QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR THE ITALIAN EMISSION INVENTORY YEAR 2022

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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 2021, the Italian inventory was submitted to a centralised UNFCCC review; also, the European annual review of GHG emission inventories of Member States took place in 2021, under the Effort Sharing Decision. 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
2021 ACTIVITIES AND FUTURE IMPROVEMENTS

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NATIONAL AIR EMISSION INVENTORY: ENERGY

Objective

The improvements carried out during the preparation of the 2021 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 2021), then implemented, are reported.

Table 1. *Issue raised for the Energy sector during the UNFCCC review in 2021*

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
Comparison with international data – refinery feedstocks Accuracy	The Party reported in CRF table 1.A(b) a figure for the stock change of refinery feedstocks (–75,646.85 TJ in 2019) which differed substantially from that provided to the IEA (18 kt in 2019, which is approximately 765 TJ). During the review, Italy clarified that there is a difference in the modalities of reporting the national energy balance compared with the format of the joint questionnaire submitted to the IEA. The Party also stated that it plans to conduct further analysis by involving experts responsible for the compilation of the national energy balance in order to harmonize the submissions. The ERT recommends that the Party check the value reported in the CRF table 1.A(b) on stock change of the refinery feedstock and report in the NIR on any further analysis of the comparison of the data reported in the CRF and those reported to the IEA.	E.4	Additional information has been included in the NIR	Annex 4
1.A.1.a Public electricity and heat production – waste – CO2, CH4, N2O Accuracy	The Party reported in CRF table 1.A(b) the amount of waste (non-biomass fraction) production in 2019. The ERT noted that this figure was 53 per cent lower than that reported to the IEA. During the review, Italy clarified that the value provided related only to waste for electricity production and did not include the waste for heat production and that for 2019 the value would be approximately 17 per cent higher if the latter were included. The ERT recommends that the Party undertake a review of the amount of waste used in the energy sector and account for waste used not only for electricity production but also for heat production and make any appropriate amendments to the CRF tables.	E.5	The figures have been revised according to the recommendation	Annex 4
1.A.3.b Road transportation – biomass – CO2, CH4, N2O Trasparency	The Party reported in its NIR (section 3.5.3.2.1.1, p.92) that biogasoline accounts for 0.4 per cent of total road gasoline consumption. The NIR refers to fossil fuel fraction in biodiesel when describing the assessment of CO2 emissions from biofuels (p. 93) without specifying the share of biodiesel, it was unclear from the text whether emissions estimates had been compiled only for biodiesel or also for biogasoline. During the review, Italy clarified that emissions had also been estimated for biogasoline consumption. The ERT recommends that the Party specify in the NIR that emission estimates also have been compiled for biogasoline consumption.	E.6	The relevant information has been provided in the NIR	Chapter 3 paragraph 5

During the EEA greenhouse gases review related to the 2020 submission of Italy, no issues were raised in the review report and no revised estimates or technical corrections were deemed necessary, issues identified during the review have been nevertheless taken into account as much as possible to improve 2021 submission.

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

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

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-1A1-2019-0001	No	1A1 Energy Production, BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, 1990 - 2017	For category 1A1 Energy Production and pollutants heavy metals and persistent organic pollutants the TERT noted that there is a lack of transparency regarding whether Italy has reviewed current country-specific emission factors against those in the EEA Guidebook 2019 and plant-specific data (where available). The TERT notes that improvements in transparency have been provided in the IIR and in the ISPRA spreadsheet of emission factors (referenced in the IIR). This was raised during the 2019 and 2020 NECD inventory review and does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that work has commenced on reviewing emission factors for 1A1 (also 1A2 and 1A4) and transparency has been improved by colour- coding of emission factors in supplementary documentation for the IIR. Furthermore, Italy has indicated that there will be a reorganisation to the IIR structure for the energy activities for the 2022 submission to improve transparency. The TERT recommends that the reorganisation of the IIR is completed for the 2022 submission and that progress on reviewing the emission factors is documented in the IIR.	No	Implemented
IT-1A2-2019-0001	Yes	1A2 Stationary Combustion in Manufacturing Industries and Construction, BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, 1990-2018	For category 1A2 Stationary Combustion in Manufacturing Industries and Construction and pollutants heavy metals and persistent organic pollutants the TERT noted that there is a lack of transparency regarding whether Italy has reviewed current country-specific emission factors against those in the EEA Guidebook 2019 and plant-specific data (where available). The TERT notes that improvements in transparency have been provided in the IIR and in the ISPRA spreadsheet of emission factors (referenced in the IIR). This was raised during the 2019 and 2020 NECD inventory review and does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that work	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			has commenced on reviewing emission factors for 1A2 (also 1A1 and 1A4) and transparency has been improved by colour- coding of emission factors in supplementary documentation for the IIR. Furthermore, Italy has indicated that there will be a reorganisation to the IIR structure for the energy activities for the 2022 submission to improve transparency. The TERT recommends that the reorganisation of the IIR is completed for the 2022 submission and that progress on reviewing the emission factors is documented in the IIR.		
IT-1A2a-2019-0001	Yes	1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel, PCBs, HCB, Cd, 2005, 2016, 2017	For category 1A2a Stationary Combustion in Manufacturing Industries and Construction: Iron and Steel and pollutants Cd and HCB the TERT noted that the IEF ratios are outliers when compared to other Member States. This was raised during the 2019 NECD inventory review. In response to a question raised during the review, Italy explained that for HCB, the emission factors used by the inventory are based on measurements from 2007 and the derived emission factors are applied across the time series as no other emission factors are available. For Cd, Italy has made changes to estimation methodology in the 2021 submission based on a revised estimate from the 2020 NECD inventory review. Italy has also commenced a review of HCB emission factors. The TERT recommends that Italy reviews the methodology for HCB emission estimates and reports in the 2022 submission.	No	Implemented
IT-1A2b-2019-0001	No	1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-Ferrous Metals, PCBs, HCB, 1990-2018	For category 1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-Ferrous Metals and pollutants HCB and PCB for all years the TERT noted that the notation key 'NA' (Not Applicable) was used in the 2021 submission. This was raised during 2019 and 2020 NECD inventory review. In response to a question raised during the review, Italy explained that emissions had been calculated but had been omitted from the 2021 submission. Italy provided a revised estimate for all years and stated that it will be included in the next submission. The TERT agreed with the revised estimate provided by Italy. The TERT recommends that Italy include the revised estimate in its 2022 NFR and IIR submission.	RE	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-1A2b-2019-0002	Yes	1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-Ferrous Metals, PCDD/F, 1990-2018	For 1A2b Stationary Combustion in Manufacturing Industries and Construction: Non-Ferrous Metals and pollutant PCDD/F the TERT noted that there is a lack of transparency regarding allocation of emissions between activity 1A2b and 2C activities. This was raised during the 2019 and 2020 NECD inventory review and does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained it intends to explore the allocation of PCDD/F emissions between 1A2b and 2C activities alongside a wider review of emission factors used in 1A2. The TERT recommends that Italy completes this improvement and reports results in the 2022 submission.	No	Not implemented
IT-1A3c-2021-0001	No	1A3c Railways, PM2.5, 1990-2009	For 1A3c, PM2.5, years 1990-2019, the TERT noted PM2.5 emissions are equal to PM10 whilst the 2019 EMEP/EEA Guidebook provides different emission factors for PM10 and PM2.5 in Table 3.1. In response to a question raised during the review the Italy stated that they will revise the estimates in the next submission. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that in the 2022 submission Italy applies the methodology for PM2.5 emissions for 1A3c from the 2019 EMEP/EEA Guidebook or update the IIR to explain the methodology used.	No	Implemented
IT-1A4ci-2021-0001	No	1A4ci Agriculture/Forestry/Fishing: Stationary, PM2.5, 2000-2019	For category 1A4ci and pollutants PM10 and PM2.5 the TERT noted that there is a lack of transparency regarding the reason why PM10 and PM2.5 emissions are the same despite significant use of non-gaseous fuels in recent years. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that it intends to review emission factors used for biomass. The TERT recommends that Italy completes the review and, implements and reports the results in the 2022 submission.	No	Implemented
IT-GRID-F-2020-0001		F Road Transport, SO2, NH3, Cd, Pb, PCDD/F, PAHs, 2015	The TERT recommends that Italy report road transport and rail emissions in the relevant separate GNFR sector categories in the next submission.	No	Implemented
IT-GRID-F-2020-0002		F Road Transport, NOX, NMVOC, PM2.5, PM10, CO, 2015	The TERT recommends that Italy report road transport and rail emissions in the relevant separate GNFR sector categories in the next submission.	No	Implemented

