Horizon 2020 Societal challenge 5:
Climate action, environment, resource efficiency and raw materials

VERIFY

Observation-based system for monitoring and verification of greenhouse gases

GA number 776810, RIA

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Changes with respect to the DoA
This deliverable was delayed as it is based on the results of D1.3 "Consolidated reporting requirements including Country Factsheets", D5.6 "First - Factsheets with national observation-based GHG Budgets" and D5.3 "Second report – Reconciliation of bottom-up and top-down methods at subnational scales".
Dissemination and uptake
EU Policy makers (DG CLIMA.C2) and the Climate Change Committee Working Group 1
Short Summary of results (<250 words)
This deliverable is primarily to present the factsheets of GHG emissions (including the three main gases CO_2, CH_4 and N_2O) for the current EU27 region. Under the context of the changing Regulation for GHG monitoring, the factsheet provides some scientific insights for the challenging switch to the post-2020 reporting regime (cfr. Regulation 1999 of 2018) that for the first time includes in the climate targets, next to the GHG emissions of the Emission Trading System (ETS) and Effort Sharing Decision (ESD) sectors, also the LULUCF GHG estimates. The information makes use of the bottom-up reported inventories as well as the top-down observation-based budget with time series from 1990 to 2018, based on the published GHG data for EU (cfr. EEA Data GHG reviewer) as well as the scientific budgets published as VERIFY deliverables (cfr. Petrescu et al. ESSDD, 17 and 18 Dec. 2020a,b). The factsheet presents the GHG total (including LULUCF) composed of CO2, CH4 and N2O, with the latter converted into CO2eq using the AR4 GWP100 metrics. Uncertainties are known to be large for CO2 (LULUCF), CH4 and N2O. For CH4 and N2O, observation-based scientific results provide insights on the uncertainty range. Improvement potentials are further indicated by addressing the uncertainties for the LULUCF estimates and by proposing a higher temporal resolution for (near) real time reporting.
Evidence of accomplishment **(report, manuscript, web-link, other)**
The factsheet will be made available on the VERIFY website, together with all other factsheets presenting the national budgets. **http://webportals.ipsl.jussieu.fr/VERIFY/FactSheets/** **Users can register their email address to receive the name and password to access the site.**

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Version	Date	Description	Author (Organisation)
V0	21/12/2020	Creation/Writing/Delivery	G. Janssens-Maenhout
V0.1	05/01/2021	Consultation with contributors	R. Petrescu, R. Andrew, P. Ciais, G. Peters, G. Grassi, P. Peylin
V0.2	02/02/2021	Revised version	G. Janssens-Maenhout
V1	15/02/2021	Final version, delivered on the Participant Portal	G. Janssens-Maenhout (JRC)

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1. Glossary

Abbreviation / Acronym	Description/meaning
GHG	Greenhouse gases
AR4	IPCC fourth Assessment Report
GWP100	Global Warming Potential over 100 yr
ETS	Sectors under the EU Emission Trading System
ESD	Effort Sharing Decision sectors
NEC	National Emissions Ceiling directive
EU=EU27	European Union 27 Member States
Mt CO2eq	1000 000 ton CO2 equivalent
LULUCF	Land Use, Land Use Change and Forestry sector
AFOLU	Agriculture, Forestry and Land Use sector
DG CLIMA	European Commission's Directorate General Climate Action
CCC WG1	Climate Change Committee Working Group 1 of DG CLIMA (C2)
EEA	European Environment Agency
CoCO2	Copernicus CO2 monitoring H2020 project
NGHGIA	National Greenhouse Gas Inventory Agencies
CES/M	Climate and Emission Scientists / Modellers

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2. Executive Summary

Purpose and target group

The GHG Factsheet for EU Policymakers presents selected results of the VERIFY Synthesis work package that are of interest to DG CLIMA and EU Member State policymakers, in particular via the Climate Change Committee Working Group 1 of DG CLIMA. It puts in perspective the observation-based insights and evidence in support of the current reported GHG inventories and their trends. Three upcoming challenges are addressed:

(1) the switch from the current reporting scheme to the post-2020 GHG reporting under the new EU regulatory framework, which requires robust and trustworthy estimates for the Land Use, Land Use and Forestry (LULUCF) Sector;

(2) the near real time monitoring of the green recovery from the current pandemic;

(3) the importance of the uncertainty in estimating CH4 and N2O emissions.

