green deal UKRAINA

GHG emissions assessment in Ukraine on the way to climate neutrality and ETS introduction

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Content

Figures

Tables

1 Introduction

Ukraine is currently facing various severe challenges related to the ongoing Russian full-scale invasion, continuous missile attacks and devastation of the national energy and industrial sector. The ongoing aggression has a direct implication on the national climate policy and goals, producing additional sources of GHG emissions and making the emissions measurement and data collection extremely difficult and ambiguous. Nevertheless, Ukraine has been firmly standing on its EU accession path and progressing with the fulfilment of its pre-accession obligations since the very beginning of the full-scale invasion. Developing a robust system of GHG emissions measurement, verification and reporting, improving the existing mechanisms for GHG emissions assessment and implementing further ambitious goals, including the ETS system, are all necessary components of the EU accession path, which are also expected to bring an impulse for domestic decarbonisation policies and measures leading to modernisation of the national industrial complex and achieving the climate neutrality.

Considering the importance of climate policy in terms of the future of Ukraine as EU Member State, Green Deal Ukraïna (GDU) project decided to take a deep look into the current situation with GHG emissions assessment in Ukraine, comparing it with the EU peers and projecting future developments based on the existing pre-full-scale invasion data.

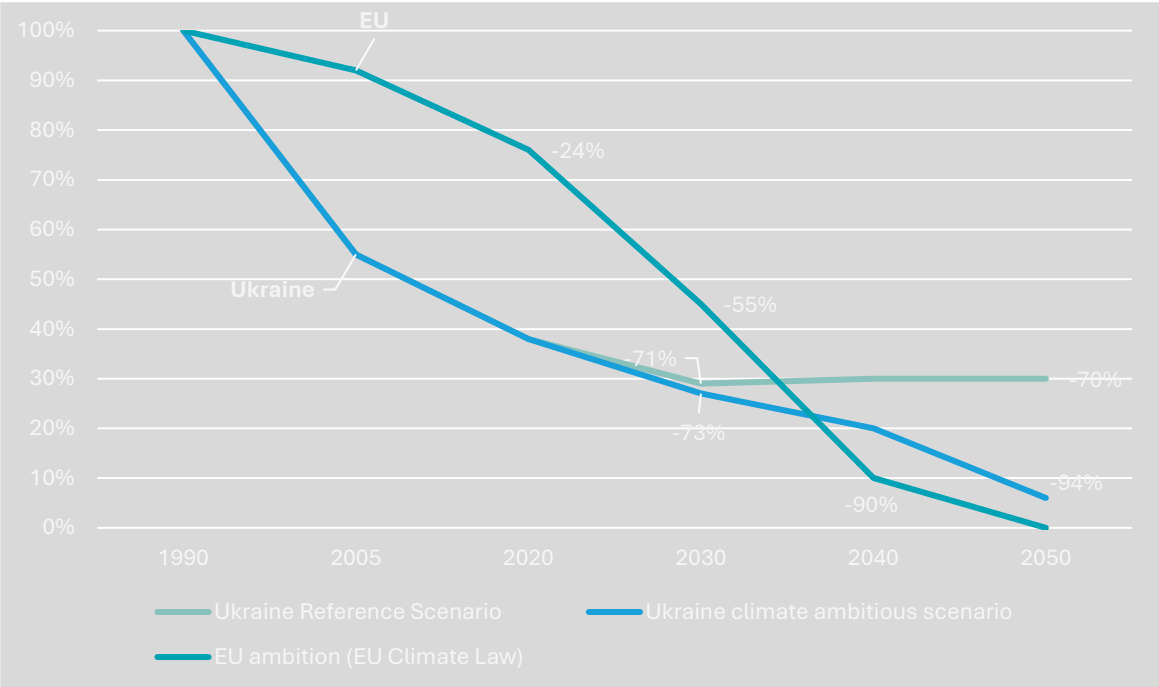
Ukraine and EU feature ambitious climate targets

There are different types of climate targets. The EU has a legally binding climate-neutrality target (net-zero greenhouse gas emissions by 2050). Intermediate targets relate to emission reductions vis-à-vis 1990 levels: minus 55 Percent for 2030 is legally binding while a more than 90 percent reduction by 2040 has just been recommended by the European Commission (2024).

Ukraine has targets to achieve zero emissions in the energy sector by 2050 and economy-wide climate neutrality no later than 2060 (according to draft NECP). As part of the Kyoto Protocol and Paris Agreement process, Ukraine has set the goal to achieve the reduction of the GHG emissions at the level of minus 65% from 1990 by 2030, according to the latest Nationally determined contribution (NDC) update submitted by Ukraine in 2021.[1]

[1] Ministry of Environmental Protection and Natural Resources of Ukraine. *Analytical Review of the Updated Nationally Determined Contribution of Ukraine to the Paris Agreement*. https://mepr.gov.ua/wp-content/uploads/2023/07/ANALYT1.pdf

Figure 1 GHG Emission-pathways (historic and committed) in Ukraine and EU



Source: own figure based on Ukraine's NDC (2021)

Note: the 2040 target for the EU is not yet formally set.

Proper emission accounting is crucial for effective climate policies

Credibly achieving these targets is only possible based on proper accounting on the national level. While increases in concentration of greenhouse gases in the atmosphere can be measured with high precision– it remains difficult to attribute contributions to individual sources. However, recent advances in remote sensing and satellite technology makes detection and measurement of emissions from point sources possible and increasingly available, with significant progress in this area achieved in the last 5 years.

To achieve overarching targets, policies need to address specific sectors (e.g., industry, energy, transportation), specific emitting processes (e.g., combustion), specific greenhouse gases (e.g., methane, laughing gas) in targeted and appropriate ways. To enforce limitations and monitor policy success, proper emission accounting is needed. Moreover, when mitigation efforts get traded (e.g., through international emission trading under the so far untested legal framework of Art. 6 of the Paris Agreement) proper accounting is essential to prevent any double-counting that could undermine both the integrity of national mitigation commitments and the trust in associated financial mechanisms.

Box 1: National neutrality targets - beware the fine-print

While China has a carbon-neutrality target that does not implicitly cover non-CO2 emissions, Ukraine and the European Union also cover those – sometimes pretty hard to abate greenhouse gases. When and how much negative carbon emissions are considered in the pathways to neutrality is another important differentiator – as it will have implications on the potential temperature-target overshooting. Even terms like carbon-neutrality, climate neutrality or greenhouse-gas neutrality are not well-enough defined, to make corresponding targets directly comparable.[2]

Ukraine's ongoing efforts in emissions' tracking

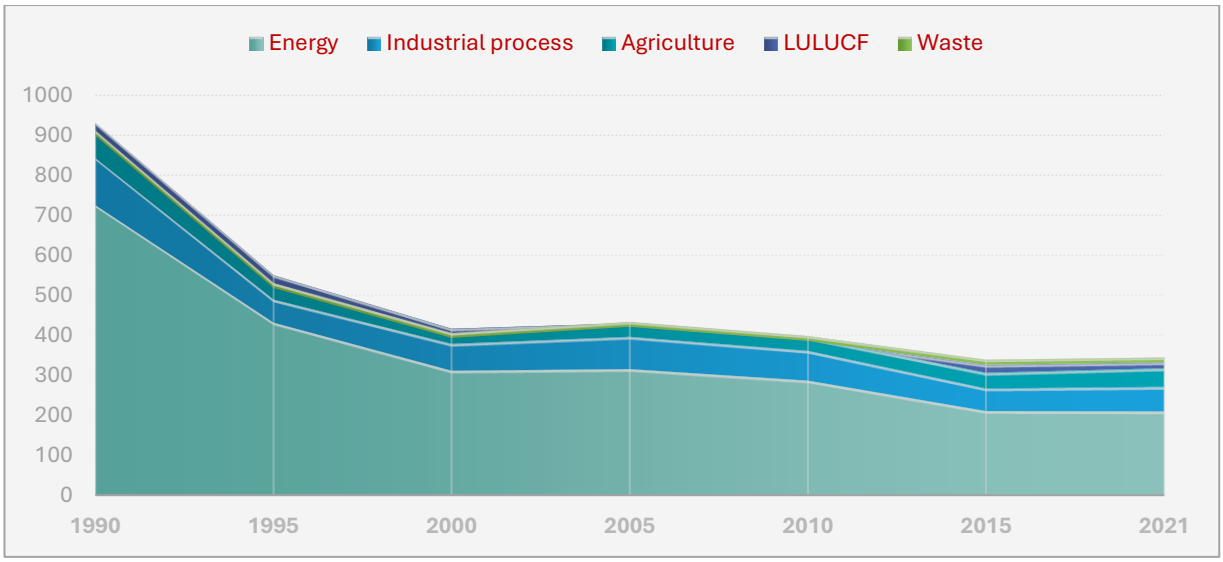
Since 2021 Ukraine regularly updates the National Inventory of GHG, which considers the GHG emissions and removals in the categories provided by the Guidelines of Intergovernmental Panel on Climate Change (IPCC), applying the IPCC 2006 methodology.[3] The national inventories are the most holistic documents in terms of GHG emissions tracking within the key areas in Ukraine. The latest available iteration is the GHG National Inventory Report submitted by Ukraine to UNFCCC in May 2023, which entails emissions up until 2021.[4] The inventory attributes Ukrainian emissions according to different gases, sectors and processes (see Figure 2). This allows comparison with the structure of EU emissions that we discuss in section 2.1. The corresponding data are collected using conventional methodologies - thereby data-uncertainties need to be clearly considered (see section 2.2).