The NIR and IIR report additional information about the last review processes (e.g UNFCCC[23] and UNECE [24]), 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 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.
For the stationary combustion in industry and in transformation sector the CO_2 emission factors for natural gas have been slightly revised for 2017 - 2019 taking into account the biogas produced and fed in the natural gas distribution network.
Fugitive CH_4 emissions from natural gas distribution have been recalculated because of new information provided by the relevant operators.
For 1.A.2 sector a revision of emission factors on the basis of EPRTR plant level data involved SO_X, NO_X and NH_3 for glass and lime production, and on the basis of plant data SO_X, NO_X, PM, Heavy metals and HCB for the iron and steel sector. Moreover HCB and PCB emissions from secondary aluminium production has been included for the whole time series.
For 1.A.3.a aviation category, there has been an update for the entire time series of PAH from 1990 to 2017 due to the correction of an error in the calculation of the emissions. Furthermore, as regards aviation, over the years verification and comparison activities covered 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.
For road transport (1.A.3.b), the upgraded version of COPERT 5, v. 5.5.1 has been used including a revision of emission factors in particular for PM and applying concurrently the improvement regarding a general review of mileages and input parameters, that resulted in a revision of emission estimates for the whole time series. Respect to last submission, biogas road consumption has been also taken into account in the Inventory, reported only for the last reporting year 2020 in the IEA - Eurostat - UNECE Energy Questionnaire. Moreover the estimation of non exhaust PAH has been revised, respect to last submission, differentiating the calculation for the two components tyre and brake wear (on the basis of PM TSP non exhaust emissions, now COPERT model gives in output the detail but previously non exhaust emissions were aggregated), according to 2019 EMEP\EEA Guidebook.
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

[23] UNFCCC, 2022. Report on the individual review of the annual submission of Italy submitted in 2019. Note by the expert review team. https://unfccc.int/documents
[24] UNECE 2021, Final Review Report 2021, Review of National Air Pollutant Emission Inventory Data 2021 under Directive 2016/2284 (National Emission reduction Commitments Directive)

have been discussed with national experts in the framework of an *ad hoc* working group on air emissions inventories, chaired by ISPRA.
For 1.A.3.d maritime activities, the total number of ships arrived has been updated from 2017.
As regards navigation, estimates were also discussed over the years with ISTAT experts and there is an ongoing collaboration and data exchange with regional environmental agencies.
Regarding QA/QC activities about pipeline compressors, fuel consumptions reported by the national operators for this activity are compared with the amount of natural gas internal consumption and losses reported in the energy balance as well as with energy consumption data provided by the operators to the emission trading scheme.
For 1.A.4 energy recovery from waste reported in the commercial heating has been updated from 2018 because of the update of activity data.
Moreover the planned improvement of the structure of the energy chapter of the IIR has been implemented introducing specific detailed paragraphs for 1A1 and 1A2 categories.

Planned improvements

In this paragraph further improvements identified during the preparation of the National Inventory, National Inventory Report 2022 and of the Informative Inventory Report 2022 are presented.

The database containing 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.
Energy data submitted to the international organizations in the framework of the Joint Questionnaire OECD/IEA/EUROSTAT are compared with the national energy statistics with the aim to reduce the differences with the international statistics. Progressively in depth verification involved different fuels and sectoral energy consumption. A revision of biomass and waste fuel consumption time series is planned on the basis of energy data communicated by the Ministry of Economic Development to the Joint Questionnaire OECD/IEA/EUROSTAT, after a verification and comparison with data up to now used and available in the National Energy Balance reports.
The use of data and country specific emission factors collected in national research involving road transport and biomass consumption in residential is planned; 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, is in plan, so to update emission factors as needed.

For maritime activities further improvements will regard a verification of activity data on ship movements and emission estimates with regional environmental agencies, especially with those more affected by maritime pollution. In particular we plan to build an emission estimation database which calculate 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. As regards 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.

The previous activities will improve the robustness and accuracy of data reported in the national balance thus of the emission inventory estimates.

Table 2. *Planned improvements*

Category	Subcategory	Parameter	Gas	Description	Timing
Cross-cutting	Energy balance	AD		A working group of ISPRA and Ministry of Economic Development is investigating about the differences between Eurostat and BEN	2022
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.	2022
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.	2022 - 2024
1.A.3.d	Maritime Navigation	EFs	NOx HC CO PM	Agreements have been established with ISTAT for maritime data provision which should allow a yearly availability of basic data and the application of more advanced Tiers for the estimation of this sector. Further improvements will regard a verification of activity data on ship movements and emission estimates jointly with regional environmental agencies, with the aim to build an emission estimation database which calculates every year emissions at harbor level taking into account the information officially provided by Italy to EUROSTAT.	2021 - 2022
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.	2022 - 2024

QA/QC INDUSTRIAL PROCESSES AND PRODUCT USE
2021 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 2022 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 previous review report for Italy because no findings for the IPPU sector additional to those included in table 3 of the review report were made by the ERT in 2021.

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. General all gases Convention reporting adherence	The ERT recommends Italy to fix the issues mentioned above including at least: a) Verifying the references as well as the web links to AD and including the right ones or a table with the information; b) Verifying systematically the processing of AD; c) Checking the description of recalculations in the NIR against the CRF tables and ensuring that any recalculations performed are correctly described in the NIR in both the category and the Chapter summarizing the recalculations. d) Ensuring the proper use of the notation keys; e) Performing QA of the NIR and the CRF tables and correcting errors annually before the submission;	I.1	The NIR has been updated accordingly and the notation keys have been updated.	Chapter 4
IPPU 2. General – CO_2, CH_4 and N_2O Transparency	The NIR provides information for each category under headings such as “source category description”, “methodological issues” and “source-specific QA/QC and verification”. However, methodological and verification issues are mixed together and described under all headings, impeding understanding. In addition, trends in most categories are explained by the use of the data source (e.g. EU ETS, The European Pollutant Release and Transfer Register (E-PRTR), the relevant association) but explanations of the methodologies and assumptions used to elaborate the emission estimates for each subcategory are not sufficiently clear. In addition, the simultaneous use of EU ETS and E-PRTR data is not transparently presented for all the categories likely to cause confusion. During the review Italy showed the methodologies used in each subcategory together with the input AD and its sources. When available, EU ETS verified data is the preferred source if it covers all plants of the subcategory. This source of information is complemented by E-PRTR data when it helps to	I.2	The NIR has been updated accordingly as possible. In particular, as regards 2.F.1 category, refrigeration sector is described separately from the stationary air conditioning sector, to better take into account the different method of emissions estimating used but also the different types of data available.	Chapter 4; paragraph 7

CRF category /issue	Review recommendation	Review report /paragraph	MS response / status of implementation	Chapter/section in the NIR
	cover the whole subcategory. Where this is not possible, national data is used and cross-checked using EU ETS and E-PRTR data. Large combustion plant data is used for cross-checking purposes. Although this is the general approach, the combination and prioritization of data sources is different depending on the subcategory. The ERT recommends that Italy include more focused information under each heading in the NIR to support understanding and provide more detailed information on the AD selection and the methodologies used to estimate emissions under the "methodological issues" heading in each subcategory of the IPPU sector			
IPPU 2.B Chemical industry – N_2O Transparency	In recent years, as EU chemical plants have to report measured emissions under the EU-ETS, Italy has used information on certain measured GHG emissions for N2O emissions from nitric acid production or adipic acid production). However, a tier 2 method is indicated in CRF table summary 3 for the gases in these categories, rather than the tier 3 method based on measurements. During the review Italy explained that a tier 2 method was indicated because the emissions had not been estimated using very detailed information or complex models. The ERT recommends that Italy select a tier methodology according to the 2006 IPCC Guidelines and provide updated information on the tiers used across the time series in the NIR.	I.3	The NIR has been updated accordingly	Chapter 4 paragraph 3
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.4	Italy is carrying out the requested investigations and a revision of official statistics is ongoing by ISTAT. In any case, it will not affect emissions in the IPPU sector but if any in Agriculture.	Chapter 4 paragraph 3
IPPU 2.F.1 Refrigeration and air conditioning HFCs Transparency	The ERT recommends that the Party describe in the NIR the approach followed and the equations used to calculate the AD and EFs used and the emissions at each stage of the useful life cycle of the equipment (manufacturing, stocks and disposal) for each subcategory in accordance with the information provided in CRF table 2(II)B-Hs2.	I.7	The approach followed and the equations used for calculating the activity data, emission factors used and the emissions of each stage of the useful life cycle of the equipment (manufacturing, stocks and disposal) for each sub-category have been described in detail in the NIR	Chapter 4 paragraph 7
IPPU 2.D.3 Other non-energy products from fuels and solvent use – CO_2 Convention reporting adherence	The ERT recommends that the Party present national totals with and without indirect CO_2 emissions in CRF table summary 2. The Party continues to report total national emissions including indirect CO_2 emissions in CRF tables (e.g., CRF table summary 2 or CRF table 10 on emission trends) under the heading for total national emissions excluding indirect CO_2 emissions and "NA" for the totals of national emissions including indirect CO_2 emissions indicated instead of numerical values to reflect the reporting of indirect CO_2 emissions from solvents. The Party stated its arguments in the NIR (p. 580) and, also, during the review. Italy stated that CRF table summary 2 is populated automatically and	I.5	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

CRF category /issue	Review recommendation	Review report /paragraph	MS response / status of implementation	Chapter/section in the NIR
	the reporting of the notation key "NO" therein is the result of using this notation key under "indirect CO_2 emissions" in background tables for the IPPU sector. It also stated that reporting indirect CO_2 emissions in the totals would reduce transparency because emissions would be reported at an aggregated level and not at the level at which they occur, and that implementing the recommendation would result in a different national total with implications for other relevant assessments (e.g., trend and key category assessments). Italy referred to the conclusions from the 17th meeting of GHG inventory lead reviewers (available at https://unfccc.int/sites/default/files/resource/conclusions-GHG_LRs-2020.pdf) to support its assessment further. The ERT considers that this approach is not in accordance with paragraph 29 of the UNFCCC Annex I inventory reporting guidelines, according to which, for Parties that decide to report indirect CO_2, the national totals shall be presented with and without indirect CO_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". The Party continues to use notation key "NO" for indirect emissions from the IPPU sector in CRF table 6 although indirect emissions are reported for this sector under category 2.D.3 (NIR, p.153). During the review, the Party stated that it seems inappropriate to use "IE" in CRF table 6. It noted that "IE" would only apply to indirect CO_2 emissions attributed to category 2.D.3 and using "IE" would conceal where such emissions occur. See ID# I.5 above.	I.6	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 2021.