EU Regulatory Context

The Factsheet starts with an overview of the EU regulatory framework. The current GHG Monitoring Mechanism, laid down in Regulation 525 (2013), for the post-2020 reporting is replaced by Regulation for the Energy Union 1999 (2018). The inclusion of the LULUCF sector within the EU post-2020 climate framework, through Regulation 841 (2018), allows the EU climate target to become economy-wide, as mandated by the Paris Agreement. This inclusion requires LULUCF GHG estimates to become more complete and accurate (including geographically-explicit estimates for land-use changes), which in turn implies better scientific understanding of the spatial dimension of LULUCF fluxes and their uncertainty.

Furthermore, the recent proposed inclusion on LULUCF in the base year (1990) calculation of the -55% EU climate target (2020/562) opens the opportunity of treating the LULUCF sector like any other sector, i.e. without the filtering of complex accounting rules. This would anticipate the approach towards the EU 2050 climate neutrality target, where the full size of the net LULUCF flux matters. This change would make the magnitude, trends, and future evolution of LULUCF even more important to monitor, understand and project but would need a simplifying of the LULUCF jargon and thus facilitating communication and transparency.

At the same time, also the emissions from Agriculture (CH4 and N2O), with high uncertainties, need further scientific insights. Finally, there is a great need of developing a near real-time monitoring system that allows a timely tracking of the green recovery in the aftermath of the COVID19 lockdowns.

Main results and findings

From 2020 onwards a few game changers are complicating the annual update of the EU GHG trend that is used to track the progress towards EU's climate targets. With the Brexit, the overachievement of the Kyoto protocol target in 2018 is reduced from -23.2% for EU27+UK to -20.7% for EU27 alone. The European Green Deal's enhanced climate target of -55% by 2030 will require a four-times larger reduction per year for the next decade (2021-2030) than the averaged -0.7%/yr drop the EU obtained during the past three decades. This can be achieved when making

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optimal use of the current green recovery momentum. This recovery ideally fosters a continuation of the downward trend, starting from the estimated CO2 level in 2020 that is 9% lower than in 2019 due to the COVID19 lockdown measures.
In collaboration with the national GHG Inventory Agencies, the most uncertain emission sectors - mainly the net CO2 fluxes from the LULUCF sector, N2O emission sources and some CH4 emission sectors, like manure management in the agricultural sector or the waste / waste water sector - have been addressed with a combination of observation-based bottom-up and top-down information. While the value of top-down information for emissions (CH4 and N2O) from Agriculture is known (cfr. the National Inventory Report of UK and of Switzerland) and can be extended to other regions, the reconciliation of the top-down information with the different bottom-up datasets (officially reported and scientifically estimated) for the LULUCF sector remains a real challenge.
Expertise in the uptake of top-down information is building up, also in view of complying with the post-2020 reporting requirements for the LULUCF sector based on spatially disaggregated data. The reconciliation of bottom-up statistical data and top-down atmospheric observations via inverse modelling, as synthesized by Petrescu et al. (18 Dec. 2020, https://essd.copernicus.org/preprints/essd-2020-376/essd-2020-376.pdf), points to the large variability of results, more visible in the top-down approaches than in the bottom-up ones.
An increased understanding of the uncertainty ranges, not only based on bottom-up data but also using observation-based evidence, is recommended. In addition, scientists plea for higher spatial and temporal resolution of anthropogenic CO2 emissions. The air quality community is providing spatial gridmaps (at 0.1°x0.1° or finer) to fulfill EU's commitments under the Convention of Long Range Transboundary Air Pollution and National Emission Ceiling (NEC) directive. This could also be an example for the GHGs. Temporal proxy data (monthly, daily) that are representative for the most emitting sectors (e.g. power generation, residential energy and road transportation) might enable a near real time monitoring that catches the current lockdown and green recovery. The EU already collects monthly data for coal, oil, gas, and by streamlining the monthly estimates, the EU could be estimating emissions routinely, at a monthly level, with a 1-3 month delay. In a next step there is the daily electricity data, which can be utilized when harmonized with the monthly data. This would be very useful in the future if almost daily overpasses of CO2 Monitoring satellites are providing the top-down observations.

Next steps

Feedback from DG CLIMA and the Climate Change Working Group 1 on the EU GHG Factsheet will be taken up to define the best "decision support system" with actionable information for monitoring progress on GHG reductions towards the 2030 targets and even towards climate neutrality. The results will also flow into the H2020 CoCO2 project.