Figure 2 GHG Emissions per sector according to Ukraine's National Inventory Report (2023)

[2] Rogelj, J., et al. "Net-Zero Emissions Targets Are Vague: Three Ways to Fix." *Nature*, vol. 591, no. 7850, Mar. 2021, pp. 365–68. www.nature.com, https://www.nature.com/articles/d41586-021-00662-3

[3] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/

[4] Ministry of Environmental Protection and Natural Resources of Ukraine (2023). *National Inventory Report (NIR) 1990 - 2021*. https://unfccc.int/documents/628276



Source: Ukraine's 2023 National Inventory Report to UNFCCC

Ukraine's emissions will become subject to the EU's existing (ETS1) and planned (ETS2) emission trading systems

When Ukraine joins the European Union, it will likely have to also become part of the existing emission trading system for industry and energy sector (ETS1) as well as the emerging emission trading system for transport and buildings (ETS2). In preparation Ukraine is already obliged to implement certain important elements of ETS in its national legislation under the EU Association Agreement. In section 3.1 we will discuss how the structure of Ukrainian emissions under the ETS1 will differ from those of the structure of said emissions in the EU. In section 3.2 we conduct the same exercise for the ETS2.

We conclude in section 4 that the general emission monitoring system is on the right track and that it allows sensible analysis of sectoral structures and trends. Based on our high-level analysis we highlight where we see priority areas for further improvements in data-quality.

2 Main sectors and emissions in the EU and Ukraine

2.1 Emissions measurement in Ukraine: GHG Inventory remains the main source of information

The National Inventory Reports (NIR) of GHG emissions of Ukraine were consistently submitted to UNFCCC on an annual basis. The latest report was submitted in May 2023, providing inventory for 1990-2021. In compiling NIRs Ukraine is facing major challenges, including the contested issue of reporting of emissions from annexed Crimea and occupied territories of Ukraine, that Russia is trying to include in its national reporting to get an international validation of acquisitions and get additional foothold.[5]

IMPORTANT NOTE

The methodology for GHG emissions accounting in the National Inventory Reports differs significantly from the methodology used in MRV process for accounting of the ETS emissions. In particular, the former focuses on the statistical information, i.e., the activity data and emission factors, as well as the information provided by the enterprises and additional studies/approaches, while the latter considers the precise data collection from the main industrial processes within each undertaking to be duly verified and reported. This results in a different level of disaggregation and accuracy of the information by NIR and ETS reporting, where the ultimate numbers may differ in some sectors significantly.

Hereinafter, the Ukraine's NIR data is used for the general assessment of the scope of GHG emissions in Ukraine to understand the potential size of the future ETS market and compare it with the EU peers. However, it should be noted that this assessment cannot replace the separate ETS data assessment based on MRV, which needs to be implemented in Ukraine with the obligation of reporting by each undertaking.

The 2023 NIR follows the IPCC methodology for assessing the emissions in various sectors, assessing the total level of emissions at 341,5 MT of CO2 eq. in 2021.

The energy sector remains the biggest source of emissions in Ukraine having the share of more than a half of all GHG emissions, followed by the emissions in industrial process and product use (around 17% of all the emissions), agriculture (almost 14% of emissions), LULUCF - Land Use, Land Use Change and Forestry (approx. 4%) and waste (3,5%).

[5] Birnbaum, M. "At War, Russia Aims to Claim Ukraine's Land — and Its Carbon Emissions." *Washington Post*, 18 Oct. 2022. www.washingtonpost.com, https://www.washingtonpost.com/climate-environment/2022/10/18/russia-ukraine-crimea-emissions/

Figure 3 Emissions per sector in Ukraine

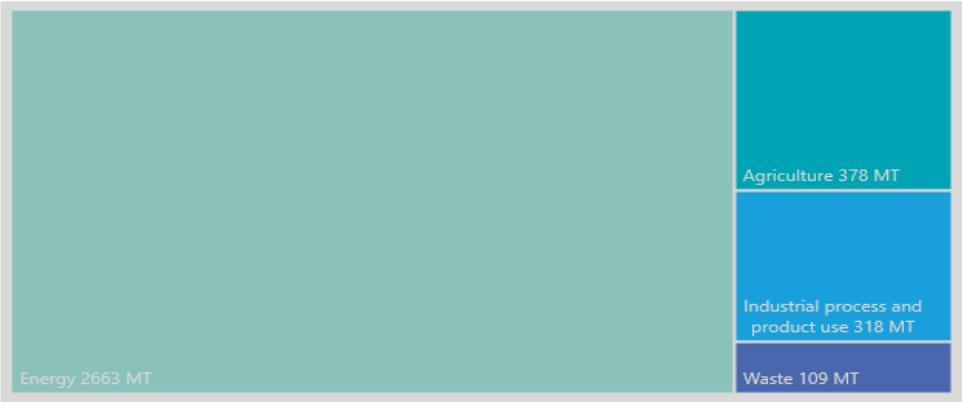
Source: Ukraine's 2023 National Inventory Report to UNFCCC

Comparing the situation with GHG emissions accounting in Ukraine to EU Inventory, one can spot some similarities, e.g., a dominant share of the energy sector, but also important differences, including a lower share of emissions from the industrial sector and negative emissions from the LULUCF sector. Such a tendency indicates that the EU industrial sector, as well as land use and forestry managed to transform into a more sustainable way of functioning compared to Ukraine, resulting in a lower share of emissions. This tendency can also be partly explained by the effect of EU ETS mechanisms applied for many industrial subsectors since 2005 and relevant policies to reduce the GHG emission rates.

IMPORTANT NOTE

EU NIR is composed of the separate NIRs by each Member State, where the level of certainty and accuracy of data may differ between the countries. In addition, there may be certain difference in reporting of some gases (e.g., fugitive). However, the data provided in the EU NIR is sufficient for making the general level comparison with Ukraine in terms of the particular gases and sectors.

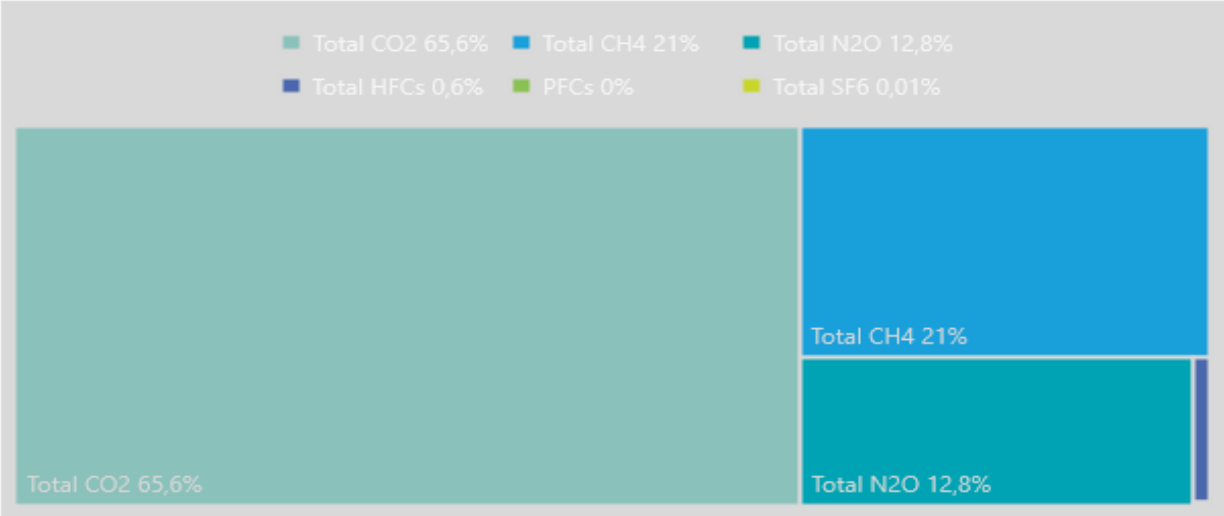
Figure 4 Emissions per sector in the EU



Source: Annual European Union GreenHouse Gas Inventory 1990 – 2021 (2023)

The observation of GHG emissions per gases demonstrates that CO2 and CH4 have the highest share in Ukraine – more than 65% and around 21% respectively, followed by N20 (approx.. 13%) with the minor share of other GHGs.