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

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
T-2A5b-2021-0001	Yes	2A5b Construction and Demolition, PM10, 1990-2019	The TERT recommends that Italy includes all the available estimates in its next submission, including a description of the method, AD and EF in the IPPU chapter of the IIR.	No	Implemented
IT-2D3c-2021-0001	Yes	2D3c Asphalt Roofing, CO, 1990-2019	For 2D3c Asphalt Roofing for CO for 1990-2019 the TERT noted that the notation key 'NA' (not applicable) is used while a Tier 1 method is available in the 2019 EMEP/EEA Guidebook. In response to a question raised during the review Italy explained that CO emissions will be included in its next submission. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Italy includes the emissions in its next submission and describes the	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			method, the AD and EF in the IPPU chapter of the IIR.		
IT-2A1-2019-0001	Yes	2A1 Cement Production, $PM_{2.5}$, 1990-2019	For 2A1 cement production for PM2.5 for 1990-2019 the TERT noted that there is a lack of transparency regarding the method AD and EF used for the estimate. This does not relate to an over- or under-estimate of emissions. This was raised during the 2019 and 2020 NECD inventory review. In response to a question raised during the review, Italy explained that the relevant paragraph of the IIR will be updated in the next submission and that the correct information about the PM10 recalculation has been reported in the relevant paragraph 4.5.1. The TERT recommends that Italy includes in its next IIR the description for the method, AD and EF for this category and pollutant.	No	Implemented
IT-2A5a-2017-0001	No	2A5a Quarrying and Mining of Minerals Other Than Coal, $PM_{2.5}$, 1990-2019	For 2A5a Quarrying and Mining of Minerals Other Than Coal for PM2.5 for 1990-2019 the TERT noted that there is a lack of transparency regarding the further investigations that Italy planned and the timeframe for those. This does not relate to an over- or under-estimate of emissions. This was raised during the 2017, 2018, 2019 and 2020 NECD inventory review. In response to a question raised during the review, Italy explained that it plans different checks and comparison with bottom-up inventories and an in-depth study is expected in 2022. Consequently, the estimates at national level should be ready in 2023. The TERT recommends that Italy includes in its next IIR the progress of these investigations and confirms or updates the time frame accordingly.	No	Not fully implemented.
IT-2A5b-2017-0001	No	2A5b Construction and Demolition, $PM_{2.5}$, 1990-2019	For 2A5b Construction and Demolition for PM2.5 for 1990-2019 the TERT noted that there may be an under-estimate of emissions. This was raised during the 2017, 2018, 2019 and 2020 NECD inventory review. In response to a question raised during the review Italy explained more in detail about the further investigations that are under way (IIR p. 114). Italy explained that it has collected statistical activity data on residential and non-residential building construction permits (from 1995 on) that will allow to apply a Tier 1 approach while for road construction it is still evaluating the proper indicator to calculate the annual	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			activity data because only economic statistics are available. The TERT is not able to determine whether the issue is above or below the threshold of significance for a technical correction. The TERT recommends that Italy includes all the available estimates in its next submission, including a description of the method, AD and EF in the IPPU chapter of the IIR.		
IT-2D3e-2017-0001	No	2D3e Degreasing, NMVOC, 1990-2019	For 2D3e Degreasing NMVOC emissions for 1990-2019 the TERT noted that there is a lack of transparency regarding the implementation of the recommendation to improve the methodology by obtaining the information on the composition of cleaning products regarding the different NMVOC compounds or (in case it would be not possible) to take into account the whole amount of used cleaning products. This does not relate to an over- or under-estimate of emissions. This was raised during the 2017, 2018, 2019 and 2020 NECD inventory review. In response to a question raised during the review, Italy explained that it used as activity data the amount of solvent used and that in absence of information on the abatement technologies, as suggested for Tier 2, the assumption is that the system is uncontrolled, and all solvent is emitted. Italy will check this assumption with the relevant industrial association for the next submission. The TERT recommends that Italy clearly describes the method, EF and AD in the IPPU chapter in its next submission.	No	Implemented
IT-2D3g-2021-0001	No	2D3g Chemical Products, $PM_{2.5}$, 1990-2019	For 2D3g Chemical Products for 1990-2019 the PM2.5 estimate is equal to the estimate for PM10. The TERT would expect that for this category, PM10 estimates are higher than (rather than equal to) PM2.5 estimates. The TERT noted that there is a lack of transparency regarding the reason for this. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that PM emissions come from polyester and polyvinychloride processing and EFs have been provided by the relevant industry and that no PM EFs are provided in the 2019 EMEP/EEA Guidebook for this activity.	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			The TERT recommends that Italy checks with the relevant industry on the method for determining the EFs, why the EF for PM2.5 is the same as that for PM10 and provides information on this in its next IIR.		
IT-2C1-2021-0002	Yes	2C1 Iron and Steel Production, PAHs, 1990, 2005, 2016, 2017, 2018, 2019	For emissions of PAHs for years 1990, 2005, 2016-2019 for 2C1 Iron and Steel Production the TERT noted that there is a lack of transparency regarding whether or not emissions from blast furnace charging, basic oxygen furnace and sinter production are estimated. From the description in the IIR it is not clear since the IIR (on p. 106) does not include an EF for these subcategories while there exists a method end EF in the EMEP 2019 Guidebook. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained that further information is given in the combustion chapter and that emissions are estimated on the basis of country specific emission factors at activity level, especially referring to sinter plants production, as provided by the main national operators and it is not possible to split up between combustion and process. For blast furnaces, results from measurements learn that the EF used for pig iron tapping covers also blast furnace charging. Emissions from BOF are negligible. Based on the data collected data in the context of the environmental authorisation of the largest Italian (and European) plant, Italy is reviewing the emissions of all pollutants starting from 2015 based on the measurement data for each section of the installation and for each chimney. The revision of the estimates is foreseen for the next submission. The TERT recommends that Italy includes a clear explanation for the estimate of PAH emissions in the IPPU chapter or a clear reference to the relevant chapters elsewhere and that Italy includes the reviewed emissions from 2015 on, including for a clear explanation on the method and data used.	No	Implemented
IT-2C3-2020-0001	No	2C3 Aluminium Production, $PM_{2.5}$, HCB, PCDD/F, PM_{10}, BC, 1990-2018	For 2C3 Aluminium Production for PM2.5, HCB, PCDD/F, PM10 and BC for 1990-2018 the TERT noted that there is a lack of transparency regarding the use of the notation key 'IE'. This does not relate to an over- or under-estimate of emissions. This was raised during the 2020 NECD inventory review. In response to a question raised during the review,	No	Partly implemented.

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			Italy provided further clarification of how emissions are estimated in 1A2b by providing the AD and the country specific EF. The TERT recommends that Italy reports these emissions under 2C3 in its next submission and reports on the method, AD and EF in the IPPU section of the IIR.		

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. Activity data and emissions reported under EU-ETS and EPER/EPRTR are compared with the information provided by the industrial associations. In particular, comparisons have been carried out for iron and steel, 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. Additional QA/QC was performed on the inventory of CO_2 emissions from the decarbonation process in the national cement industry: resulting suggestions to focus on raw materials fed to clinker kilns[25] were considered and the description of the fluctuation of the CO_2 implied emission factor was already improved in the previous NIR accordingly. Specifically, further investigations about the amount of limestone & dolomite used have led to an update of the activity data and CO_2 estimates along the whole time series.

Further exchange of information with the only facility operating the Titanium dioxide manufacturing process has allowed for avoiding double counting of CO_2 process-related emissions which, in fact, have not been occurring. The whole timeseries was revised accordingly in 2021.