Conclusions

In the post-2020 reporting regime, progress towards the enhanced climate target of -55% by 2030 for the EU27 needs to be carefully monitored. Higher spatial and temporal resolution of the inventories provide essential information to monitor the implementation of actions locally. In particular, a faster update of the major CO2 emitting sectors for EU27 Member States (if reliable

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monthly energy statistics become available and are backed up by near-real time monitoring tools) might allow early warning in case the downwards trend would be discontinued. With the decrease of the major emitting sectors, other more uncertain sectors (e.g. fugitive emissions of CH4 from coal mining or from waste disposals or N2O indirect emissions from leaching and run-off) are of increasing importance. Better understanding of the uncertainty range and trend uncertainty using observation-based evidence is recommended. Last but not least, a solid reconciliation of bottom-up and top-down information would support more robust and harmonised LULUCF numbers across EU27 Member States, which are needed to ensure a trustworthy contribution of LULUCF to the 2030 the climate- neutrality 2050 target.

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3. Introduction

Situating WP6.1 deliverable in the context of the VERIFY project

The VERIFY project produces several different factsheets, each with a different content and target audience:

- WP1: Summary of national GHG inventory reports by national inventory agencies
- WP5: Synthesis of the GHG budgets from the scientific results in WPs2-4 for national and regional technical experts
- WP6: Synthesis of the WP1 and WP5 EU27 GHG factsheets for policy makers (DG CLIMA& EU Member State Representatives of the Climate Change Committee Working Group 1).

The WP1 factsheets show information on GHG trends over time (aggregated, but also per sector, per GHG and per country), shares for the latest inventory year, and uncertainty information for the last inventory year (t-2), based on bottom-up data with self-reported statistics of the countries, officially reported to UNFCCC. The WP5 factsheets are based on the data of model runs in WP2, WP3, and WP4 (observation-based ecosystem model and top down inversions), using state-of-the art science. The results from bottom-up statistics are reconciled with top-down atmospheric measurements (inverse modelling)

The WP5 factsheets summarise the key results for the fossil CO2 sources, land CO2 from the LULUCF sector and CH4 and N2O direct and indirect emissions, in particular to address the entire AFOLU (Agriculture, Forestry and Land Use) emissions. More information is given in the synthesis papers of Petrescu et al. 2020a (17 December 2020, CH4 and N2O) and Petrescu et al. 2020b (18 December 2020, CO2). While the WP5 factsheets provide a huge source of detailed scientific information in a comprehensive way, only some results are selected as input for the WP6 factsheets for policymakers.

The deliverable D6.1 “EU GHG Factsheets for Policymakers” starts from the policy context and selected those results that were timely and providing actionable information to DG CLIMA and its EU Member State representatives in the Climate Change Committee Working Group 1. Timely means that the information is applicable to 2020 and future years, which explains the focus on EU27 and the new post-2020 reporting framework with special attention to the LULUCF sector as part of the new climate targets.

The VERIFY web portal (http://webportals.ipsl.jussieu.fr/VERIFY/) contains all the datasets, figures and factsheets (http://webportals.ipsl.jussieu.fr/VERIFY/FactSheets/) for all WPs and so also for WP6. A user interface allows the selection of the GHGs and plot variants (country/region) and a further link allows premade factsheets to be selected, for WP1, WP5, and soon WP6.

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Background and policy context of WP6.1 deliverable

The GHG inventory of the EU27 is based on the GHG Monitoring Mechanism regulation 525 (2013) and the new Regulations on LULUCF 841 (2018) and the Energy Union 1999 (2018).

- Regulation 525 defines the work until 2022 on the EU GHG inventory (when the NGHGI 2020 will be submitted) following the current rules. All sectors (incl. the Agriculture, Forestry and Other Land Use sector (AFOLU) will undergo a full QA/QC process and checks for completeness and consistency. In addition, there is a complete European review process, but since the LULUCF is not part of the EU 2020 climate targets, it is currently not subject of this complete European review process contrary to all other sectors.
- From 2023 onwards, the post-2020 reporting of the EU GHG inventory is defined by Regulation 1999 (replacing Regulation 525). The post-2020 framework includes for the first time the LULUCF sector into the 2030 EU climate targets and a corresponding reporting as defined by Regulation 841. This requires an increase in confidence on LULUCF numbers and more reliable, comprehensive GHG inventories to monitor the progress towards reduction targets. As such, the LULUCF inventory will also become fully subject of the substantial European revision (and where needed correction) as like all other sectors.