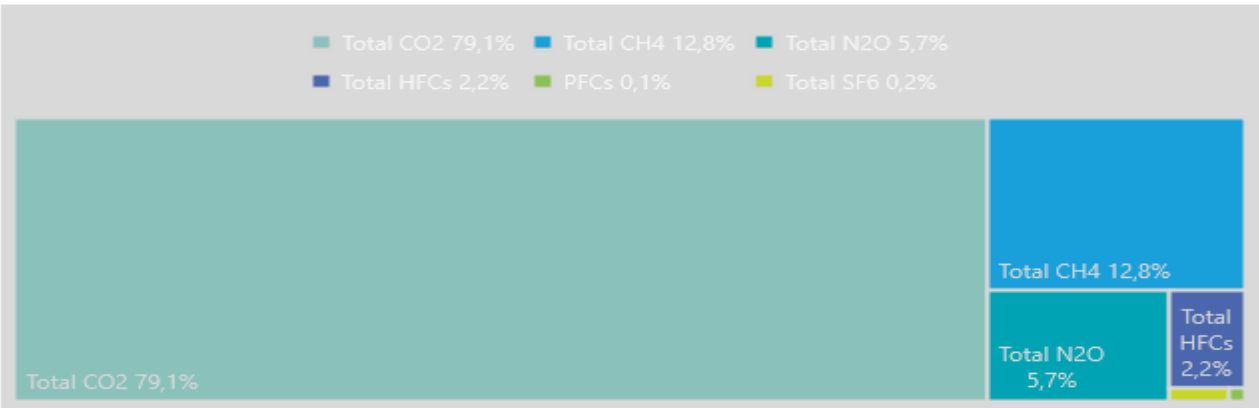
Figure 5 Emissions per gas in Ukraine



Source: Ukraine 2023 National Inventory Report

This tendency goes in line with the overall EU tendencies where carbon dioxide remains the main GHG present among the rest of emissions. At the same time, certain biases are present regarding the certainty of GHG emissions estimations as for various gases in different sub-sectors, where the emission factors and activity data certainty may vary, e.g., between CO2 and CH4. Meanwhile, the share of CO2 among other GHGs in the EU is also higher compared to Ukraine and more precise data exists on other gases (including PFCs and SF6). Further observations prove that certainty of this data for the EU is also higher compared to Ukraine.

Figure 6 Emissions per gas in the EU



Source: Annual European Union GreenHouse Gas Inventory 1990 – 2021 (2023)

Another important area requiring a separate attention in respect to GHG emissions inventories is a clear understanding of the exact scope of carbon removals. The LULUCF sector is usually considered as the main source of removals given that it includes natural carbon sinks, e.g., forests. However, in the case of Ukraine the net sector's emissions have outweighed the removals beginning from 2015, being at the level of 14 MT in 2021.

Table 1 Emissions vs removals in Ukraine (MT CO2-eq.)

Gas	1990	1995	2000	2005	2010	2015	2019	2020	2021
CO2 (excl. LULUCF)	706	390	286	314	294	224	222	207	210
CH4	183	139	118	103	85	62	70	72	72
N2O	54	33	24	26	28	33	41	38	44
HFCs	NO	NO	0	0	1	1	2	2	2
PFCs	236	178	116	142	27	NO	NO	NO	NO
SF6	0	0	0	5	10	20	39	43	49
NF3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Net CO2 from LULUCF	-32	-32	-23	-9	-9	20	23	-1	14
CO2 (incl. LULUCF)	675	358	263	304	285	243	245	206	224
Total (excl. LULUCF)	943	562	428	442	407	319	334	318	327
Total (incl. LULUCF)	911	530	405	434	398	339	357	318	342
Total (excl. LULUCF, incl. indirect CO2)	943	562	428	442	407	319	334	318	327
Total (incl. LULUCF & indirect CO2)	911	530	405	434	398	339	357	318	342

Source: Ukraine 2023 National Inventory Report

At the same time, the certainty of the removals data is also quite problematic in Ukraine, as e.g., the combined uncertainty in the sub-sector of Forest Lands constitutes 44% for CO2, 44 % for CH4 and 186% for N2O. The methodology for estimating this subsector uses Tier 2 with some national-specific approaches (e.g., expert estimates), while the available data still lacks some important elements - for instance, the state statistics has a limited scope of data regarding the impact of forest fires.[6] Further improvement of the approaches and moving to Tier 3 methodology is likely to bring a clearer picture of the total emissions in Ukraine including LULUCF, considering the factors of removals and emissions.

At the same time, the EU data demonstrates a generally lower share of removals to emissions among all the sectors, while the general certainty of LULUCF data (containing the major share of removals) is higher compared to Ukraine being at the level of 40%. The tendency indicates that despite the presence of efficient and carbon neutral land use and forestry in the EU, the total amount of removals constitutes quite a minor contribution compared to emissions rate. This fact is underlining the key role of emissions reductions in climate change mitigation efforts, both for the EU and Ukraine.

[6] Ministry of Environmental Protection and Natural Resources of Ukraine (2023). *National Inventory Report (NIR) 1990 - 2021*. https://unfccc.int/documents/628276

Figure 7 Emissions vs removals in the EU

Source: Annual European Union Greenhouse Gas Inventory 1990 – 2021 (2023)

2.2 GHG emissions reporting and uncertainty

The emission estimation's accuracy may be lower in the areas where only general emission factors and activity data area assessed, and no detailed verification and additional estimation is provided. The lack of detailed emission data for some subsectors, including the ones associated with ETS, is another significant issue, as this may complicate establishing a reliable emission trading mechanism in Ukraine and create barriers in assessing sectoral mitigation potentials.

For compiling National Inventory Reports, the aggregated data per sector is assessed using various approaches focused on the activity data of the sector's undertakings and on the relevant emission factors per the unit of output in the sectors. Thus, the emission factor, which represents the estimated GHG emissions per unit of production, depends significantly on the assumed characterises of fuels and equipment used in the industrial processes, heat and power generation, etc. The economic activity data concerning GHG emissions production significantly depends on the availability of statistical information and reporting from the industries.

Processing of the necessary data for estimation of GHG emissions may involve both high-level and specific research relying either on general statistical information and generic characteristics of fuels and equipment or making a deeper research and verification of data, on-site activities and sampling. IPCC outlines several Tiers of methodology for emissions estimates.

The Tier 1 methodology refers to the estimations based on the general data on emission factors and activity, while Tier 2 involves a higher degree of details of the data, including national and industrial-specific

parameters. Finally, the Tier 3 approach is the most sophisticated method involving site-specific data acquisition and advanced measurement.

The utilisation of these Tiers in Ukrainian Inventory can be summarised in the table below.

Table 2 Tiers of GHG emissions calculation

Tiers	Sub-sectors[7]
Tier 1	2.D. Non-energy products from fuels and solvent use 3.C. Liming; 3.H. Urea application; 4.D. Wetlands; 4.E. Settlements; 4.F. Other lands; 4.G. Harvested Wood Products; 5.B. Biological Treatment of Solid Waste.
Tier 2	1.A.1. Manufacturing industries and construction; 1.B.2. Oil and natural gas and other emissions from energy production; 2.F. Product uses as substitutes for ODS; 3.A. Enteric fermentation; 3.B. Manure management (+ some country-specific methodology); 3.D. Agricultural soils (+ some country-specific methodology); 4.A. Forest lands (+ some country-specific methodology); 5.C. Incineration and open burning of waste; 5.D. Wastewater treatment and discharge (+ some country-specific methodology).
Tier 3	1.A. Fuel Combustion activities; 1.A.1. Energy Industries; 1.A.3. Transport; 1.B. Fugitive emissions from fuels (+ some country-specific methodology); 1.B.1. Solid Fuels; 2.A. Mineral Industry; 2.B. Chemical industry; 2.C. Metal Industry; 4.B. Cropland (+ some country-specific methodology); 4.C. Grassland (+ some country-specific methodology); 5.A. Solid waste disposal.

Thus, the vast majority of GHG emissions sub-sectors use at least Tier 2 methodology for assessment, which provides a certain degree of clarity of the data. However, the utilisation of higher tier methodology may not fully offset the issues of data availability for many installations, as the higher tier methods are more limited in scope of review. In addition, the more sophisticated methods also require bigger investment and resources for completion, which is another problematic issue in the case of GHG emission assessment in Ukraine.

Different degrees of uncertainty may occur depending on input data

Depending on the availability of necessary data, the different uncertainty in GHG emissions estimation may occur. IPCC methodology acknowledges certain general and specific frameworks to address the uncertainty issues.