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. Emissions from primary aluminium production have been also checked with data reported under EU-ETS. Concerning the electric arc furnaces, since 2004, the same estimation scheme as the previous period has been followed but using data becoming from ETS (only process emissions) and related to the amounts of pig iron, metallurgical coke, graphite, anthracite, dolomite, limestone and electrodes. The availability of data for each plant has allowed also the application, for a first attempt, of the Tier 3 methodology (IPCC, 2006) that demonstrated the soundness of estimates.

As the production of primary lead and zinc, in the last year, thanks to the ETS data it has been possible to separate CO_2 emissions in energy and process emissions and Italy is investigating the possibility of extension to other pollutants for the next submissions.

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.

25 Aether ltd, 2013. *Findings and Recommendations of the Independent Review of the Italian Greenhouse Gas Inventory*

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*"[26] 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[27]. The results are reported in "*Fattori di emissione per l'utilizzo di solventi*"[28]) 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.
Additional verifications of the emissions from the sector occurred in 2013, on account of the bilateral independent review between Italy and Spain and the revision of national estimates and projections, where national emissions from the solvent sector were revised by the Spanish team. The analysis by category has not highlighted the need of major methodological revisions of the sector although some general issues on the appropriateness of the activity data used were highlighted as well as the update for some categories of the emission factors for the last years of the time series on the basis of the recent available scientific documentation.
Hence, a revision involved the chemical products subsector with respect to NMVOC emissions, due to the update of emission factors for polyurethane processing; on the basis of the industrial association communication, the phase out of CFC gases occurred in the second half of nineties and the blowing agent currently used is pentane, which resulted in a strong reduction of emissions. NMVOC emission factors for paint application in construction and building, domestic use, wood and other industrial have been checked and when relevant updated in consideration of the latest available source of information.
In the actual submission, minor recalculations occurred for paint application subcategories mainly due to the update of emission factors in paint application for the manufacture of automobiles and wood and the update of some activity data in 'Other' (fat edible and non edible oil extraction).

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.

26 TECHNE, 2004. *Progetto MeditAiraneo. Rassegna dei fattori di emissione nazionali ed internazionali relativamente al settore solventi*. Rapporto Finale, novembre 2004
27 EMEP/EEA, 2009. *Air Pollutant Emission Inventory Guidebook*. EEA. Technical report No 9/2009
28 TECHNE, 2008. *Fattori di emissione per l'utilizzo di solventi*. Rapporto Finale, marzo 2008

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.

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	2020-2023
Mineral products	Cement and lime production	Activity data	CO_2	Further investigations concerning the replacement of natural raw material in lime production are planned.	2020-2023
	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"	2020-2023
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.	2020-2023
Metal production	Lead and zinc production	Allocation	All	Combustion vs process for air pollutants. Possibility to split up between zinc and lead production	2020 - 2023
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. 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 to the emissions. In the air conditioning and refrigeration sectors improvements are planned to improve the	2020-2023

Category	Subcategory	Parameter	Gas	Description	Timing
				evaluation of disposal and recovered emissions, the topping up and the use of other refrigerants. Other improvements are planned in the Commercial and Professional Refrigeration. 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.	

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

Electronics Industry Emissions (2E)

Emissions from the use of heat transfer fluids in the semiconductor industry started to be collected for the year 2017. The national industry is part of the European Semiconductor Industry Association (ESIA) and is involved in the activity of WSC (World Semiconductor Council), including gathered emissions from the use of heat transfer fluids. A further investigation in order to better specify the whole time series is again planned.

Emissions of fluorinated substitutes for ozone depleting substances (2F)

Improvements in the estimations of emissions of HFCs used as substitutes for ODS 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 and 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, in order to overcome these problems, we contacted the Responsible of the Registry and we expect to report the results of these investigations in the next year submission.

Stationary Air Conditioning. Thanks to a previous collaboration with the Ministry for Ecological Transition for a survey, at a national level, about HFCs alternative substances with low GWP, natural refrigerants and alternative technologies made in Italy (ISPRA, 2018 [a]) and for the first national census on Italian alternative technologies (ISPRA, 2019), ISPRA is continuously in contact with ASSOCLIMA, the air conditioning national association and with the major experts of the sector. A further investigation in the air conditioning sector is planned to improve the evaluation of emissions from disposal, recovered and containers management, by checking data reported in the National Database and by contacting, as mentioned, the national association and experts. Improvements are also planned regarding the HFCs topping up, the use of R-32 and other significant refrigerants with a lower or null GWP (R-448A, HCs, etc.), in substitution of the traditional R-410A, R-407C and R-134a and the changes in the percentage distribution of equipments by refrigerant type and by average charges, over the years. A check regarding the trend of the average charges of the equipments over the time series is also expected by considering the effect of the Eco-design Directive in terms of energy efficiency of machines.

Commercial Refrigeration. Investigations are planned to improve the evaluation of disposal and recovered emissions and of the HFC topping up, by checking data reported in the National Database and by contacting the national associations and experts. New actions are also planned to gather information about the refrigerants market, by evaluating the presence and use of new HFCs with lower GWP (i.e. R-448A) or natural refrigerants, such as CO_2 that is entering the market especially with the transcritical configuration adopted in supermarket and hypermarket The effects of the growing prices of the traditional gases and the reduction of their availability, together with the bans of F-gas regulation, is causing the switch to alternative substances and thus the reduction of HFC emissions. A further fact-finding survey on organized large-scale distribution, and trade retail for the commercial refrigeration subsector is also planned in order to use this information for integrating and/or checking the estimation method used at present.

Professional Refrigeration – dryes and washer -dryers.Italy has started to investigate the dryers and washer-dryers heat pump machines sector. According to Applia Italia, that we contacted, these machines have been starting to use HFC (R-134a, R-450A, R-407C) since recent times and R-290 is indicated as the main alternative to HFC. For all these machines the manufacturing loss rate is estimated less than 1% (Applia Italia, 2019). To date, no further specific data is available to allow an estimate of emissions but we remain in constant contact with the Association, to check the availability of new information over time.

Fire protection systems, Foam blowing, Aerosols. Sectoral experts were contacted in the last years in order to try gathering additional data and information about Foam blowing, Fire extinguishers and Aerosols sub-sectors but at present no new information is available. For the Foam blowing the investigation focuses on the consumption of other F-gases eventually used in the sectors (i.e. HFC-365mfc and l'HFC-227ea) and on the different contribution of closed cell and open cell foams to the emissions. However, we are in constant contact with these experts to collect any new information that gradually become available.

Other production (2G)

Regarding the other production - (SF_6 Emissions from electrical equipment, SF_6 used in equipment in university and research particle accelerators, N_2O from product uses), the new Presidential Decree, n° 146 of 16 November 2018 adopted due to the enter into force of the F-Gases Regulation n. 517/2014 (EU, 2014), including in its scope also electrical equipment, will improve the control and monitoring system of the appliances. Moreover, improvements in emissions from the use of SF_6 in particle accelerators are expected from new contribution ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and companies belonging to national defence.

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	2020-2023
Paint application	Other industrial paint application	8%	Assess the possibility to split non industrial application according to the Guidebook EMEP/EEA	2020-2023
Degreasing, dry cleaning and electronics	Metal degreasing	4%	Update information, from the national chemical industrial association (Federchimica), on activity data and emission factor	2020-2023
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	2020-2023
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	2020-2023
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	2020-2023

QA/QC AGRICULTURE
2021 ACTIVITIES AND FUTURE IMPROVEMENTS

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April, 2022

NATIONAL EMISSION INVENTORY: AGRICULTURE

Objective

This report describes activities and improvements carried out during the preparation of the 2022 national inventory submission for the agriculture sector.

Review process recommendations

During the last UNFCCC Greenhouse gases review process in 2020 the following issues were raised.

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

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
3.A.2 Sheep – CH4 Transparency	Improve the transparency of reporting on the enteric fermentation of sheep by providing information on the assumptions used to adjust the DE% values for mature ewes and other mature sheep. The ERT noted the provided explanations on the selection of DE% value. It considers, however, that the recommendation is still not fully resolved as it is still not clear in the NIR which assumptions were used to adjust the DE% values for mature ewes and other mature sheep	A.1	Additional information has been provided in the NIR	Chapter 5 paragraph 5.2.2 and 5.2.6
3.A.1 Cattle – CH4 - Transparency	The ERT recommends that the Party conduct further verification of country-specific Ym values for the non-dairy cattle category, as indicated by Italy during the review, and report the results of the verification in the NIR to demonstrate that country-specific values better represent the national circumstances and that a justification is provided in the NIR	A.16	Additional information has been provided in the NIR	Chapter 5 paragraph 5.2.2 and 5.2.6 and Annex 7 paragraph A7.1
3.B Manure management – CH4 - Transparency	The ERT recommends that the Party 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	A.17	Requested information has be provided in the NIR	Chapter 5 paragraph 5.3.2
3.B Manure management – CH4 - Accuracy	The ERT recommends that the Party 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 MCF 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	A.18	Emission factors have been corrected and estimates recalculated	Chapter 5 paragraph 5.3.2 Methane emissions (cattle and buffalo)
3.C Rice cultivation – CH4 - Transparency	The ERT recommends that the Party 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	A.19	Requested information has been provided in the NIR	Chapter 5 paragraph 5.4.3

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
3.B.4 Other livestock – N2O - Consistency	The ERT recommends that the Party report consistently on ostrich manure management emissions between CRF tables 3.B(a) and 3.B(b) including estimates or appropriate notation key together with justification of the exclusion of N2O emissions from ostrich manure management as being an insignificant source, in line with paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines. The ERT also recommends that Italy correct the MMS for ostriches in CRF table 3.B(a)s2.	A.20	N2O emissions from ostrich manure management have been estimated and reported in the CRF. MMS for ostriches in CRF table 3.B(a)s2 has been corrected	Chapter 5 paragraph 5.5.2 Other livestock categories
3.D.a.1 Inorganic N fertilizers – N2O - Transparency	The ERT recommends that the Party 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.	A.21	Requested information has been provided in the NIR	Chapter 5 paragraph 5.5.2

During the last ESD Greenhouse gases review process in 2021 no issue was raised.