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4. Findings

The enhanced climate targets under the European Green Deal require close monitoring including observation-based verification of inventories. The period 2020-2021 witnesses several game changers:

- 2020 marks the end year of the second Kyoto Protocol period. The Kyoto Protocol target is collectively already in 2018 overachieved by the 27 Member states with a total of 20.7% reduction from 1990 to 2018.
- the EU moved from 28 Member States to 27 Member States because of the Brexit. UK belonged to the best in the class and brought the reduction from 1990 to 2018 further down to even 23.2%.
- 2020 was dominated by the COVID19 pandemic and the consecutive lockdown measures in most Member States of the EU.
- 2021 marks the start of the new post-2020 reporting regime, which needs to be fully operational in 2023 (given the lag of 2 years in the reporting cycle).
- from 2021 to 2030 the GHG reduction committed by the EU27 Member States needs to increase its pace with a 4-fold to achieve collectively the enhanced climate target of 55% reduction over the period 1990-2030.
- the reported emission inventory for the year 2021 needs to include also the LULUCF sector, fully reviewed as like all other sectors. Robust and trustworthy numbers for the LULUCF need to be derived under high quality standards and based on spatially disaggregated information.

To achieve the enhanced climate target by 2030, the European Union initiated a movement for green recovery, which implementation will need to be monitored with timely and actionable information. There is common agreement by the VERIFY experts that a **higher disaggregation of the emission inventories in space and time** would be beneficial. This was one of the outcomes of an exchange meeting in November 2020 between national inventory agencies and climate/emission experts, where their different approaches were compared (cfr. Table 1). Moreover, a near real time monitoring with monthly data, which are already available by the ESTAT, allows early redirection of activities that are not showing the desired GHG trend. ESTAT also collects monthly data for coal and oil for the most CO2 emitting sectors (large scale combustion for power generation and industry, small scale stationary combustion for the residential, commercial and service sector, non-stationary combustion for the transportation sector). This data pool could be enhanced to enable National GHG Inventory Agencies to estimate emissions sub-annually, by streamlining the monthly estimates, which is also useful for the t-1 estimate. Scientific efforts have been coupling these already with daily electricity data for power generation, and heating degree days for residential heating and even hourly statistics from e.g. TOMTOM, flight tracks etc, such as done by Carbonmonitor.org. In this way a link could be more easily made with the CO2 Monitoring system that is building up with satellites which will overpass from 2026 onwards Europe and the entire globe every three days in the late morning hours to measure the total CO2 column.

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The uncertainty of the national inventory per gas and sector is characterized by the 80/20 rule. While CH4 and N2O emissions in 2015 contribute with smaller shares, respectively 11% and 6% to the GHG total, their uncertainties contribute to respectively 10% and 70%, according to Solazzo et al. (2020). With decreasing share of the fossil CO2, the share of CH4, N2O and land CO2 become of larger importance. National inventory agencies of UK and Switzerland took up top-down information to improve the CH4 and N2O estimates. Petrescu et al. (2020a) did provide a complete reconciliation of the CH4 and N2O bottom-up and top-down information.

Table 1: Exchange between National GHG inventory Agencies (NGHGIA) and climate and emission scientists/ modellers (CES/M) confronting their different approaches to the atmospheric emission fluxes

	NGHGIA	CES/M
Temporal scale	Low resolution: Yearly, till t-2 (t-1)	High resolution Monthly, dialy, (hourly)
Spatial scale	Low resolution: Territorial, country specific (1MS)	High resolution of spatially disaggregated data, applicable for regional/global coverage without political borders
Activity link	Fine granularity: Disaggregated by source, subsector, human activity specific	Course granularity: Larger groups of activities for which spatial and temporal data are available, of interest for near real time emission assessment
Challenges	Direct/indirect emissions, uncertainties, increased complexity	Modelling of processes, biofuel/biomass, Carbon Capture and Storage as new sink activity, priors?

The bottom-up and top-down synthesis for CH4 and N2O reveal for EU27 the following observations (for more information we refer to Petrescu et al., 2020a):

- the uncertainty range of the bottom-up estimates (by UNFCCC) is half as large as the spread of the CH4 top-down results, which is partially explained by the uncertainty and omission of some natural CH4 emissions.
- the average level of the top-down results for CH4 are 22% higher than the bottom-up results.
- the downward trend of the CH4 bottom-up estimates is not confirmed by the top-down results. Only the one inversion (iFLEXPART: FLeKF-TM5-4DVAR from EMPA) confirms a downward trend for the bottom-up estimates but with a stronger decreasing slope.