The more general approach focuses on the estimated gaps in data availability and emissions factors, which are extrapolated over the GHG emissions estimates. The uncertainty in both emission factors and activity data are then calculated as the general combined uncertainty. At the same time, some more sophisticated

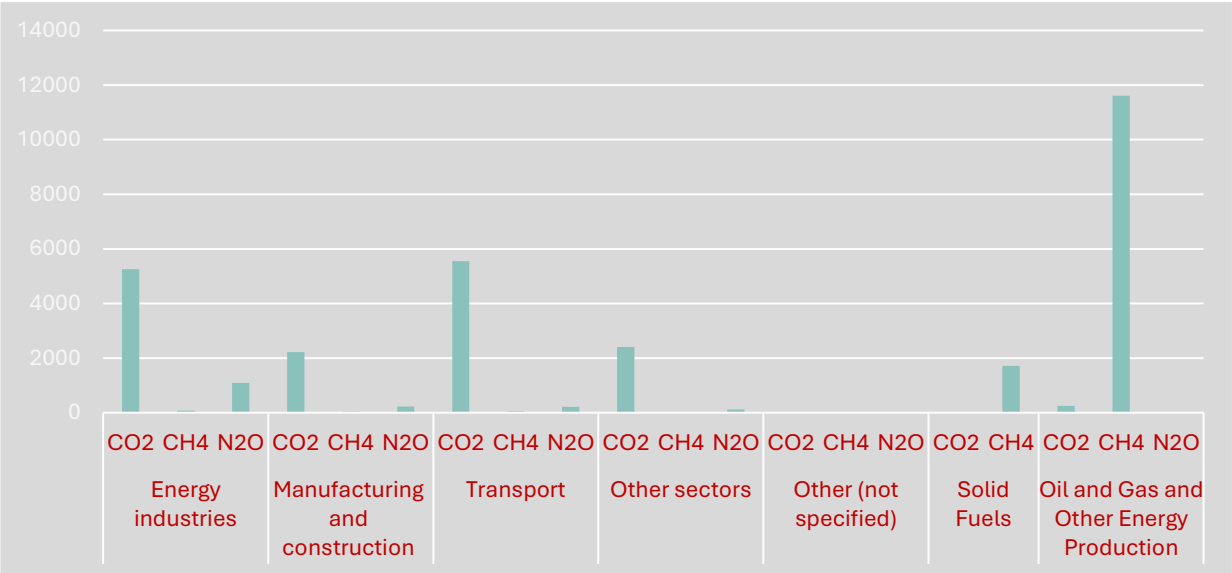
[7] Some sub sectors may combine higher and lower tier-methodology.

approaches also exist in uncertainty estimation: e.g., Monte Carlo simulations, involvement of expert judgements, sensitivity checks with regards to various parameters.

In assessing the uncertainty, Ukraine's 2023 National Inventory Report mostly uses the general approach focusing on the gaps in emission factors and activity data.

Even such a general approach reveals certain significant uncertainty resulting in potential missing of the GHG emissions in important sectors. For instance, the energy sector's uncertainty demonstrates that accounting for significant amounts of CO2 and CH4 emissions can be missed in energy industries, transport and oil and gas sectors.

Figure 8 Possible deviations from GHG Inventory numbers in energy sector given the uncertainty level (kt CO2 eq.)

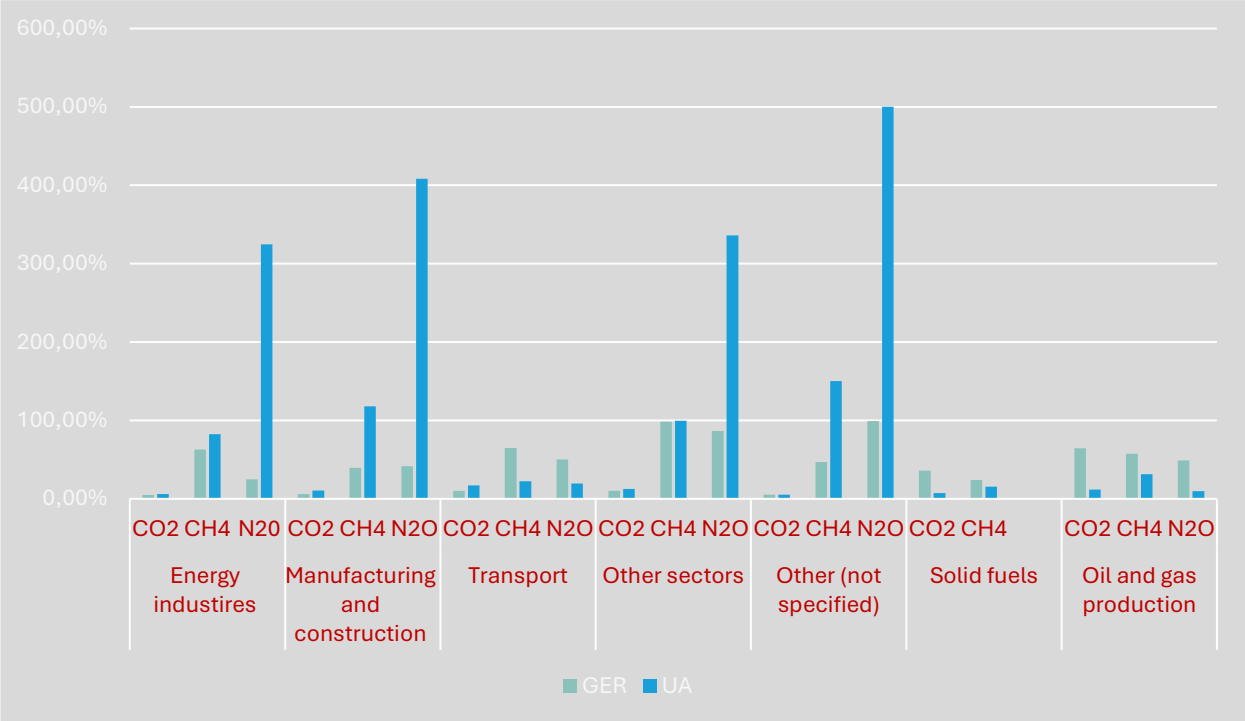


Source: Ukraine's 2023 National Inventory Report to UNFCCC

Further improvement of National Inventory completion and utilisation of more sophisticated tools can significantly reduce the uncertainty. At the same time, the introduction of MRV at the individual enterprise level and regular reporting can significantly improve the assessment and bring more reliable results for generalised emissions assessment too.

The comparison of uncertainty of GHG emissions accounting (e.g., in the energy sector) in Ukraine to the situation in the large EU countries like Germany indicates the need for a better accuracy of activity data and emission factors assessment. Thus, the level of uncertainty of the Ukrainian GHG emissions estimations exceeds the correspondent level in Germany by 300% - 400% for some gases and sectors (especially CH4 and N2O emissions).

Figure 9 Comparison of GHG emissions uncertainty in Ukraine and Germany in the energy sector



Source: National Inventory Report for the German Greenhouse Gas Inventory 1990 – 2021 German Environment Agency 1990 – 2021 (2023) and Ukraine's 2023 National Inventory Report

At the same time, the Ukrainian Inventory states a better certainty in CH4 and N2O emissions for some sectors compared to Germany, including transport and oil&gas production. This can be explained either by a better availability of data on CH4 and N2O emissions in such sectors in Ukraine or underestimation of some emission factors uncertainty in the Ukrainian Inventory. It is worth noting that many EU Member States also use a more detailed approach to GHG emission rate and uncertainty calculation, including Monte Carlo simulations.

The general takeaways of GHG emission tracking in Ukraine:

GHG emission tracking is generally aligned with IPCC methodology, but not always uses the highest tier-approaches.

The lack of clear verification of the GHG emissions at the level of individual sources is another significant barrier in terms accuracy of the emissions accounting.

In some sectors the level of certainty may vary significantly as for the whole sector or particular gases.

Improving the tracking of GHG per individual installation is critically important for future establishment of ETS in Ukraine.