During the last NECD review process[29] in 2021 no issue was raised.

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 *2022 submission*[30].

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.

ISPRA together with CRPA participated to the preparation of the instructions for specific queries (grazing, housing, storage and land spreading) of the 2010 Agricultural Census, 2013 and 2016 Farm Structure Survey (FSS), and 2020 Agricultural Census. This exercise will allow obtaining information useful as required by the EC regulation and the improvement of the emission inventory, which will include peculiarities of agricultural production in Italy.

[29] 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).

[30] Di Cristofaro E., several years. *Procedura per la preparazione, caricamento e reporting dell'inventario nazionale delle emissioni 1990-2019, del settore Agricoltura. Rapporto interno VAL-ATM/ISPRA*. Roma – Italia.

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.

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.

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[31,32].

Regarding uncertainty analysis applied to GHG estimates, Monte Carlo analysis has been extended to other key categories of the sector, the estimation of uncertainties are 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, as regards CH_4 emissions from rice cultivation, the cultivation period (days) for some rice varieties have been updated. Despite the upload of the vegetation period of some varieties, the estimate of the average value for water regime does not change the previous values.

In November 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.

As regards N2O emissions from agriculture soils, in 2015, 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 N2O 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.

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

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

[32] 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.

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.
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. Moreover, an assessment of the methane conversion factors (MCF) has been carried out on the basis of the data coming from the Farm Structure Survey 2007 (carried out by ISTAT) and the 2010 Agriculture Census (ISTAT), resulting in very slight differences comparing to the used average methane conversion factors. The percentage of animals in temperate zone based on data from the 2010 Agriculture Census and the average temperature at provincial level are shown in the NIR. This information has been included to support the details on the estimation of the methane emission factors from manure management.
Data on cow's milk collection from farms for dairy industry provided by the AGEA[33] 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. Further investigation will be carried out.
Data on national sales of synthetic nitrogen fertilizers (by type of fertilizers) as provided by *Assofertilizzanti – Federchimica* (personal communication) for the period 2012-2016 have been compared to official statistics provided by ISTAT and used to estimate the FSN amount. Differences were mainly found for the amount of simple mineral nitrogen fertilizers, where data from *Assofertilizzanti* are higher by 20%, on average, for the years 2013-2016. This could be due to a possible double counting of some product which could be considered as a single product and as a compound with other fertilizers. Further investigations will be conducted.
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.
In 2016, 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

[33] AGEA is the Agency for Agricultural Payments. The Agency has the task of performing the functions of coordination, monitoring and disbursement of European funds for agriculture - http://www.agea.gov.it/portal/page/portal/AGEAPageGroup/HomeAGEA/home. Data are available online at the link http://www.sian.it/downloadpub/jsp/zfadlx001.jsp (the filename is *Riepilogo per regione di produzione delle consegne mensili non rettificate registrate*).

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 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 CH4 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

[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).

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 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 equine 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).

Planned improvements

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

Table 4. *Planned improvements*

Category	Subcategory	Parameter	Gas	Description	Timing
Enteric fermentation	Non-dairy cattle	Emission factor	CH_4	Considering the evolution of Italian beef sector in the last 5 years, a revision of the current feeding plan, diets and slaughtering categories is foreseen. The breeding of beef cattle in Italy has evolved in the last five years towards types of animals that are following the consumer's demand: leaner meat, hence also younger animals. Animals consume less dry matter and	2022

Category	Subcategory	Parameter	Gas	Description	Timing
				have higher energy and protein requirements. Therefore, they use less dry matter in relation to live weight, hence more concentrated diets. Based on the collected information, 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 values in use will be recalculated with the Ellis formula based on the updated results of the composition of the diets, and then compared with the values reported in the IPCC 2019 guidelines.	
	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, as recommended during the 2019 UNFCCC review. The data used have been confirmed by experts in the sheep sector of AGRIS Sardegna, the agency of the Region of Sardinia for scientific research, experimentation and technological innovation in the agricultural, agro-industrial and forestry sectors.	2022
Manure management	Livestock categories	CH_4 EFs	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	2023
Agricultural soils	Activity data	Urea	NH_3/GHG	Further checks will be made between apparent consumption and end uses, based on production data, import, export and final uses.	2022

National statistics

The implementation of an *ad hoc* survey on "Agricultural Production Methods", namely Farm and structure survey (FSS), regulated by the European Commission (EC), will be crucial for improving the preparation of the national agriculture emission inventory (UNFCCC/UNECE-CLRTAP). This survey was carried out during the 2010 General Agricultural Census in Italy. 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 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. During 2022, ISTAT will provide data from the 2020 Census of Agriculture that will be used to update inventory estimates.

Estimation improvements

Information and administrative data related to number of heads, average weight by livestock category, food rations of livestock for cattle and swine, milk production data is collected every year by the Ministry of Economic Development as part of the Decree of Ministry for Ecological Transition 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) and comparisons and verifications with the data used to estimate emissions is carried out.

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.

QA/QC LULUCF
2021 ACTIVITIES AND FUTURE IMPROVEMENTS

Prepared by: Marina Vitullo and Guido Pellis

April, 2022

NATIONAL AIR EMISSION INVENTORY: LULUCF

Objective

The report summarizes the improvements and remarks, which have been identified during the preparation of the 2022 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 2020, are described.

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

CRF category / issue	Review recommendation	Review report / par.	MS response / status of implementation	Chapter/section in the NIR
4. General (LULUCF)	Report more detailed explanatory information and a justification for recalculations in the NIR	L.1	Additional information has been included in the NIR	Chapter 6 paragraph 1 of the NIR
4.A Forest Land -CO2	Document the For-est Model validations in the NIR	L.4	Complete NFI2015 results will be available in the late 2022, supplying data related to current increment and stocks; therefore the For-est model validation against the latest NFI data is planned to be implemented for 2023 submission.	chapter 6 paragraph 2
4.G HWP – CO2 (L.16, 2019) Transparency	Document in the NIR the methodology used for estimating CO2 emissions from SWDS reported in CRF table 4.Gs1 and the rationale for the reported half-life value of 3.89 years.	L.12	Additional information has been included in the NIR	Chapter 6 paragraph 13 of the NIR
4. General (LULUCF)	The ERT recommends that the Party to ensure that key category analysis is reported in a consistent manner in chapter 6 and in the rest of the NIR.	L.15	The key category analysis has been revised.	Chapter 6 paragraph 1 of the NIR
4. General (LULUCF) – CO2	The ERT recommends, with specific reference to cropland and settlements remaining settlements, that the Party use the notation key “NA” in all circumstances where a tier 1 assumption of carbon stocks being in equilibrium (i.e. gains equal losses) is used (see also ID# KL.15 below).	L.16	In LULUCF categories, the notation key "NA" is used, with a comment for each NA occurence, to report carbon stock changes from carbon pools where carbon stock changes are neutral (i.e. FL-Fl (soil), Other wooded land under GL-GL (soil)). for KP activities, the notation key "NE" is used with a comment for each NE occurence (FM (soil), CM-GM (litter, deadwood)), addressing an UNFCCC review recommendation (KL1-ARR 2018, KL1-ARR 2019)	
4.G HWP – AD	The ERT recommends that the Party include in CRF table 4.Gs2 the full series of AD from 1961 onward for HWP used for the estimation of emissions.	L.19	The information requested is available at the link reported in the NIR	Chapter 6 paragraph 13 of the NIR
4.G HWP – CO2	The ERT recommends that the Party estimate HWP in SWDS using methods consistent with the 2006 IPCC Guidelines for the waste sector and report under the information item in CRF table 4.Gs1 and under the memo item in CRF table 5, and also include these in their HWP estimates if they meet the significance criteria of a key	L.20	Additional information has been included in the NIR	Chapter 6 paragraph 13 of the NIR