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- Scientific bottom-up estimates from CAPRI/EDGAR lead to higher energy and waste sector emission than reported by the National GHG Inventories.
- the uncertainty range of the bottom-up estimates (by UNFCCC) almost doubles the spread of the N2O top-down results.
- the average level of the top down results for N2O are even 37% higher than the average bottom-up results (but BU with a >100% uncertainty!).
- the downward trend of the N2O bottom-up estimates is not confirmed by the top-down results. Only the FLEXINVERT_NILU model confirms a downward trend for the bottom-up estimates but with a stronger decreasing slope.

The net CO2 estimates from land fluxes (aggregated over different land use groups varying for the land use with 6 classes (forest, cropland, grassland, wetlands, settlements and harvest wood products) are of increasing importance, require many efforts to be derived, and need further improvement, because of the following observations (for more information we refer to Petrescu et al., 2020b):

- a relative large spread is still present under the bottom-up results from UNFCCC, FAOSTAT and bookkeeping models.
- the uncertainty of the bottom-up results is sometimes smaller than the spread of the differently derived bottom-up results.
- the spread of the top-down results is very large and used to estimate a top-down uncertainty
- the inter-annual variability is larger in the top-down derived results for CO2 land compared to the bottom-up results, because models are more influenced by variable meteorological conditions (climate).
- no downward trend can be observed for the period 1990-2018.
- Bottom up models (sector specific and global ecosystem) provide much larger inter-annual variations than the National GHG Inventories but with rather similar multi-annual mean values.

The VERIFY project aims to provide further research on the improvement of the inventories of CH4, N2O and CO2 (from fossil and land use activities), such that in the post-2020 reporting regime robust and high-quality emission inventories can be provided for all sectors, including LULUCF.

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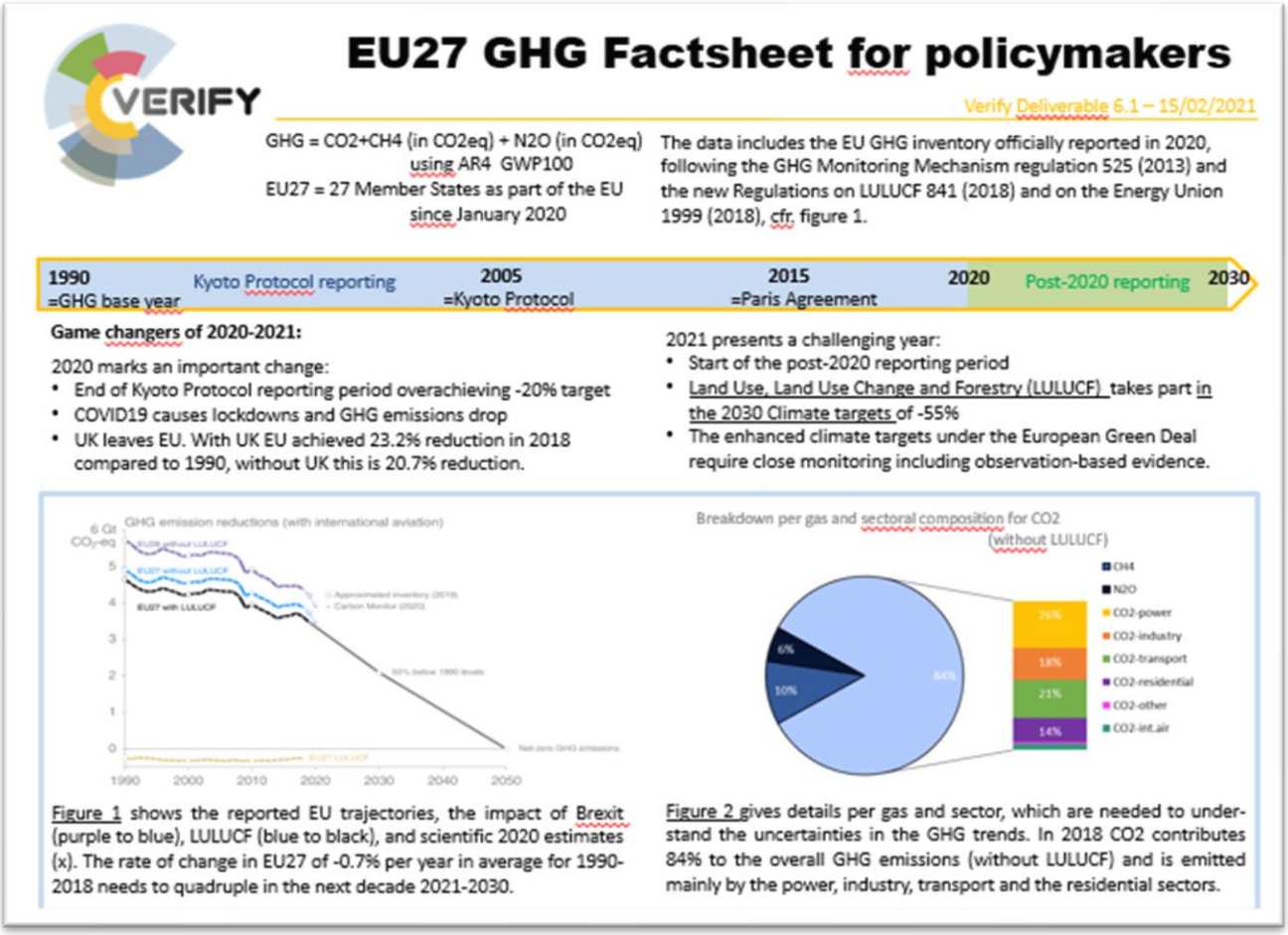
5. EU27 GHG Factsheet for Policymakers