3 ETS 1 and ETS 2 emissions scope in Ukraine

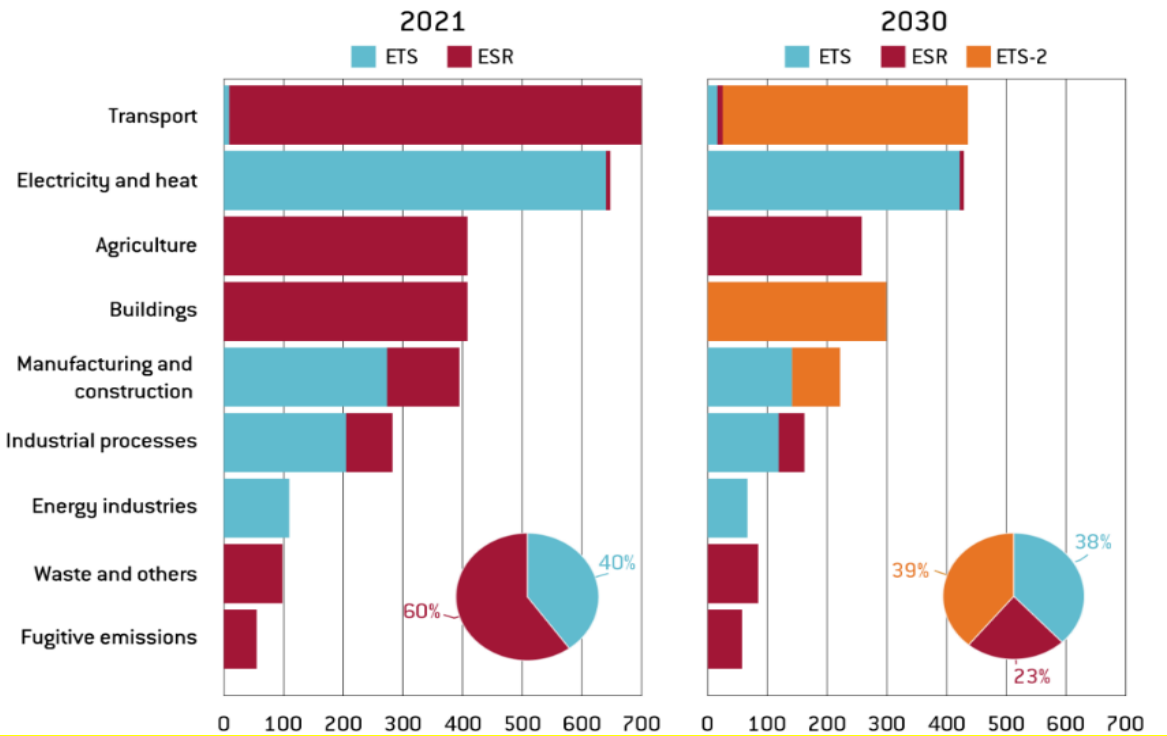
Emission trading will soon become the dominant compliance mechanism in the EU

In the European Union, about 38% of the emissions are covered by the EU emission trading system (ETS1) that ensures that all covered facilities together do not emit more than the cap. The more than 10,000 large point-emitters are primarily energy-installations (power and heat plants) as well as large industrial installations (chemical industry, refineries, cement, metallurgic plants), but internal flights and some maritime emissions. The cap is expected to reach zero around 2040.

Up until now, emissions in the transport and buildings sector are only subject to national targets under the effort-sharing regulation (ESR). To ensure the EU meets its overall targets (-55% from 1990 to 2030) this regulation allocates necessary reductions in emissions that are not covered by the ETS1 (-40% from 2005 to 2030) among member states. As the ESR mechanism has not delivered substantive emission reductions in transport and buildings and is feared to be too weak to ensure compliance, the EU plans to introduce a new emission trading system for transport and buildings by 2027. The covered sectors currently contributed 36% to EU emissions.

By the time Ukraine joins the EU, both systems will be core-pillars of the EU's climate architecture.

Figure 10 EU emission compliance mechanisms: Emission Trading System 1 & 2 (ETS); and Effort Sharing Regulation (ESR)



Source: Pisani-Ferry, J., S. Tagliapietra and G. Zachmann (2023) 'A new governance framework to safeguard the European Green Deal', Policy Brief 18/2023, Bruegel

Ukraine is already obliged to implement certain important elements of ETS in its national legislation under the EU Association Agreement, including the identification of relevant installations, allocating quotas, implementing monitoring, reporting and verification (MRV). This process had already started before the Russian full-scale invasion, e.g., when MRV became mandatory for the ETS sectors in Ukraine.[8] However, extra time may be needed to ensure the high quality of verification of GHG emissions data and to establish a robust system of tracking and reporting.

Some of the important remarks regarding the current emissions' inventory and the main critical factors to be considered in the further advancement of GHG monitoring are outlined below in this paper having some parallels with the EU ETS practice.

3.1 Which Ukrainian emissions would fall under the ETS1

As it is mentioned above, the ETS emissions accounting differs from the one used for NIR and a robust system of individual reporting is needed to achieve clear vision on ETS emissions scope. However, the existing account of GHG emissions under NIR in Ukraine may provide with some high-level estimations compared to a 'big picture' in the EU.

The accurate emissions accounting in Ukraine directly relates to the successful transition to climate neutrality of the country and future introduction of the important instruments to stimulate the transition at the level of industry, including the ETS mechanism. Thus, some important takeaways from the EU experience of ETS functioning are relevant for understanding what sectors require particular attention and which records should be especially precise for successful climate transition in Ukraine.

The ETS scheme has been in place in the EU since 2005 covering the main emitting sectors: electricity and heat generation, energy-intensive industries (e.g., metals, glass, cement, oil refineries etc.), aviation and maritime transportation. Each year the Commission sets a cap on the maximum number of allowances corresponding to one tone of emissions of CO2 equivalent, which has a tendency for reduction every next year. For example, around 1.485 mn of allowances were provided in 2023 with reduction to 1.386 mn already in 2024.

The key consideration behind introducing the ETS scheme is the complete reduction of GHG emission in the future that is to be achieve by gradual reduction of allowances and transition to clean industrial technologies. At the same time, the ETS scheme is also considered as a significant instrument for accumulating the necessary financial sources for such a transition, where the revenues from ETS trade are channelled for relevant energy efficiency and decarbonisation measures at the EU and national levels. The introduction of ETS scheme in Ukraine is supposed to serve the relevant objective of a gradual reduction of GHG emissions and centralised accumulation of sources for the decarbonisation and energy efficiency measures, where further allocation can ensure the proper utilisation the revenues by the industries.

[8] Cabinet of Ministers of Ukraine Decree No.880 from 23.09.2020. *On the approval of the list of activities that are subject to monitoring, reporting and verification of GHG emissions*. https://zakon.rada.gov.ua/laws/show/880-2020-%D0%BF#Text

Further comparison of the sectoral emissions in Ukraine and the EU, as well as the recent carbon price trends, is important for a better understanding of the scale of future ETS scheme in Ukraine.

ETS and carbon price as the efficient financial mechanism for decarbonising EU industries

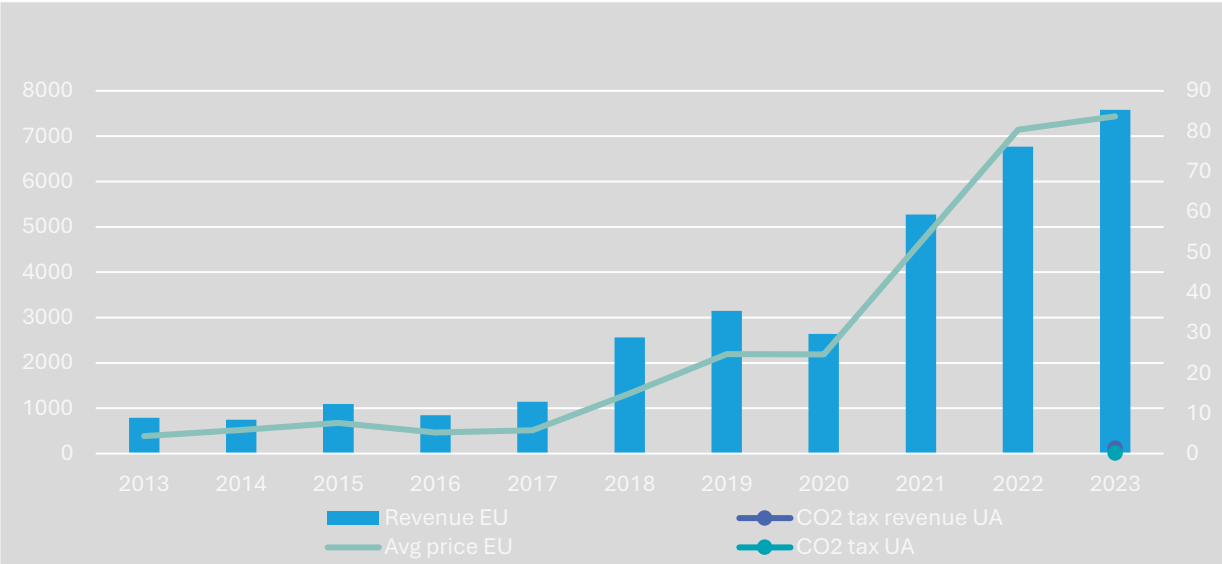
ETS auctions generate significant revenue annually, e.g. 7.7 bn EUR in 2023.[9] The tendency for ETS allowance price increase driven by the carbon price increase, decrease in emissions caps and growing industrial output, results in a significant increase of ETS auctions revenues in recent years in the EU.[10]

Comparing the revenues from ETS trade in the EU to the current measures in Ukraine, namely from the extremely low carbon tax at the level of 0.70 EUR per ton of CO2, and relevant budget revenues in EU member states and Ukraine, one can clearly see that no similar effect can be expected from the current minor Ukrainian fiscal measures. In particular, the Ukrainian carbon tax plays rather a symbolic role and does not result neither in stimulating the industries to reduce their emissions, nor in the significant budgetary revenues. It is worth noting that since 2023 the carbon tax revenues in Ukraine were allocated for financing the State Fund for Energy Efficiency and Decarbonisation, which is expected to support the green post-war recovery in Ukraine and so far, are clearly insufficient to meet the scale of the task.