	category, in accordance with guidance provided in the 2006 IPCC Guidelines (vol. 4, chap. 12, pp.12.8–12.10 and figure 12.1).			
4.G HWP – CO2	The ERT recommends that the Party report in the NIR information which identifies deforestation-sourced HWP as negligible in Italy as justification for not estimating additional deforestation-sourced HWP emissions or sequestrations under the Convention compared with those estimated under the Kyoto Protocol.	L.21	Additional information has been included in the NIR	Chapter 6 paragraph 13 of the NIR
4. General (LULUCF)	Report more detailed explanatory information and a justification for recalculations in the NIR	L.1	Additional information has been included in the NIR	Chapter 6 paragraph 1 of the NIR
4.A Forest Land -CO2	Document the For-est Model validations in the NIR	L.4	Complete NFI2015 results will be available in the late 2022, supplying data related to current increment and stocks; therefore the For-est model validation against the latest NFI data is planned to be implemented for 2023 submission.	chapter 6 paragraph 2
4.G HWP – CO2 (L.16, 2019) Transparency	Document in the NIR the methodology used for estimating CO2 emissions from SWDS reported in CRF table 4.Gs1 and the rationale for the reported half-life value of 3.89 years.	L.12	Additional information has been included in the NIR	Chapter 6 paragraph 13 of the NIR
General (KP-LULUCF)	The ERT recommends that the Party ensure that time series consistency is maintained in the publishing of CRF table NIR-2 by ensuring that, for all categories in all reported years, the area total at the end of the previous year aligns with the previous year's total at the end of the current year and that a consistent total national area is reported in all years.	KL.8	CRF table NIR-2 has been filled with correct data	
General (KP-LULUCF) – CO2, CH4, N2O	The ERT recommends that the Party report transparent and detailed information in the NIR on how its method for applying the natural disturbances provision in FM and AR avoids the expectation of net credits and net debits (see ID# KL.11 below). The ERT encourages the Party to conduct quality assurance on its approach for the next annual submission by personnel not directly involved in the inventory compilation/development process, to support its conclusions.	KL.9	Italy did not apply natural disturbance provision. Additional information has been included in the NIR	Chapter 9 paragraph 4 and 5 of the NIR
General (KP-LULUCF) – CO2, CH4, N2O	Noting that the 2022 submission would be the final annual submission under the second commitment period of the Kyoto Protocol, the ERT recommends that the Party clearly report on its final decision on applying the natural disturbances provision. In the case that the Party decides to apply the provision, the ERT recommends that Italy include all information on areas and emissions from activities relevant to natural disturbances in CRF tables 4(KP-I)A.1.1 and 4(KP-I)B.1.3, allowing the accounting of emissions and removals and the effect of natural disturbances for FM, and also make proper use of these tables to subsequently exclude emissions from accounting in the CRF accounting table.	KL.10	Italy did not apply natural disturbance provision. Additional information has been included in the NIR	Chapter 9 paragraph 4 and 5 of the NIR
AR – CO2, CH4, N2O	The ERT recommends that the Party use methods for estimating the natural disturbance background level and margin ensuring that there is no expectation of net credits or debits and that the methods for natural disturbances are consistent between AR and FM in accordance with decision 2/CMP.7, annex, para. 33(b) and footnote 9.	KL.11	Italy did not apply natural disturbance provision. Additional information has been included in the NIR	Chapter 9 paragraph 4 and 5 of the NIR

AR – CO2, CH4, N2O	The ERT recommends that the Party provide transparent information in the NIR regarding the areas of wildfire in AR from 1990 onward and justify its methods for the estimation of emissions from biomass burning in AR. The ERT also recommends that the Party explains in detail in the NIR how it uses the estimates from biomass burning in construction of the natural disturbances background level and margin.	KL.12	Italy did not apply natural disturbance provision. Additional information has been included in the NIR	Chapter 9 paragraph 4 and 5 of the NIR
FM – CO2, CH4, N2O	The ERT recommends that the Party provide comprehensive and transparent information in the NIR as to how the FMRLcorr is calculated, demonstrating that the policy assumptions used in the construction of the FMRLcorr are the same as for the FMRL, including how the harvesting rate assumptions used for FMRL are maintained in the FMRLcorr and how wildfire emissions have been updated in the FMRLcorr in a manner consistent with the calculation of the natural disturbance background level for FM.	KL.13	Additional information has been included in the NIR; in relation to the calculation the natural disturbances background level and margin for FM, Italy did not apply natural disturbance provision.	Chapter 9 paragraph 5 of the NIR
CM	The ERT recommends that the Party provide additional information in the NIR regarding the consequences of excluding land areas which are reported under CM and GM only in the base year.	KL.14	Additional information has been included in the NIR	Chapter 9 paragraph 5 of the NIR
CM – CO2	The ERT recommends, with specific reference to CM and GM, that the Party use the notation key “NA” in all circumstances where a tier 1 assumption of carbon stocks being in equilibrium (i.e. gains equal losses) is applied.	KL.15	In LULUCF categories, the notation key "NA" is used, with a comment for each NA occurence, to report carbon stock changes from carbon pools where carbon stock changes are neutral (i.e. FL-Fl (soil), Other wooded land under GL-GL (soil)). for KP activities, the notation key "NE" is used with a comment for each NE occurence (FM (soil), CM-GM (litter, deadwood)), addressing an UNFCCC review recommendation (KL1-ARR 2018, KL1-ARR 2019)	
GM – N2O	The ERT recommends that the Party estimate and report N2O emissions from N mineralization or immobilization where CSCs are negative and report the areas and CSCs in mineral soils (including where N2O emissions are not occurring owing to increasing carbon stocks and negative FSOM in mineral soils) in CRF table 4(KP-II)3, and ensure that the reporting under the Convention is consistent with this.	KL.16	The N2O emissions from N mineralization or immobilization have been estimated and reported, where CSCs are negative, in CRF table 4(KP-II)3.	

Inventory improvements and QA activities

Forest land (4A)

Several activities have been implemented and carried out; following the election of Cropland Management and Grazing land Management activities under article 3.4 of the Kyoto Protocol, the Ministry for Ecological Transition (MiTE) jointly with the Ministry of Agriculture, Food and Forest Policies (MIPAAF) has established a Committee of National experts at institutional and scientific level, aimed to deal with all issues related to reporting and coordination of activities related to LULUCF reporting, included also the needs set

out by the Kyoto Protocol. In addition, a specific Decree[36] was adopted by Ministry for Ecological Transition to fulfil the requirements outcoming from the ratification of the Doha amendment to the Kyoto Protocol establishing the second commitment period. The technical annex to the abovementioned Decree includes 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 entry into force of the Decree facilitates the data collection as well as is aimed to increase the quality and timeliness of the gathered data. A specific Annex is included to the NIR to provide detailed information on *For-est* model.

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 living biomass pool, for perennial crops under cropland remaining cropland, and for soil pool. For living biomass, total woody crops area has been broken down into age groups, taking into account three main woody crops categories (i.e. olives, vineyards and other fruit). The estimation process has been carried out at NUTS2 (regional) level based on the available data from national statistics (ISTAT) related to the different woody crops species[37], harvest/maturity cycles. The values of aboveground and belowground biomass carbon stock at harvest for the different crops used to estimate the living biomass C stock changes have been assessed on the basis of the database collected in the framework of the LIFE project MEDINET[38].

For mineral soils, the change in mineral soil C stocks is the result of a change in management practices in a unit of land across time; the detailed list of cropland management practices, for annual and perennial crops, as well as the relevant data sources used for each of the abovementioned management practice, are reported in the NIR (tables 6.17, 6.18). The SOCs, per region and per management practices, for annual and woody crops, are also reported in the NIR (table 6.20).

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.

For mineral soils, the change in mineral soil C stocks is the result of a change in management practices in a unit of land across time; the list of grazing land subcategories, including the relevant data sources used, are reported in the NIR (table 6.25). The SOCs, per region and per management practices, are also reported in the NIR (table 6.27).

Supplementary information required under Article 7.1 of the KP - article 3.3 (Afforestation/Reforestation/Deforestation) and article 3.4 (Forest Management, Cropland Management, Grazing land management)

Following the election of Cropland Management and Grazing land Management activities under article 3.4 of the Kyoto Protocol, the Ministry for the Environment, Land and Sea (MATTM) jointly with the Ministry of Agriculture, Food and Forest Policies (MIPAAF) has established a Committee of National experts at institutional and scientific level, aimed to deal with all issues related to reporting and coordination of activities related to LULUCF reporting, included also the needs set out by the Kyoto Protocol.

[36] Decree of Ministry for Ecological Transition 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).

[37] Olive, vineyard (for wine grapes and other), orchards (orange, mandarine, clementine, lemon, grapefruit, bergamot, cedar, chinotto), apple, peach, pear, apricot, cherry, kiwifruit, other fruits (carob, fig, plum, hazelnut, almond, raspberry)

[38] MEDINET (Mediterranean Network for Reporting Emissions and Removals in Cropland and Grassland): https://www.lifemedinet.com/

Relevant updates occurred in Cropland Management (CM) and Grazing land Management (GM). Living biomass pool has been estimated, for woody crops under CM, considering different woody crops species, broken down into age groups, harvest/maturity cycles. Soil carbon stock changes, under CM and GM, have been estimated based on the change of management practices in a unit of land across time, as reported in the NIR (tables 9.1). The SOCs, per region and per management practices, are also reported in the NIR (table 9.2, 9.3).