The EU27 GHG factsheet uses data made available up to end 2020 for fossil and land CO2, CH4 and N2O for the European Union with its 27 Member States. The double-sided A3 page is provided in the four panels here underneath.



EU27 GHG Factsheet for policymakers

Verify Deliverable 6.1 – 15/02/2021

GHG = CO2+CH4 (in CO2eq) + N2O (in CO2eq) using AR4 GWP100
EU27 = 27 Member States as part of the EU since January 2020

The data includes the EU GHG inventory officially reported in 2020, following the GHG Monitoring Mechanism regulation 525 (2013) and the new Regulations on LULUCF 841 (2018) and on the Energy Union 1999 (2018), cfr. figure 1.

1990 =GHG base year | Kyoto Protocol reporting | 2005 =Kyoto Protocol | 2015 =Paris Agreement | 2020 | Post-2020 reporting | 2030

Game changers of 2020-2021:

2020 marks an important change:
- End of Kyoto Protocol reporting period overachieving -20% target
- COVID19 causes lockdowns and GHG emissions drop
- UK leaves EU. With UK EU achieved 23.2% reduction in 2018 compared to 1990, without UK this is 20.7% reduction.

2021 presents a challenging year:
- Start of the post-2020 reporting period
- Land Use, Land Use Change and Forestry (LULUCF) takes part in the 2030 Climate targets of -55%
- The enhanced climate targets under the European Green Deal require close monitoring including observation-based evidence.

Figure 1 shows the reported EU trajectories, the impact of Brexit (purple to blue), LULUCF (blue to black), and scientific 2020 estimates (x). The rate of change in EU27 of -0.7% per year in average for 1990-2018 needs to quadruple in the next decade 2021-2030.

Figure 2 gives details per gas and sector, which are needed to understand the uncertainties in the GHG trends. In 2018 CO2 contributes 84% to the overall GHG emissions (without LULUCF) and is emitted mainly by the power, industry, transport and the residential sectors.

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Emissions scientists plea for higher spatial and temporal resolution of anthropogenic CO2 emissions:

In order to be monitor the emission sources, the National GHG Inventory Reports could be enriched with information on the spatial distribution of the emission sources (building on available information from e.g. the European Pollutant Release Transfer Register. A higher spatial resolution goes together with a higher temporal resolution.

To take advantage of the current momentum of a green recovery of the COVID19 lockdowns, near real time monitoring is proposed. Scientific efforts (e.g. carbonmonitor.org) focused on major emitting CO2 sectors and temporal proxies with hourly profiles. This enables to follow up the emissions with only 1 month time lag.

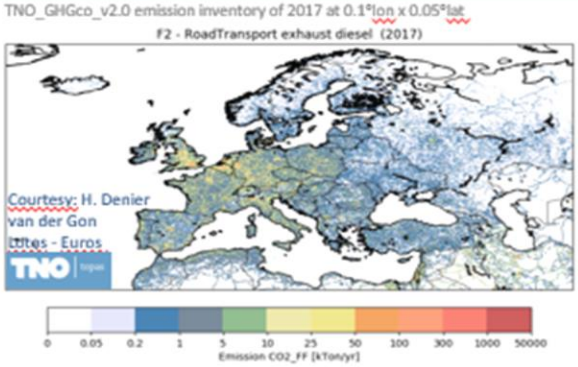

Figure 3 shows gridded sub-sectoral emissions reported in fig. 1, using e.g. point source data (e.g. EPRTR) and spatial proxy data (population data at 1km² resolution). The gridmaps visualize emission hotspots to policymakers and provided the detailed input for atmospheric models.