[9] Nasr, J. "New Record Revenue in Emissions Trading: More than 18 Billion Euros for Climate Protection." *Umweltbundesamt*, 8 Jan. 2024, https://www.umweltbundesamt.de/en/press/pressinformation/new-record-revenue-in-emissions-trading-more-than;

[10] Umweltbundesamt (2022). Auctioning (EU ETS) German Auctioning of Emission Allowances. *Annual Report*. https://www.dehst.de/SharedDocs/downloads/EN/auctioning/2022/2022_annual-report.pdf?__blob=publicationFile&v=2

Figure 11 ETS allowance prices and revenues in the EU vs. carbon tax and revenues in Ukraine



Source: German Emissions Trading Authority (DEHSt) at the German Auctioning of Emission Allowances Periodical Report: Annual Report (2023)

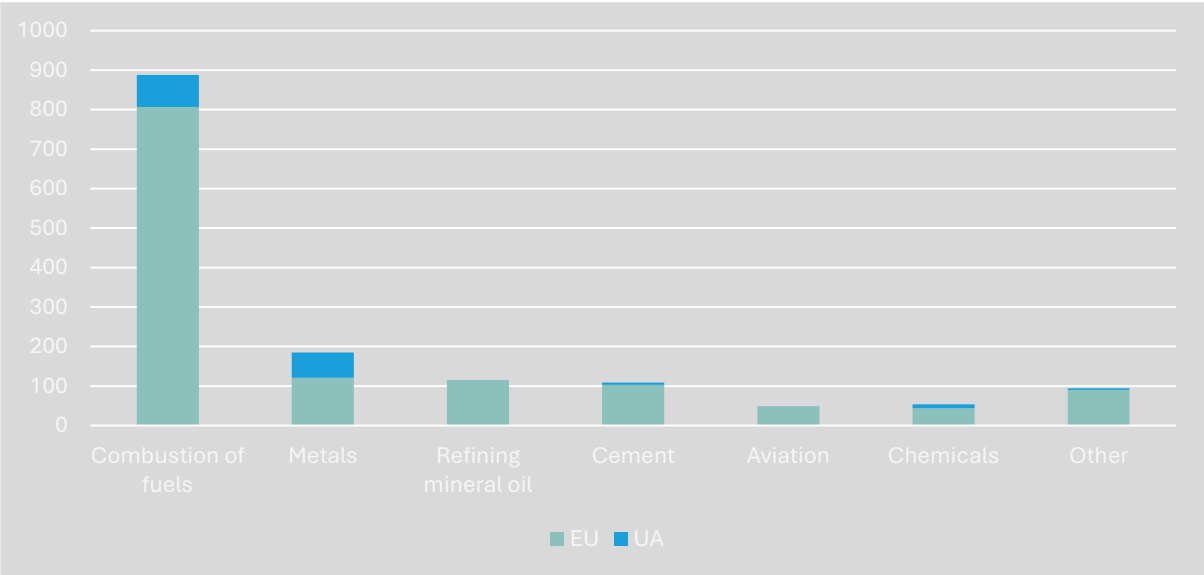
Energy sector and 'heavy' industries generate the majority of ETS1 emissions

A track record of verified GHG emissions in the EU demonstrates that the energy sector has a much higher share followed by some large industries (metals, refining, cement production). The possibility to collect the information from all the individual holders of the allowances in a single EU registry[11] allows having precise information on the verified emissions in the Union. Even though the provided information demonstrates similar tendencies to the estimation of the GHG emissions in Ukraine, the more precise and accurate focus per sector provides for a better understanding of the ETS market size and dynamics in the EU.

Comparing the verified emissions per different industries in the EU and Ukraine, one can also notice that Ukraine had a very significant share of emissions in metal industries before 2022 - being as big as almost a third of all EU emissions in this sector. The post-war dynamic, i.e., loss of many assets in the steelmaking industry, and the sector's modernisation prospects involving potential for deployment of zero carbon technologies (DRI+EAF), can change the situation in Ukraine dramatically.

[11] European Commission (2024). *Union Registry*. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/union-registry_en

Figure 12 Verified ETS emissions per sector in the EU and UA (mn ton CO2 eq.)

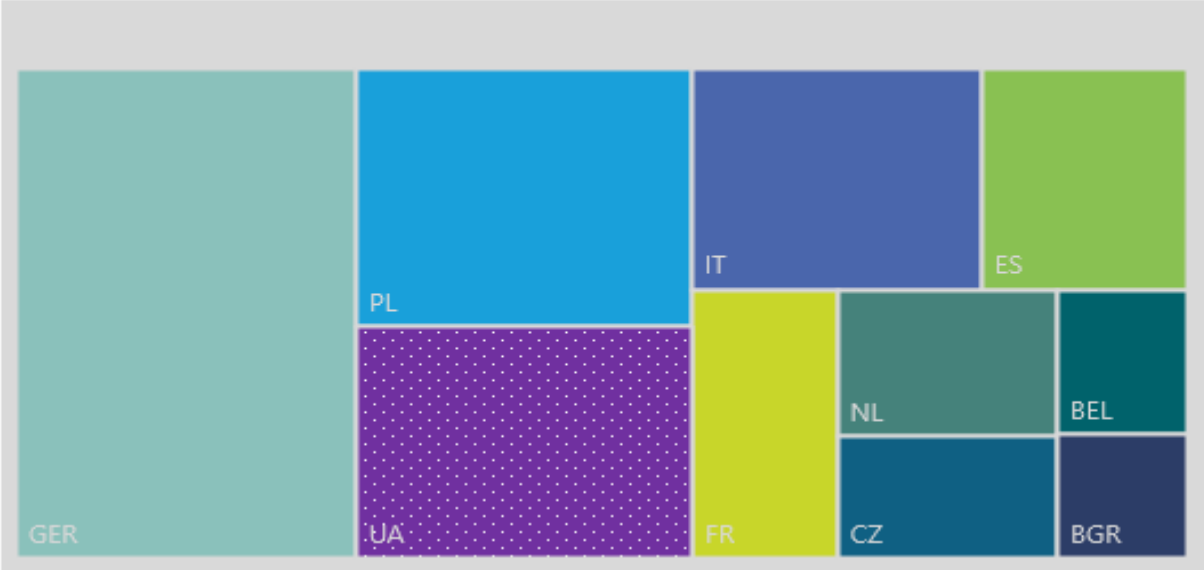


Source: GDU calculations based on European Environmental Agency data

The structure of GHG emissions also demonstrates the difference in terms of each EU Member State, where the largest EU economies alongside several other countries having a high degree of carbon-intensity of their economies (e.g., Poland) represent the main sources of GHG emissions covered by EU ETS scheme. The introduction of monitoring, reporting and verification of the emissions at individual facility level in all EU Member States was important to allow carbon-intensive transitional industries to be smoothly integrated in the common EU ETS.

The 2021 level of GHG emissions in Ukraine would have placed the country among top-3 emitters being at almost the same level as Poland. The post-war situation may significantly shift this position depending on the final damage to the energy sector, metals production and other industries.

