changes in living biomass – losses. Conversely, the For-Fires model quantifies non-CO_2 emissions from forest fires using event-specific combustion factors, representing the proportion of total biomass actually combusted. The harmonization and integration of the two modelling approaches are under consideration, intending to prevent potential double-counting of biomass C losses associated with forest fire events.

Cropland (4B) - Grassland (4C)

Italy is currently considering the implementation of a comprehensive literature review aimed at identifying country-specific emission factors for CO_2 emissions from organic soils under cropland and grassland land-use categories, in line with IPCC guidelines and with the objective of improving national GHG inventory accuracy.

Biomass Burning (4(V))

In addition to implementing a methodology for estimating CO_2 emissions from wildfires in forest land based on event-specific combustion factors (see Section Forest Land (4A)), Italy is considering updating the estimation approaches for wildfire-induced emissions affecting perennial crops and other wooded land, which fall under the Cropland and Grassland land-use categories, respectively. These approaches would include country-specific biomass data for both of them, and the application of event-specific combustion factors for the other wooded lands only.

QA/QC WASTE
2024 ACTIVITIES AND FUTURE IMPROVEMENTS

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NATIONAL AIR EMISSION INVENTORY: WASTE

Objective

This report summarises the improvements, which have been identified during the preparation of the 2025 inventory submission for the waste sector.

Review process recommendations

In the following table, issues raised during the review process and related to the waste sector are reported; responses to each subject are also included. Table 1 describes the responses to the recommendations under the UNFCCC review process; reported recommendations are those included in the last review report for Italy by UNFCCC in 2023.

Table 1. *Response to the UNFCCC review process recommendations*

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
5. General (waste) – CO_2 (W.9, 2021) Accuracy	Revise estimates of the annual change in total long-term carbon storage in HWP waste in CRF table 5, ensuring that the corresponding CO_2 emissions are greater than, or equal to, zero.	w.1	Resolved. The Party revised the reporting on the memo item in CRF table 5 across the time series, … During the review, Italy submitted the first-order decay waste model, and the ERT could confirm that the Party has correctly inserted the annual change in total long-term carbon storage in HWP waste.	
5.C.1 Waste incineration – CO_2 (W.7, 2021) (W.12, 2019) Transparency	Improve the transparency of reporting on waste incineration by including the values of carbon content for the whole time series and the reason for the changes in carbon content, fossil carbon fraction and oxidation factor in order to facilitate the replication of the estimation.	w.2	Resolved. The Party reported in its NIR (table 7.24, p.319) the values of carbon content for the whole time series and the reason for the changes in carbon content, fossil carbon fraction and oxidation factor (p.317)…	
5.D.1 Domestic wastewater – CH_4 (W.10, 2021) Accuracy	Provide a justification in the NIR for using the value 1.25 as the correction factor for all additional industrial biochemical oxygen demand discharged into sewers or revise its current practice and apply the default value of 1.00 for uncollected wastewater, especially in the case of rural populations using latrines.	w.3	Resolved. The Party reported in its NIR (p.325) that a correction factor of 1.25 has been applied to both collected and uncollected wastewater in order to account for illegal wastewater spills from industry or craft activities that are not taken into account in official statistics or other industries and	