Planned improvements

In the following, specific improvements and remarks to be considered in the next submission of the national GHG inventory for LULUCF sector are reported.
In Table 2, the planned improvements are synthesized; for each topic, the reference to the UNFCCC category or KP activity, which the improvement is focussed, is reported.

Table 2. *Planned improvements*

Category	Sub category	Parameter	Gas	Description	Timing
Forest land	FL-FL; L-FL	-	GHG	− Implementation of the III NFI's outcomes; the final outcomes, related to the field surveys, are expected to be available in 2022. − Update of the model could be planned to allow for disaggregated estimates of C stock changes in land converted to forest land, since the current version of for-est model do not discriminate among forest remaining forest and land converted to forest.	2023
Forest land	FL-FL; L-FL			- the for-est model currently do not remove year by year the impact of deforestation from the calculation of the forest biomass density and consequently from the calculation of the annual increment. - the for-est model currently do not calculate annual biomass increment in the areas converted to forest in the year. The inclusion of such areas is considered necessary to address the identified underestimations of the biomass C stock.	2023
Cropland	CL	Activity data	GHG	Verification activities, data collection	2023
Grassland	GL	Activity data	GHG	Verification activities, data collection	2023
HWP	HWP	emission factors	CO_2	Data collection and verification activities	2023

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

Forest land (4A)

The complete set of third NFI (NFI2015) data, expected in 2022, will allow calibrating the increment curve and verifying the *For-est* estimates through a comparison with estimates prepared with the stock-difference method. Currently, the *For-est* model does not remove year by year the impact of deforestation from the calculation of the forest biomass density and consequently from the calculation of the annual increment. This improvement is planned for the 2023 submission. The *For-est* model currently does not calculate annual biomass increment in the areas converted to forest in the year. The inclusion of such areas is deemed necessary to address the identified underestimate of the biomass C stock (see Annex 14 on the *For-est* model). This improvement is planned for the 2023 submission. The *For-est* model does not discriminate among forest remaining forest and land converted to forest, once data from the third NFI will be available an update of the model could be planned to allow for disaggregated estimates of C stock changes in land converted to forest land.

Cropland (4B) - Grassland (4C) - Wetlands (4D) - Settlements (4E) - Harvested wood products (HWP) (4G)

No improvements are planned for the next submission.

Biomass Burning (4(V))

No improvements are planned for the next submission.

QA/QC WASTE
2021 ACTIVITIES AND FUTURE IMPROVEMENTS

Prepared by: Barbara Gonella, Ernesto Taurino

April, 2022

NATIONAL AIR EMISSION INVENTORY: WASTE

Objective

This report summarises the improvements, which have been identified during the preparation of the 2021 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. *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.11, 2019) Convention reporting adherence	Ensure that the information on the annual change in total long-term carbon storage in HWP waste presented in CRF table 5 is consistent with the information reported under LULUCF in CRF table 4.Gs1.	W.1	Resolved. The Party has changed its reporting of annual change in total long-term carbon storage in HWP waste in CRF table 5 from "NO" to the same value as that contained in CRF table 4.Gs1.	
5.A Solid waste disposal on land – CH_4	Provide in the NIR further explanation on how time-series consistency and completeness is ensured.	W.2	Resolved. The Party included in the NIR (section 7.2.2, p.293) a brief explanation as to how AD were estimated, gaps filled, and consistency ensured across different waste classifications.	NIR (section 7.2.2, p.293)
5.A Solid waste disposal on land – CH_4 (W.3, 2019) (W.7, 2018) Transparency	Provide in the NIR a reason for applying the current waste composition in the calculation for the weighted average k values for the entire time series (for slowly degraded waste (paper, nappies, textiles, leather, wood), which varies in composition and is inconsistently categorized throughout the time series).	W.3	Resolved. The NIR (section 7.2.3, p.293 and pp.296–297) contains additional background information on the role of the k values used to ensure consistency. In addition, the ERT noted that the Party carried out a comparison between its national model and the IPCC Waste Model using the same AD and parameters (including the six different k values) and there was sufficient parity between the results (NIR section 7.2.4, p.301). During the review, Italy provided the ERT with the results achieved using the IPCC Waste Model.	NIR section 7.2.4, p.301

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
5.A Solid waste disposal on land – CH_4 (W.4, 2019) (W.8, 2018) Transparency	Provide in the NIR summary information on waste disposal amounts for each climate zone.	W.4	Resolved. Information on shares of solid waste disposed of in dry and wet zones was included in the NIR (section 7.2.3, p.297).	NIR (section 7.2.3, p.297)
5.A.2 Unmanaged waste disposal sites – CH_4 (W.6, 2019) (W.10, 2018) Transparency	Include in the NIR information to justify why disposal amounts from unmanaged disposal sites related to the Naples waste management issue are not included in the inventory estimates	W.5	Resolved. Justification was provided in the NIR (section 7.2.4, p.302) as to why disposal amounts in connection with certain episodes of illegal dumping were not included in the inventory, with the situation in the Naples region given as an example.	NIR (section 7.2.4, p.302)
5.B Biological treatment of solid waste – CH_4 and N_2O (W.7, 2019) (W.11, 2018) Transparency	Include in the NIR the information of dry basis AD and the assumption of moisture content.	W.6	Resolved. Table 7.16 (section 7.3.2, p.304) of the NIR was supplemented with dry weight AD consistent with the information provided in CRF table 5.B	section 7.3.2, p.304 of the NIR
5.C.1 Waste incineration – CO_2 Transparency	The ERT recommends that the Party 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. Table 7.23 (section 7.4.2, p.308) of the NIR was supplemented with information on carbon content of different incinerated waste types. However, no information could be found in the NIR on the oxidation factor used. During the review, the Party clarified that the oxidation factor used is 100 per cent.	W.7	The NIR has been updated accordingly	Chapter 7 paragraph 4
5.D.2 Industrial wastewater – N_2O(W.9, 2019) (W.12, 2018) Transparency	Improve the transparency of the NIR and of CRF table 5.D by using the appropriate AD in the CRF table or by including an explanation that the AD reported in CRF table 5.D are in fact the N-N2O in the effluent.	W.8	Resolved. The Party reported in CRF table 5.D the appropriate AD and the estimated value of N in the effluent, resulting in comparable N_2O IEFs. Furthermore, the Party provided additional background information in its NIR (section 7.5.2, p.323) as to how these AD were derived, namely from N_2O emission estimates that are based on various AD, volume of wastewater and an EF of 0.25 g N_2O/m^3.	NIR (section 7.5.2, p.323)
5. General (waste) – CO_2 Accuracy	Italy reported negative values in CRF table 5 whereas annual change on total long-term carbon storage in SWDS should be greater than, or equal to, zero. Moreover, the ERT noted that the estimates provided by the IPCC Waste Model, which the Party uses for verification, are significantly lower than the figures reported in the CRF tables (for example, for 2019, the IPCC	W.9	HWP have been estimated using the IPCC waste model (MS excel- 2006 IPCC Guidelines) and the CRF tables have been updated accordingly	

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	Waste Model calculated 571 kt C, whereas 1,083 kt C is included in CRF table 4.Gs1). During the review, the Party stated that it will assess the results produced by the IPCC Waste Model and consider importing this calculation into its national model for the next annual submission. See also ID# L.20 above. The ERT recommends that Italy revise its estimates of the annual change in total long-term C storage in HWP waste in CRF table 5 ensuring that the corresponding CO2 emissions are greater than, or equal to, zero.			
5.D.1 Industrial wastewater – CH_4 Accuracy	The Party reported in its NIR (section 7.5.2, p.314) that it used the value 1.25 as the correction factor for additional industrial BOD discharged into sewers for the calculation of total amount of organically degradable material in the wastewater. The ERT noted that this parameter was applied to all wastewater, whereas the 2006 IPCC Guidelines (vol. 5, chap. 6, p.6.14) provide different default values for collected and uncollected wastewater, namely 1.25 and 1.00, respectively. During the review, the Party confirmed that it had used the value 1.25 for uncollected wastewater, as industries and establishments (e.g. restaurants, butchers and grocery stores) might discharge additional BOD into domestic wastewater. The ERT recommends that the Party provide a justification in the NIR for using the value 1.25 as the correction factor for all additional industrial BOD 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 population using latrines.	W.10	The NIR has been updated accordingly	Chapter 7 paragraph 5
5.D.1 Domestic wastewater – CH_4 Accuracy	The ERT noted that anaerobic processes are used in sludge treatment of wastewater (NIR, pp.312–313), but the NIR does not specify if the CH4 emissions from leakage from anaerobic digestion of sewage sludge in wastewater treatment plants were estimated. During the review, the Party confirmed that such emissions were not estimated. The ERT noted that, considering the level of biogas production in 2019 reported by Eurostat (2,137 TJ) and the default leakage rate of 5 per cent from the 2006 IPCC Guidelines (vol. 5, chap. 4, p.4.4), the potential underestimation of CH4 emissions would be below the threshold of significance for Italy. The ERT recommends that the Party estimate CH4 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.11	Emissions have been added	Chapter 7 paragraph 5
5.D.1 Domestic wastewater – CH_4	The ERT recommends that the Party include information on the approach used to estimate TOW in sludge in the NIR.	W.13	Information in the approach used to estimate TOW in sludge has been reported in the NIR	Chapter 7 paragraph 5