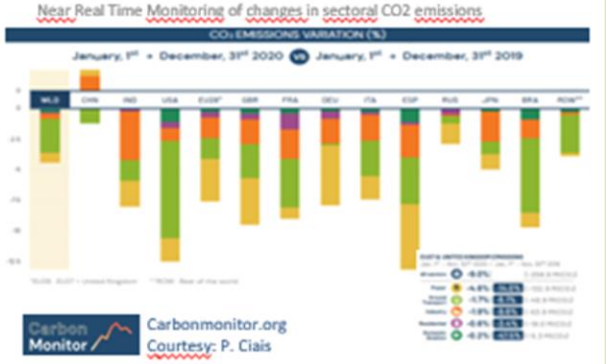

Figure 4 shows the 2020 lock-down effect on CO2 emissions, which are estimated to cause on average -9% decrease in the CO2 emissions of EU in 2020 compared to 2019. The reductions per sector are given on a monthly basis, comparing the months in 2020 to the months 2019.

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More information: Denier van der Gon et al. VERIFY Deliverable 2.2 (2/4/20); Liu et al. Nature Scientific Data (9/11/20)

EU27 GHG Factsheet for policymakers

Verify Deliverable 6.1 – 15/02/2021

Data include as GHGs CO2, CH4 (in CO2eq) and N2O (in CO2eq) officially reported in 2020 for EU27 (cfr. figure 1).

The 80/20 rule for the emission uncertainty:
While N2O (and CH4) contribute less than 20% to the emission total, they contribute more than 80% to the uncertainty.

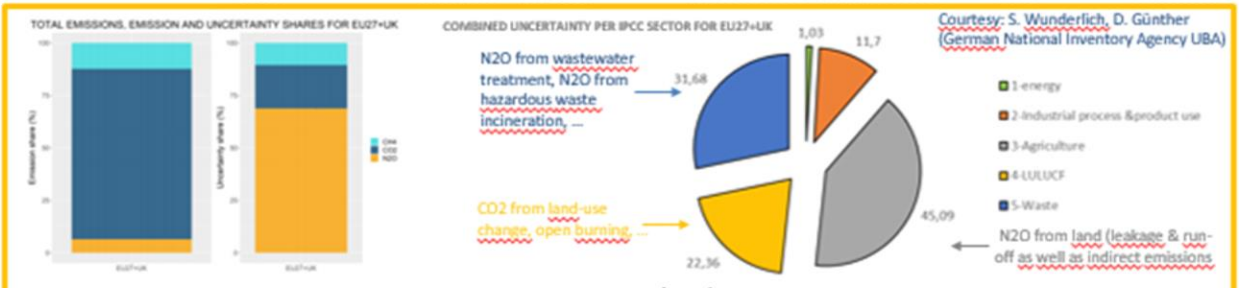

Figure 5 shows the uncertainty contributed per gas and sector using the IPCC (2006) error propagation approach for the 2018 EU27+UK inventory

The European Green Deal expresses the desire for observation-based verification of self-reported bottom-up inventories (*What gets measured, gets done* (von der Leyen, Dec. 2019). Largest uncertainties are recognised for CO2 from LULUCF (cfr. 4C in fig. 5), and for anthropogenic CH4 and N2O emissions. Atmospheric measurements have shown to improve estimates in National Inventory Reports of UK and Switzerland.