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
			establishments (e.g. restaurants, butchers or grocery stores) that can be co-discharged with domestic wastewater. The ERT agreed with the justification.	
5.D.1 Domestic wastewater – CH_4 (W.11, 2021) Accuracy	Estimate CH_4 emissions from leakage from anaerobic digestion of sewage sludge by using either country-specific information on the leakage rate or, if no country-specific information is available, the default value of 5 per cent from the 2006 IPCC Guidelines (vol. 5, chap. 4, p.4.4).	w.4	Resolved. The Party reported in its NIR (p.326 and table 7.24, p.319) that CH_4 emissions from sludge have been subtracted from the total amount of CH_4 produced because emissions from sludge from wastewater treatment are considered under landfills, agricultural soils and incineration. In addition, Italy has distinguished between CH_4 recovery from flaring and for energy generation, the latter being reported under the energy sector.	
5.D.1 Domestic wastewater – CH_4 (W.13, 2021) Transparency	Include information on the approach used to estimate TOW in sludge in the NIR.	w.5	Resolved. The Party reported in its NIR (p.326, including table 7.35) that TOW in sludge has been estimated as half of standard TOW, on the basis of international literature (Metcalf and Eddy, 1991), which states that the typical reduction in volatile solids achieved in anaerobic digestion for mixed sludge (primary plus secondary) varies between 45 and 60 per cent.	
5.A Solid waste disposal on land – CH_4 accuracy	The ERT recommends that the Party plan and begin research in order to verify that the parameters presented in the national short term studies are still relevant to the national conditions of Italy in order to improve the estimates by using a higher-tier methodology (tier 2 or 3) that use separate country-specific DOC_f values defined for specific waste types. The ERT notes that it is good practice to use disaggregated DOC_f values specific to waste types only when waste composition data are based on representative sampling and analysis over a longer period.	w.6	Italy has planned a survey on the characterization of waste also from the point of view of degradable organic carbon through discussions with the staff of the national waste center managed by ISPRA. The goal is to evaluate data and studies with useful information and to verify the accuracy and consistency of DOC_f values.	

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
5.C.2 Open burning of waste – CO2 transparency	The ERT recommends that the Party update the values for the fraction of the population burning waste and the fraction of the waste amount that is burned relative to the total amount of waste treated using best available research data or expert judgment.	w.7	Italy does not agree with the recommendation. The 2006 IPCC Guidelines report as default value Bfrac=0.6. In recent years the most important fires (industrial warehouses) involved 1800 Mg in Corteolona in 2018 and 8400 Mg in Pomezia in 2017 which means negligible quantities even considering an order of magnitude higher. For example, if they were 100,000 Mg of open burning waste annually, they would be equivalent, from 1990 to 2018, to approximately 0.4% to 0.3% (instead of the 60% represented by the default). More 2006GL stated that "For countries that have well functioning waste collection systems in place, it is good practice to investigate whether any fossil carbon is open-burned. In a developed country, Pfrac can be assumed to be the rural population for a rough estimate. In a region where urban population exceeds 80 percent of total population, one can assume no open burning of waste occurs." And Pfrac (Istat,2017 "Forme, livelli e dinamiche dell'urbanizzazione in Italia") is less than 10% (9-9.4%) which means that rural population is more than 90% and open burning of urban waste can be considered negligible.	
5.D.1 Domestic wastewater – CH_4 Accuracy	The ERT recommends that the Party reconsider its assumption of a 50 per cent share of CH_4 in biogas and provide the value and its documentation in the NIR. The ERT also recommends that Italy investigate possible reasons for the remaining difference between the amount of indigenous sewage sludge gas production reported to Eurostat (2,137 TJ in 2019) and the amount it estimated on the basis of the volume of biogas provided by Terna (1,415 TJ in 2019), which may include other uses of biogas (e.g. blending with natural gas, own use in wastewater treatment plants) in addition to the use of biogas for the production of electricity and heat, or consider estimating CH_4 recovery for energy on the basis of total indigenous biogas production.	w.8	Production data is not comparable with biogas recovered wich will be less than production data . Biogas not recovered has been flared in high temperature torches. Moreover biogas data in the energy balance are not comparable at all with emissions from sewage sludge management. As a consequence it is not clear why we should revise the amount of CH_4 in biogas.	

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
5.D.1 Domestic wastewater – CH_4 **Not an issue/problem**	The ERT encourages the Party to pursue its investigation into a different methodology for estimating total biogas production and revise the amount of CH_4 flared accordingly.	w.9		
5.D.2 Industrial wastewater – CH_4 Accuracy	The ERT recommends that the Party conduct an investigation into COD values and wastewater generation for the most significant industries and report the findings in the next submission.	w.10	Additional info has been included in the NIR	Paragraph 7.5.2 & 7.5.4

Under the European National Emission Ceiling Directive (NECD), an in-depth review has been conducted since 2017. The main resulting findings and how the recommendations were addressed for the waste sector in 2024 review process are reported in Table 2.