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. *Response to the NECD review process recommendations*

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-5C1bii-2021-0002	No	5C1bii Hazardous Waste Incineration, SO2, NOX, NMVOC, PM2.5, BaP, PAHs, PCBs, HCB, Cd, Hg, Pb, PCDD/F, PM10, CO, BC, TSP, 2008-2019	For 5C1bii Hazardous Waste Incineration and all pollutants and years 2008-2019 the TERT noted that there is a lack of transparency regarding the different use of the notation keys in the NFR tables between the emissions part ('NA' is used) and the part of the activity data for 'other activity' ('NO' is used) and that no explanation on the use of the notation keys for this source is given in the IIR. This does not relate to an over- or under-estimate of emissions. In response to a question raised during the review, Italy explained for this source that indeed there is no incineration of hazardous waste in the period 2008-2019 and that suggested for the emissions to use 'NO' for this period. The TERT recommends that Italy uses the notation key 'NO' for both emissions and activity data when the process is no longer occurring and explains this in the IIR in the 2022 submission.	No	Not implemented
IT-5C1bi-2021-0001	No	5C1bi Industrial Waste Incineration, PM2.5, 1990-2009	For 5C1bi (Industrial Waste Incineration) and PM2.5 and years 1990-2007 the TERT noted that the PM2.5 and PM10 emissions reported in the NFR tables are equal. In response to a question raised during the review Italy explained that the PM10-emissions relate to a personal communication (in 1999) in the period that only PM10 needed to be considered and now uses the same emission factor as conservative estimate for PM2.5. In their answer Italy also suggested that they could use the EMEP/EEA Guidebook PM10/PM2.5 ratio to correct this. The TERT notes that using PM2.5 as being a fraction of PM10 is in line with the EMEP/EEA Guidebook where in fact this is also the case as the units for PM10 and PM2.5 are the same. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Italy in the 2022 submission of the NFR and IIR explains the personal communication for using the PM10 emissions factor for the period 1990-2007 and calculates the PM2.5 emissions over that period with the PM10/PM2.5 ratio from the EMEP/EEA Guidebook.	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-5C1bii-2021-0001	No	5C1bii Hazardous Waste Incineration, PM2.5, 1990-2007	For 5C1bii Hazardous Waste Incineration and PM2.5 and years 1990-2007 the TERT noted that the PM2.5 and PM10 emissions reported in the NFR tables are equal. In response to a question raised during the review Italy explained that the PM10 emissions relate to a personal communication (in 1999) in the period that only PM10 needed to be considered and now uses the same emission factor as conservative estimate for PM2.5. In their answer Italy also suggested that they could use the EMEP/EEA Guidebook PM10/PM2.5 ratio to correct this. The TERT notes that using PM2.5 as being a fraction of PM10 is in line with the EMEP/EEA Guidebook where in fact this is also the case as the units for PM10 and PM2.5 are the same. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Italy in the 2022 submission of the NFR and IIR explains the personal communication for using the PM10 emissions factor for the period 1990-2007 and calculates the PM2.5 emissions over that period with the PM10/PM2.5 ratio from the EMEP/EEA Guidebook.	No	Implemented
IT-5C1biv-2021-0001	No	5C1biv Sewage Sludge Incineration, PM2.5, 1990-2009	For 5C1biv (Sewage Sludge Incineration) and PM2.5 and years 1990-2009 the TERT noted that the PM2.5 and PM10 emissions reported in the NFR tables are equal. In response to a question raised during the review Italy explained that the PM10 emissions relate to a personal communication (in 1999) in the period that only PM10 needed to be considered and now uses the same emission factor as conservative estimate for PM2.5. In their answer Italy also suggested that they could use the EMEP/EEA Guidebook PM10/PM2.5 ratio to correct this. The TERT notes that using PM2.5 as being a fraction of PM10 is in line with the EMEP/EEA Guidebook where in fact this is also the case as the units for PM10 and PM2.5 are the same. The TERT noted that the issue is below the threshold of significance for a technical correction. The TERT recommends that Italy in the 2022 submission of the NFR and IIR explains the personal communication for using the PM10 emissions factor for the period 1990-2009 and calculates the PM2.5 emissions over that period with the PM10/PM2.5 ratio from the EMEP/EEA Guidebook.	No	Implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
IT-5E-2019-0001	No	5E Other Waste, PM2.5, Cd, Hg, Pb, PCDD/F, PM10, TSP, 1990-2019	For 5E Other Waste the TERT noted from the NFR tables and IIR pages 157-158 that there may be an under-estimate of emissions for the years 1990-2019. This was raised during 2019 and 2020 NECD inventory review. In response to a question raised during the review, Italy explained that the emission factors reported in the EMEP/EEA Guidebook are inadequate to the Italian reality and, in general, highly uncertain. However, Italy also provided revised estimates for the years 1990-2019 based on the EMEP/EEA Guidebook Tier 2 methodology and including all accidental building fires for PM10, PM2.5 and PCDD/F and BC based on the IIASA, 2004 (Interim Report IR-04-079). The TERT noted that in the estimates an EF for PM2.5 of 27.33 kg/fire is used instead of the EF from the EMEP/EEA Guidebook of 27.23 kg/fire. This relates possibly to a typing error. The TERT agreed with the revised estimate provided by Italy. The TERT recommends that Italy checks the EF used for PM2.5 and explains in the IIR in more detail the origin of the EF used for BC and include the revised estimates and the emissions from heavy metals from this source in its 2022 NFR and IIR submission.	RE	Implemented
IT-5C-2019-0001	Yes	5C Waste Incineration, PCBs, HCB, 1990-2018	For 5C (Waste incineration) and pollutants PCBs and HCB and years 1990-2019 the TERT noted that there may be an over-estimate of emissions. This was raised during the 2019 and 2020 NECD inventory review. This over-estimate does not have an impact on total emissions that is above the threshold of significance. In the 2020 review the TERT reiterated the recommendation from the 2019 review to take in account the implementation of abatement technology over the years for those sources where this is not considered yet (for instance 5C1bv). The 2021 review noted that in the IIR (pg 153) is stated that the results of this will be available in the 2022 submission. In reply to a question during the review Italy confirmed that this is still the plan. The TERT reiterates the recommendation to take in account the implementation of abatement technology over the years for those sources where this is not considered yet (for instance 5C1bv). The TERT additionally, reiterates the recommendation that Italy further improves the transparency in the IIR and to use the emission factors from	No	Partly implemented

Observation	Key Category	NFR, Pollutant(s), Year(s)	Recommendation	RE or TC	Implementation
			the survey on incineration of sewage sludge in the 2022 submission.		

Inventory improvements and QA activities

Other improvements not identified during the review processes have been carried out in the last years.
An in depth analysis of EWC codes of waste disposed of in landfills has been done for the year 2007, thanks to the complete database of Waste Cadastre kindly supplied by ISPRA Waste Office. This accurate analysis has permitted to verify the correctness of waste typology assumptions used for the estimations. 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)[39] .
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[40], 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.

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.

[39] TERNA, several years. *Dati statistici sull'energia elettrica in Italia*. Rete Elettrica Nazionale.
[40] 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.

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;
- 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.

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.	2022
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.	2022

Category	Subcategory	Parameter	Gas	Description	Timing
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.	2022
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 will permit to adequate the waste composition to the current situation.

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

Finally, 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%.

Biological treatment of solid waste

Anaerobic digestion of solid waste is under investigation to collect more information about technologies and emission factors.

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. In order to update the government's strategy to achieve Italy's emissions reduction target under the Kyoto Protocol, the GHG emission projections for 2020, specific to waste management, have been updated with a focus on how this could influence the waste composition. 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, Territory and Sea 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.

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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April, 2022

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	2020-2022
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	2020-2022
	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	2022
	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	2022
IPPU	Cement /lime production	AD	CO_2	Further investigations concerning the replacement of natural raw material in clinker manufacture and in lime production	2022
	Building industry	AD	PM10	Estimate and report emissions from categories 2A7a, “Quarrying and mining of minerals other than coal” and 2A7b, “Construction and demolition”	2022
	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	2022
	Lead and zinc production	Allocation	All	Allocation of emission between combustion and process sectors	2020-2022

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.	2020-2023
	Paint application	EFs	HC CO_2	Assess the possibility to split non industrial application according to the Guidebook EMEP/EEA	2020-2022
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	2022
	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	2022
	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	2022
	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.	2022
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	2023
	Cropland /Grassland	AD/EFs	GHG	Verification activities, data collection	2023
	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	2023
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.	2022
	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	2022