Figure 13 Verified emissions per EU Member State and UA (top-10 in mn ton CO eq)



Source: European Environmental Agency data

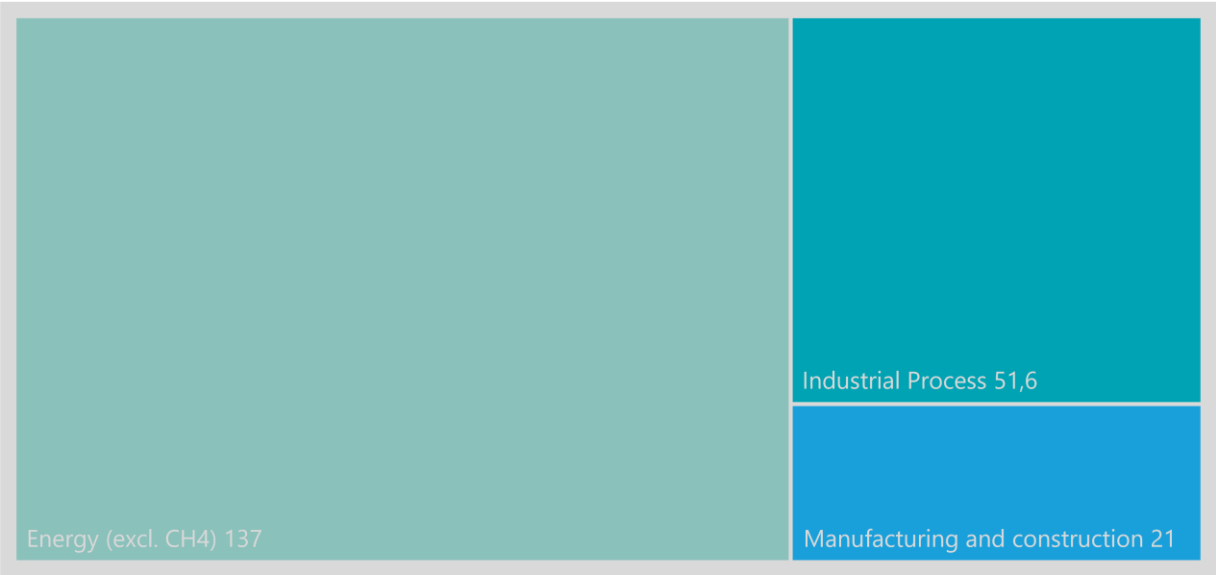
At the same time, an accurate comparison of EU ETS sectors with the relevant emissions in Ukraine is limited due to the obstacles of individual measurement and verification of the emissions in the country. Current generalised data is mainly available through the National GHG Inventory, where the clarity of the assessment may vary in the different sectors.

Given the available information from the latest National Inventory Report, we can draw some conclusions regarding the expected scope of ETS 1 and ETS 2 emissions in Ukraine just before the Russian full-scale invasion started. Apparently, the scope of such emissions has changed significantly due to the consequences of the Russian war against Ukraine and certain adjustments need to be made to understand the clear picture. In addition, the National GHG Inventory contains some uncertainties and gaps, which are not fully comparable to ETS emissions assessment, and which also need to be improved with the more sophisticated assessments and introduction of the MRV. Nevertheless, the existing data can still be an important starting point for further elaborations and research of the topic.

ETS 1 in Ukraine: energy and metals dominate the scope

The ETS 1 scope focuses predominantly on energy generation, metal production and some other industries. Emissions falling into this category had especially strong presence from the metal industry in Ukraine pre-2022 Russian invasion.

Figure 14 Main ETS 1 emissions in Ukraine (based on Inventory)



Source: Ukraine's 2023 National Inventory Report to UNFCCC

It is still quite difficult to fully align the National Inventory data and ETS 1 sector, given that the Inventory's categories and subcategories are not always identical to the ETS categories and may include some extra installations (e.g., smaller ones) or do not specify necessary production method information. In addition, the estimation in the National Inventory may not be based on the highest tiers for some of the categories and use quite generic data (e.g., in the case lime production), while the individual verification of emissions is currently not fully established in Ukraine.

Considering the ETS thresholds (e.g., 20 MW capacity for installations of fuel combustion) the ETS emissions numbers may be reduced in some sectors compared to Inventory information. According to GIZ Report 'Support to the Establishment of an Emissions Trading Scheme in Ukraine', the percentage of emissions covered by ETS varying in different sectors from 61% - 100% in the Energy Industries, 45% to 100% in Manufacturing and Construction and from 42% to 91% in Industrial Processes in different EU Member States.[12]

[12] GIZ (2022), Support to the Establishment of an Emissions Trading Scheme in Ukraine. Cap-setting for the ETS in Ukraine. *Report on Work Package 2*

To estimate the cap based on inventory data, two steps need to be taken: first, the sectors need to be matched with the respective CRF categories used for reporting under the UNFCCC. The relevant categories are:

- Energy industries: CRF categories 1.A.1 (energy industries) and 1.A.3.e (pipeline transport) .
- Energy use by industry: CRF category 1.A.2
- Industrial processes (process emissions): CRF categories 2.A (Mineral industry), 2.B.1 (ammonia production), 2.B.2 (nitric acid production), 2.C.1 (iron & steel production), 2.C.2 (ferroalloys production)

Greenhouse gases covered are CO2 for all energy and process emissions. Additionally, for nitric acid production N2O is included as well.

The key sources of emissions in the Chemistry industry are Ammonia and Nitric acid production with CO2 and N2O emissions respectively where the emissions are related to the production processes, the correlation of emissions in CO2-eq and amounts of these products' is taken into account in the Inventory.

Including all emissions reported in the GHG inventory would lead to an overestimation of historic emissions as there is no minimum size for the inclusion of a source in the national GHG inventory. A sector-specific correction factor is therefore required.

The second step is to correct the values of total emissions in the sectors estimated based on national inventories to the likely size of actual emissions in the ETS sectors, which could be lower due to the inclusion thresholds in the ETS. For emissions from fuel combustion, this is based on the rated thermal input which needs to be at least 20 MW.

As of today, due to incomplete and restricted access to MRV data, we are limited to making approximate extrapolations regarding the coverage of the ETS in these categories at the EU level.

As a back-up approach the share of ETS emissions by the IPCC sector from EU Member States can be used as a proxy - i.e., the caps mentioned for different categories of emissions In the GIZ Report mentioned above. The proxy for Ukraine could be based on the EU average or one or several Member States with a similar structure of the energy and industry sectors.

Since the average share of covered emissions by the ETS sector in the EU also includes fugitive emissions in the energy sector, we recalculated the relevant indicator for Ukraine and obtained the following data on the emission cap. At the same time, the CH4 emissions in the energy sector are not included to the calculation similar to the EU approach. They are now fully comparable to those in the table to determine the approximate coverage of ETS emissions by category in Ukraine.

Table 3 Approx. capped Ukraine's ETS Emissions based on 2021 data

	Category	2021 (Mt of CO2-eq)
Energy Industries	1.A.1 Energy Industries	85
	1.A.3.e Other types of transport (pipeline transport)	1.6
	1.B Fugitive Emissions	50.4
Manufacturing and Construction	1.A.2 Manufacturing Industries and Construction	21
Industrial Processes	2.A (Mineral industry)	7
	2.B.1 (ammonia production)	3
	2.B.2 (nitric acid production)	2.4
	2.C.1 (iron & steel production)	36.8
	2.C.2 (ferroalloys production)	1.6
SUM		209

Further clarification is needed for assessing the exact war-related impact on ETS emissions in Ukraine and acknowledging the verified data based on the MRV process.

Expected outcome from introducing ETS 1 in Ukraine: a comparative perspective

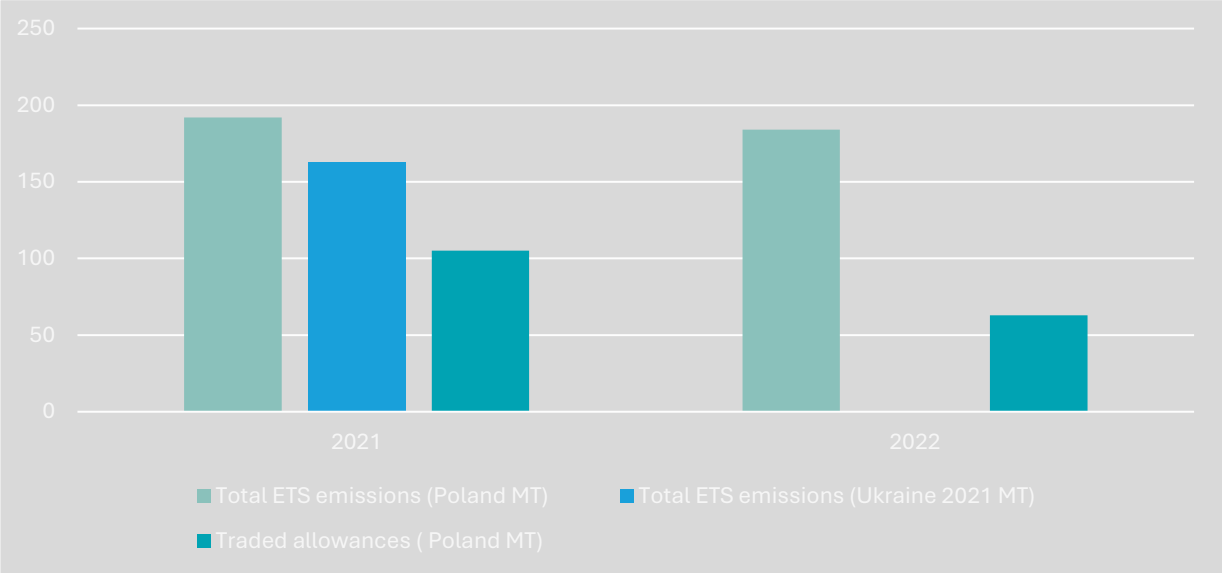
Currently. ETS Introduction is widely discussed in Ukraine in terms of the country's EU accession requirements and providing efficient stimulation for GHG emissions reduction in various industries. An advanced level of verification of the GHG emissions is required for introduction of this system in Ukraine as the first important step. At the same time. many additional issues need to be considered. including the elaboration of the optimal cap on emissions. allocation of per sector allowances and development of the necessary infrastructure for allowances trade.