Table 2. *Response to the NECD review.*

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-5B1-2022-0001	No	5B1 Biological treatment of waste - Composting, NH_3, 1990-2022	For category 5B1 Biological treatment of waste - Composting, NH3, all years, the TERT notes that the implied emission factor is 0.024 g/Mg of waste, which corresponds to the application of the Tier 2 methodology with an abatement efficiency of 90% applied to the total amount of waste composted. This was raised during the 2022 and 2023 NECD inventory reviews. The recommendation was to consider the penetration rate of abatement technologies and improve its methodological description. The TERT notes that the issue is below the threshold of significance for a technical correction. The TERT notes that the IIR Guidance (p. 199) states the issue has been included in the list of improvements and that Italy is looking for further information to apply the penetration of technologies back to 1990. The TERT reiterates the recommendation that Italy provide further justification for its application of the 90% abated emission factor 0.024 g/Mg across its entire time series of NH3 emissions from 5B1 Compost production. If appropriate, Italy may need to recalculate the early time series using an unabated emission factor.	NO	YES

Inventory improvements and QA activities

Other improvements not identified during the review processes have been carried out in the last years.
In recent years, Italy has investigated more deeply the country specific conditions and revised the k-values considering the subdivision of the national territory in dry or wet zones on the basis of georeferenced data (30 km grid) consisting of the monthly average climatic summaries (period 1986-2015) of precipitation and evapotranspiration referring to the rainy period (October-December) and to the entire national territory provided by the Research Centre for Agriculture and Environments CREA-AA. Subsequently the ratio between precipitation (MAP = Mean Annual Precipitation) and evapotranspiration (PET = Potential Evapotranspiration) has been calculated and dry and wet zones distinguished following the 2006 Guidelines.

The LCV used for biogas derives from national experts and it has been verified with energy and quantitative data about biogas production from waste supplied by TERNA (National Independent System Operator)[37] .
Where information is available, wastewater flows and COD concentrations are checked with those reported yearly by the industrial sectoral reports or technical documentation developed in the framework of the Integrated Pollution and Prevention Control (IPPC) Directive of the European Union (http://eippcb.jrc.es).
A thesis on GHG emissions from wastewater handling has been carried out at Environmental, Hydraulic, Infrastructures and Surveying Engineering Department (DIIAR) of Politecnico di Milano[38], where national methodology has been compared with that reported in 2006 IPCC Guidelines and with a methodology developed in the framework of a previous thesis for the estimation of emissions from wastewater treatment plants located in Regione Lombardia.
Moreover, in the framework of EPER/E-PRTR registry the methodology used to estimate emissions from wastewater handling can be used by the operators of wastewater treatment plants to check if their emission data exceed the reporting threshold values.

As planned in the previous submissions a rearrangement of incinerators database has been made. During this process an in depth analysis of all incineration plants has been carried out with the target to eliminate double counting and to add eventual no counted plants. Once the list of plants was updated, a new and unique database has been developed to manage activity data, emissions of greenhouse gases and other pollutants, and spatial disaggregation, supporting QA / QC processes. On the basis of carbon content in different waste fraction and the relevant variation along the time series the CO_2 emission factor for incineration has been updated. In a similar way for air pollutants since 2010, emission factors for urban waste incinerators have been updated on the basis of data provided by plants concerning the annual stack flow, the amount of waste burned and the average concentrations of the pollutants at the stack. As the emission factors are considerably lower than the old ones due to the application of very efficient abatement systems it was necessary to apply a linear smoothing methodology assuming a progressive application of the abatement systems between 2005 and 2010. Emission factors for industrial waste incinerators have been updated from 2010 onwards on the basis of the 2019 EMEP/EEA Guidebook. Similarly to municipal waste smoothing has been applied between 2005 and 2010 supposing a linear application of the abatement systems.
Following the discussion started during the European review a specific survey on methane emission factor from composting and the relationship with technologies and management practices has been conducted (ISPRA, 2017) resulting in a new emission factor equal to 0.65 kg CH_4/Mg waste treated on a wet weight basis.
In the same way, detailed information has been acquired about solid waste disposal sites, in particular about:

- Inventory of methane generation rate (k) values for CH_4 from landfills;
- Assessment of values and background of k values;
- Spatial distribution of dry and wet zones in Italy and location of landfills;
- Formulation of a proposal for emission estimates for CH_4 in future NIRs;

[37] TERNA, several years. *Dati statistici sull'energia elettrica in Italia*. Rete Elettrica Nazionale.
[38] Solini, 2010. *Emissioni di gas serra dallo scarico e trattamento di acque reflue*. PhD tesi
ISPRA, 2017. Update of CH4 emission factor from composting. Technical note n.1/2017.