- Inter-annual variability is larger for top-down estimates of CO2 (LULUCF), CH4 and N2O than in reported bottom-up inventories.
- For anthropogenic CH4 is the UNFCCC uncertainty half as large as the spread of top-down estimates (cfr. fig.6: pink versus grey)
- For anthropogenic N2O is the spread of top-down estimates of the same order as the UNFCCC uncertainty (cfr. fig.7: green versus grey)

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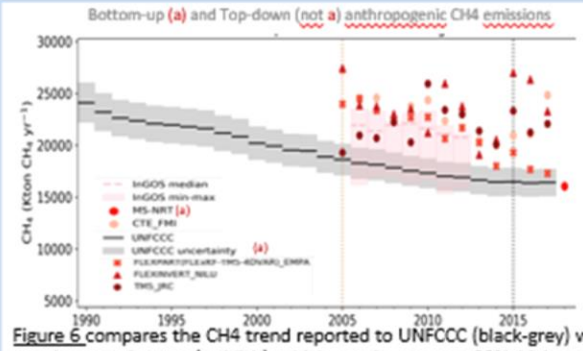

Figure 6 compares the CH4 trend reported to UNFCCC (black-grey) with top-down estimates (reddish) which are in average 22% higher and suggest a higher uncertainty for the reported CH4 emission inventories (cfr. Petrescu et al., 2020 a).

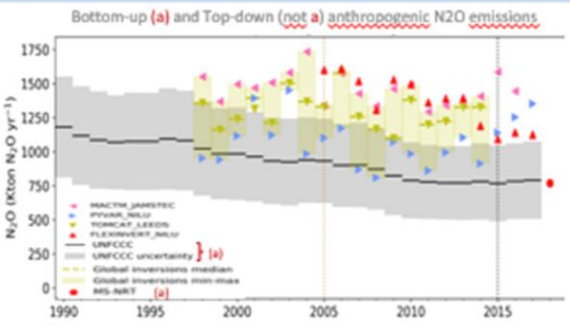

Figure 7 compares the N2O trend reported to UNFCCC (black-grey) with top-down estimates (coloured) which are in average 37% higher and show a very different inter-annual variability and average trend (cfr. Petrescu et al., 2020 a).

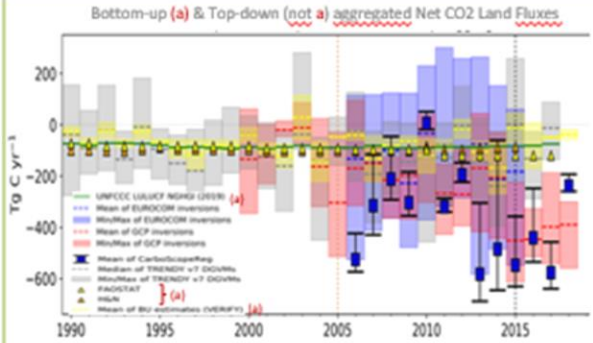

Figure 8 compares bottom-up CO2 land estimates for EU27 with reported inventories & bookkeeping estimates (grey-green-yellow) with the top-down net CO2 fluxes (blue-red). (cfr. Petrescu et al., 2020 b)

Land fluxes are becoming an important part of the 2030 EU emission targets and need to offset the remaining emission sources when aiming at climate neutrality by 2050. In the post-2020 reporting regime (foreseen from 2023 onwards), trustworthy numbers for the LULUCF inventories of the EU27 are needed as well as their review to guarantee high quality and robustness.

While it is not surprising that top-down estimates (strongly impacted by meteorological conditions) show a much higher inter-annual variability than bottom-up estimates, emission scientists observe also for the bottom-up estimates a larger variability than reported (cfr. fig. 8 yellow band estimates versus green reported line). In some cases (e.g. 2003, 2016) certain bottom-up estimates cannot confirm the presence of a sink (and become even positive).

While Regulation 841 describes how LULUCF estimates have to be derived (including spatially distributed data), more research is needed to grasp better the inter-annual variability and help guiding the land use management such that long term sinks are guaranteed.

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More information: Petrescu et al. ESSDD a and b (17/12/20; 18/12/20), Günther et al. VERIFY Deliverable 1.2 (4/10/20)

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6. Conclusions

D6.1 deliverable "EU GHG Factsheets for policymakers" presents selected major VERIFY results with timely and actionable information for DG CLIMA and its Climate Change Committee Working Group 1, based on summary factsheets of WP1 and WP5 with reported bottom-up inventories and scientific budget syntheses. This factsheet for policymakers calls for:

1. Higher spatial and temporal resolution of the GHG inventories to enable near real time monitoring of sectors and local implementation of climate actions under the European Green Deal's green recovery initiative.

2. More uptake of top-down information for assessing uncertain CH4 and N2O bottom-up emissions (and improving the estimates and in particular their uncertainties)

3. Research and capacity building across EU27 for improving the LULUCF estimates into robust and trustworthy inventories derived from spatially disaggregated information (as prescribed by Regulation 841), reviewed with top-down information and accounting for seasonality and meteorological extremes.

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