In the EU. the ETS emissions allowances cap is set at all-EU level for stationary installations and aviation. A part of allowances within the cap is provided for free. while the rest is auctioned: e.g.. since 2021 around 57%

of allowances are auctioned in the EU. The cap is also reduced each year to stimulate lowering the emission rate by EU industries.[13] The EU approach to setting the cap is based on the absolute level emissions deriving from the base year towards future reduction. This approach leads to the increase of allowance price when the industrial output is growing. unless efficient energy efficiency measures are not provided by the undertakings.

Comparing Ukraine to similar-size EU countries participating in EU ETS trade demonstrates that significant revenues can be achieved if such volumes are traded on a liquid market. E.g., the case of Poland which has almost the same level of ETS sector emissions as the one in Ukraine proves this assumption.

Figure 15 ETS Emissions vs allowances in Poland

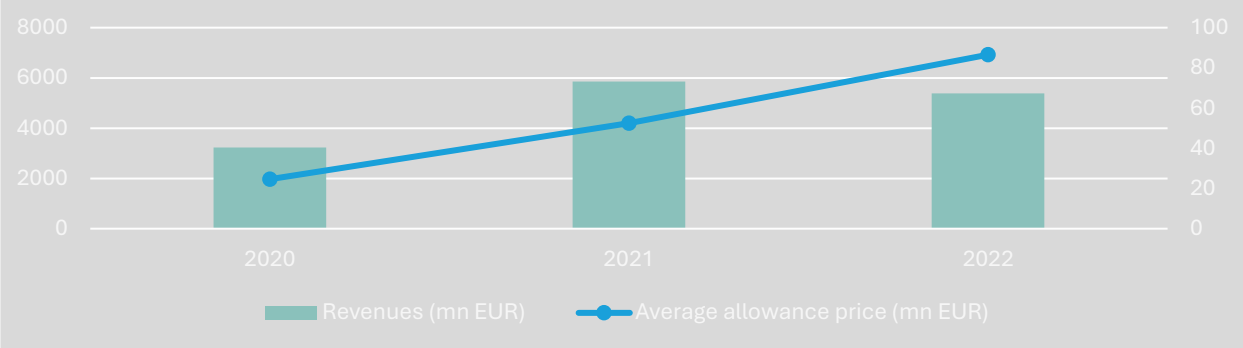


Source: European Environment Agency

With the recent increase in ETS allowance prices, the total revenues by Poland exceeded 40 bn EUR per year. even despite some decrease in industrial output in 2022.

[13] European Commission (2024). *Emissions cap and allowances*. https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/emissions-cap-and-allowances_en

Figure 16 ETS Revenues and average allowance price - Poland



Source: Forum Energii (2023)[14]

However, various parameters need to be assessed in Ukraine when developing the national ETS system. including the impact on post-war industrial recovery, the standardisation of Ukrainian allowances with EU-one and necessary verification, as well as the necessary degree of ETS trade liquidity and transparency to allow actual price discovery.

With the successful implementation of ETS 1, Ukraine can also move forwards towards the involvement of ETS 2 sectors.

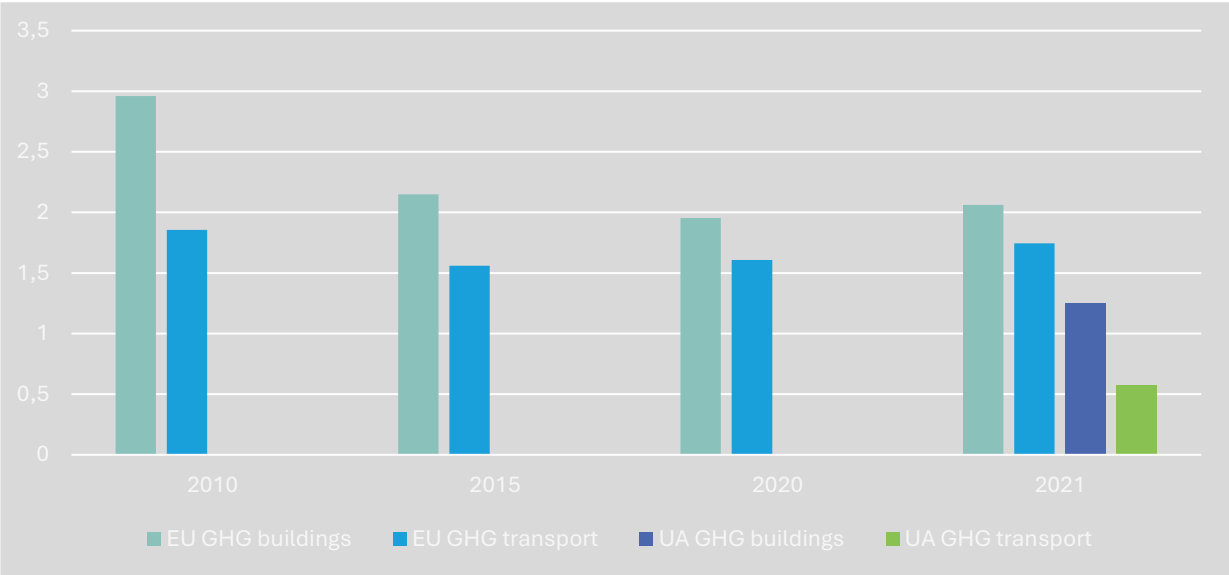
3.2 Which Ukrainian emissions would fall under the ETS2

ETS 2 in Ukraine: relatively smaller scope compared to the EU, but better clarification is needed

In 2027 EU ETS 2 is to be introduced, which will bring the emissions accounting and trade to a more granular level. covering also buildings, road transportation and some additional sectors not covered by the current ETS scheme. This makes the emission at the level of households to be especially important for further consideration, where a precise understanding of their individual heating and cooling activities, as well as private transport utilisation. This may be especially tricky in case of future applying ETS 2 in Ukraine, where the individual energy use metering (especially for heating) is still not fully introduced for many households.

[14] Forum Energii (2023). *Transformacja energetyczna w Polsce*. https://www.forum-energii.eu/transformacja-energetyczna-w-polsce-edycja-2023

Figure 17 EU and UA GHG emissions per capita in buildings and road transportation (in ton CO2 eq.)



Source: European Environmental Agency data and National GHG Inventory

The comparison of the ETS 2 emissions in buildings and transport per capita in the EU and Ukraine demonstrate that Ukraine has almost 3 times lower emissions per capita. Partly this tendency can be explained by a smaller road transportation park compared to an average EU Member State in Ukraine. But also, the lack of reliable data on individual consumption is likely to be the reason for such a difference, which signalises on the need to improve data collection and verification in Ukraine, especially in the building sector.

Figure 18 ETS 2 in Ukraine in mn tones CO2 eq.

Source: Ukraine's 2023 National Inventory Report to UNFCCC

The overall picture of the ETS 2 emissions in Ukraine based on the National GHG Inventory demonstrates that buildings are likely to remain the main ETS 2 sector in the country followed by almost equal shares of road transportation and additional sectors (other energy sectors not covered by ETS 1, as well as energy utilisation in manufacturing Industries and construction).

However, this data needs to be better verified with regards to Individual energy utilisation, where certain shifts and clarification may impact the final ETS 2 distribution.

4 Conclusion

The overview of the current GHG emissions assessment in Ukraine and prospectives for future ETS introduction demonstrates that despite the continuous efforts in introducing the system of GHG emissions assessment and drafting the second National GHG Inventory some significant gaps still exist in reliable GHG tracking and reporting.

Namely, the lack of individual GHG measurement reporting and verification significantly impedes the reliability of data and worsens the uncertainty of GHG emission assessment. In addition to this, the lack of reliable metering of households' consumption provides another difficulty. In the assessment of actual GHG emissions emitted in Ukraine. Partly these limitations may also be improved by introducing more sophisticated approaches to GHG assessment and verifying the uncertainties in the National Inventory process.

Future introduction of the ETS scheme in Ukraine based on the EU experience will require significant efforts in improving the data collection and verification with the focus on particular ETS sectors. The overall assessment of the potential ETS market in Ukraine demonstrates that the country's scope could be compared to the biggest EU ETS market before the Russian full-scale invasion in 2022. Given all the necessary adjustments to war-related impact on various industries, the detailed reassessment has to be done and strengthened by the more advanced GHG emission reporting and verification.

The success in pursuing the improvement of GHG emissions measurement and reporting is crucially important for further transition to climate neutrality and efficient implementation of EU requirements for ETS allowances trade, which also constitutes a part of Ukraine's pre-accession commitments.

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