- Verification.

On the basis of this information new estimates have been produced. On the basis of the last European Review (EEA, 2020) A comparison of the IPCC waste model (MS excel) with the model used by Italy for the simulation of biogas production was carried out. To adequately compare the two calculation models, 4 outputs were created corresponding to the categories used in the Italian model:
wet-managed (SWDS in wet zone and well managed), wet unmanaged (SWDS in wet zone and not managed), dry managed (SWDS in dry zone and well managed) and dry unmanaged (SWDS in dry zone and not managed).
Based on the last review process, CO_2 emissions from HWP in SWDS are under investigations. In the current submission, as discussed during the review process in an intersectoral way (LULUCF and waste team), a revision of the method used to estimate the HWP in Solid Waste Disposal Sites has been applied: the waste team has implemented the HWP sheet used in the IPCC FOD model to estimate the long-term storage of C in waste disposal sites and the annual change in total long-term C storage in HWP waste.
Finally, an important improvement in waste data collection has been implemented by ISPRA and the Regional Agencies for the Protection of the Environment, consequently the waste statistical report includes the urban waste data referred to last years allowing timely reporting.

Planned improvements

In the following, specific improvements and remarks to be taken into account in the next submission of the national air inventory for the waste sector are reported.
In Table 4, the planned improvements are synthesized; for each topic, the reference to the UNFCCC category, which the improvement is focussed, is reported.

Table 4. *Planned improvements*

Category	Subcategory	Parameter	Gas	Description	Timing
Biological treatments	Anaerobic digestion			Anaerobic digestion of solid waste is under investigation to collect more information about technologies and emission factors. This survey is taking longer than expected due to connections with other sectors (agriculture, wastewater) to ensure consistency and no double counting.	2022-2026
Waste incineration	Municipal waste incineration	Combustion technologies	GHG	An assessment of the changes in GHG EFs across the time series with the aim of reflecting efficiency improvements or other changes with time is planned for the future.	done
Wastewater treatment and discharge	Domestic and commercial	Activity data	CH_4	The served population equivalent figures supplied by the National Institute of Statistics will be verified with the results of the next national survey, if available.	done
Wastewater treatment and discharge	Domestic and commercial	Anaerobic digestion technology	CH_4	Anaerobic digestion of sludge form activated sludge processes is under investigation to collect more information about technologies and possible gas escape.	2025
Wastewater treatment and discharge	Industrial	Activity data and emission factors	CH_4, N_2O	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories will be applied for industrial wastewaters.	2025

Category	Subcategory	Parameter	Gas	Description	Timing
Other waste	-	Activity data and emission factors	AQ pollutants	Acquire more info about data and management system of waste not considered in 5A-5B-5C-5D categories. Focus on accidental episodes.	done

Solid waste disposal on land

An in depth analysis of EWC codes of waste disposed of in landfills will be done for the year 2019, as for 2007, thanks to the complete database of Waste Cadastre kindly supplied by ISPRA Waste Office. This accurate analysis permits to adequate the waste composition to the current framework. Starting from the settings of the previous work carried out on the 2007 data, the municipal waste sent to landfill was classified into the different classes considered in the 2006 IPCC Guidelines in order to obtain the three categories: slowly, moderately and rapidly biodegradable. These values were compared with various regional studies conducted over the last 10 years on the characterization of waste in landfills. The studies taken into consideration were drawn from the PRGRs of Piemonte (Regione Piemonte, 2016), Emilia Romagna (Regione Emilia Romagna, 2016), Toscana (Regione Toscana, 2014), Lazio (Regione Lazio, 2020), Calabria (Regione Calabria, 2016), Campania (Regione Campania, 2016) and Sardinia (Regione Sardegna, 2016). Compared to the previous processing (based on 2007 data), the fractions of food residues (-6%) and cellulosic materials (-8%) decrease, related to the better penetration and effectiveness of separate waste collection, which are able to better intercept these fractions and subtract them from landfill disposal. On the other hand, the fraction defined here as underscreen (sottovaglio) and linked to the increase in TMB (Biological Mechanical Treatments) treatments of waste which has led to an increase in treatment residues. Furthermore, from various studies and hypotheses reported in the PRGRs (Regional Waste Management Plan), an increase in the organic fraction in the underscreen was noted, which was assumed to be equal to 70%.

More recent data on the fraction of CH_4 in landfill gas and on the amount of landfill gas collected and treated are under investigation. Different sustainability report and E-PRTR declaration are and will be analysed to obtain activity data about the collected biogas.

Regarding the energy conversion efficiency of biogas engine, actually assumed equal to 0.3, as the technological evolution is probably leading to increase efficiency to around 40%; further investigations are planned.

Investigation on industrial sludge disposed into landfills is on-going, the information about the amount of sludge disposed in managed landfills has already been collected and must be processed and checked on the basis of data reported in the National Cadastre. The National Waste cadastre is managed by ISPRA and is formed by a national branch hosted by ISPRA and regional and provincial branches hosted respectively by the Regional Agencies for the Protection of the Environment. So the system requires continuous and systematic knowledge exchange and QA/QC checks in order to ensure homogeneity of information concerning waste production and management throughout the entire Italian territory.

Following another recommendation deriving from the review process, Italy investigated the possibility to estimate the emissions from certain episodes of illegal dumping. There are no quantitative data about this issue but from a qualitative point of view it was known that waste was prevalently industrial waste rich in heavy metals and inorganic chemicals, generally no or slowly biodegradable. Anyhow, the waste has been collected and temporarily stored in “ecoballe”, therefore officially registered and sent to appropriate treatments resulting in the data reported by the National database

Biological treatment of solid waste

Anaerobic digestion of solid waste is under investigation to collect more information about technologies and emission factors. As concerns composting, an in depth survey has been conducted in 2017 investigating literature and plant data.

Waste incineration

As reported for solid waste disposal on land, the waste composition is very important to improve CO_2 emission factor on the basis of carbon content, but in the case of incineration combustion technologies are equally important. The new information on waste composition has improved also CO_2 waste incineration emission estimates reviewed in the 2019 submission.

The analysis regarding incineration plants has been conducted through verifications and comparisons with data reported in E-PRTR registry, Emissions Trading Scheme and updated data of waste amount and pollutants emissions (ENEA-federAmbiente, 2012). These investigations have led, in the previous submissions, to the allocation of some plants erroneously reported as incinerators whilst boilers and cement kiln facility already considered in the energy sector have been deleted. New updates will come from the new report on energy recovery from waste management published by Utilitalia and ISPRA in 2019 which will be used for next submissions.

Wastewater handling

Possible improvements in future submissions could come from the share of information with the Office of the Ministry of the Environment who is responsible for water activities.

Some improvements could also come from the analysis of E-PRTR data and from Environmental Reports of those industries whose produce wastewaters.

The served population equivalent figures supplied by the National Institute of Statistics will be verified with the results of the next national survey, when available. Anaerobic digestion of sludge form activated sludge processes is under investigation to collect more information about technologies and possible gas escape.

Possible improvements, especially for industrial wastewater estimation, could be derived from a collaboration in a project with SECAM (a company that produces chemicals for wastewater treatment plants), ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and the University of Bologna.

According to the 2021 annual submission review process, where the ERT encouraged the Party to pursue investigation into a different methodology for estimating total biogas production and revise the amount of CH_4 flared, a draft methodology has been applied, with substantial differences in biogas production. Differences are very important, thus investigations are ongoing, concerned also volatile solids destroyed.

Finally, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories will be applied for industrial wastewaters.

IMPROVEMENT PLAN

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NATIONAL AIR EMISSION INVENTORY: IMPROVEMENT PLAN

The quality objectives of the Italian inventory are revised every year and improvements are planned on account of the results of the various review processes, the accuracy of the estimation method, the uncertainty and weight of the category analysed, and a cost effectiveness evaluation.
The following table show a list of priorities identified by the inventory team to be implemented in the next submissions.

Sector	Category	Parameter	Gas	Description	Timing
General	-	-	-	Quantitative uncertainty analysis of emission estimates of other pollutants reported in the UNECE/CLRTAP framework	2020-2025
Energy	-	AD	-	A working group of Ispra and Ministry of Economic Development is investigating about the differences between Eurostat and BEN. The analysis of differences includes the comparison of ETS data with figures of energy consumption for electricity production reported by the Italian Independent System Operator (TERNA) to the Ministry of Economic Development Activities for publication in the BEN	2020-2025
	Public electricity and heat production	EFs	HMs	Update/change emission factors for those pollutants, as zinc, where figures reported in the EPRTR lead to average EFs significantly different from those used	2025
	Transport-maritime	EFs	NOx HC CO PM	Update of average national emission factors for maritime on the basis of the information collected at harbour level by regional environmental protection agencies which should allow the application of more advanced Tiers for this category	2025
IPPU	Cement /lime production	AD	CO_2	Further investigations concerning the replacement of natural raw material in clinker manufacture and in lime production	2025
	Building industry	AD	PM10	Estimate and report emissions from categories 2A7a, “Quarrying and mining of minerals other than coal” and 2A7b, “Construction and demolition”	2025
	Chemical industry	AD	CO_2	A detailed balance of the natural gas reported in the Energy Balance, as no energy fuel consumption, and the fuel used for the production processes in the petrochemical sector	2025
	Lead and zinc production	Allocation	All	Allocation of emission between combustion and process sectors	2020-2025

Sector	Category	Parameter	Gas	Description	Timing
	Consumption of halocarbons and SF_6	AD	F-gases	Investigations are planned in order to gathered further data on emissions from the use of heat transfer fluids. For the foam blowing improvements are planned in order to investigate the consumption of other F-gas used and the different contribution of closed cell and open cell foams. In the air conditioning and refrigeration sectors improvements are planned to improve the evaluation of disposal and recovered emissions, the topping up and the use of other refrigerants.	2020-2025
	Paint application	EFs	HC CO_2	Assess the possibility to split non industrial application according to the Guidebook EMEP/EEA	2020-2025
Agriculture	Non-dairy cattle	Emission factor	CH_4	On the basis of the information on the standard diets of cattle for fattening, which will be provided by the CRPA, the updating of values relating to dry matter intake currently in use will be evaluated. In addition, the Ym v1lues will be evaluated on the basis of the information on the diets and the data reported in the 2019 IPCC guidelines	2025
	Sheep	Emission factor	CH_4	Additional data and information will be collected to improve the estimation of methane emissions from sheep, in particular for the DE parameter for mature ewes and other mature sheep	2025
	Livestock categories	Emission factor	CH_4	Further assessments will be made on the estimation of methane emissions from storage, considering estimating emissions according to both temperate and cool climate zones, updating temperatures and 2021 Census livestock data	2025
	Agriculture soils	Urea activity data	GHG/ NH3	Further checks will be made between apparent consumption and end uses, based on production data, import, export and final uses.	2025
LULUCF/ KP-LULUCF	Forest land	-	GHG	Implementation of the III NFI's outcomes; the final outcomes, related to the field surveys, are expected to be available in 2022 and update of the estimation for-est model	2025
	Cropland /Grassland	AD/EFs	GHG	Verification activities, data collection	2025
	HWP	EFs	CO_2	Analysis on the end-use, the discard rates of HWP, as well as the final market use of wood in Italy. The main outcome of this investigation could be the set-up of country specific emission factors to be used in the estimation process	2025
Waste	Biological treatment	Anaerobic digestion technology	CH_4	Anaerobic digestion of solid waste is under investigation to collect more information about technologies and emission factors.	2025
	Industrial wastewater	Activity data and emission factors	CH_4, N_2O	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories will be applied for industrial wastewaters	2025