Report on CORSIA implications and carbon market development (Deliverable 3.2.)

Assess CORSIA implications and carbon market development

Prepared by KPMG in Ukraine

December 2022

Abstract

This report was written as a part of the Supporting Green Recovery in Ukraine project by the United Nations Development Programme (UNDP) office in Ukraine.

This report includes analytics in CORSIA status in Ukraine, current and potential challenges, the issues related to CORSIA implementation, carbon markets use to offset excessive emissions. Worldwide practices of carbon offsetting schemes in the aviation and the models being developed are considered as well. Report also includes an analysis of subject legislation and relevant recommendations.

Table of contents

Glossary of terms

ACC	Approved Carbon Credit
ACR	American Carbon Registry
ANO	Air Navigation Order
CAEP	Committee on Aviation Environmental Protection
CAGR	Compound annual growth rate
CAR	Climate Action Reserve
CARB	California Air Resources Board
CCER	China Certified Emission Reduction
CCR	CORSIA Central Registry
CCUS	CO2 capture, utilisation, and storage
CDM	Clean Development Mechanism
CEEUs	CORSIA Eligible Emissions Units
CER	Certified emission reduction
CERT	CO2 Estimation and Reporting Tool
CHP	Combined Heat and Power
CMU	Cabinet of Ministers of Ukraine
CO2	Carbon dioxide
CO2-eq	Carbon dioxide equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CRTs	Climate Reserve Tonnes
EEA	European Economic Area
EMP	Emissions Monitoring Plan
ERPA	Emission Reduction Purchase Agreement
ESG	Environmental, Social, Governance
ETS	Emissions Trading Scheme
EUC	Emissions Unit Criteria
GCC	Global Carbon Council
GHG	Greenhouse Gases
GS	Gold Standard
HFLD	High Forest Low Deforestation
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ISO	International Organisation for Standardisation
JCAB	Japan Civil Aviation Bureau
JI	Joint Implementation
LULUCF	Land Use, Land Use Change and Forestry
MBM	Market-based Measure
MRV	Monitoring, reporting, and verification
NFT	Non-fungible token
NGO	Non-governmental organisation
NZ	New Zealand
NZAM	Net Zero Asset Managers
OPR	Offset Project Registry
REDD	Reducing emissions from deforestation and forest degradation
RTK	Revenue Tonne Kilometres
SAAU	State Aviation Administration of Ukraine
SAF	Sustainable aviation fuel
SARPs	Standards and Recommended Practices
SI	Statutory instrument
TAB	Technical Advisory Body
TOR	Terms of Reference
TREES	The REDD+ Environmental Excellence Standard
UK	United Kingdom of Great Britain and Northern Ireland
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market

Executive summary

This study of the implementation of CORSIA in Ukraine was carried out in comparison with global practices, including implementation of MRV, the CORSIA carbon offset model and credit sales practices, key market players and drivers, market size and prices, global experience in trading carbon credits, mandatory and voluntary offsetting schemes, global experience in aviation, as well as prospects for carbon credit sales models and market in Ukraine. Eligible programmes, promising sectors, and technologies and projects for decarbonisation and generating carbon credits both globally and in Ukraine were all considered, as well as a pilot carbon offsetting project which has been modelled to better understand its process. Furthermore, the legal aspects of the implementation of carbon offset projects has also been analysed.

The following summarises the main conclusions that can be drawn from our research and analysis:

- **Ukraine is a CORSIA participant in the voluntary stages of the programme.** Ukraine is one of the 118 countries participating in CORSIA on a voluntary basis. All eight Ukrainian airlines that meet CORSIA requirements are CORSIA participants. From 2027, participation in CORSIA will be mandatory.
- **MRV according to CORSIA has been successfully implemented in Ukraine.** The SAAU approved and implemented Aviation Regulations of Ukraine "Technical requirements and administrative procedures for monitoring emissions by civil aircraft operators". Eight Ukrainian aeroplane operators report their emissions to the SAAU.
- **Insufficient legal basis for implementing and regulating a carbon offset model.** In order to be able to apply offsetting (a carbon dioxide emissions compensation mechanism) in Ukraine, it will be necessary to develop sufficient and effective legal infrastructure. This includes a logically co-ordinated dynamic system of unified legal terms and conditions to ensure effective legal regulation of public relations.
- **Ukrainian aeroplane operators have experience in mandatory European Emissions Trading Schemes (EU ETS).** For all EEA flights, aeroplane operators must report and later purchase quotas in accordance with the requirements of the EU ETS (if they meet the applicable requirements). For these purposes, each airline is registered in a European constituent country of the scheme.
- **Ukrainian aeroplane operators do not use voluntary offsetting schemes.** Most major international airlines use a voluntary offsetting scheme whereby they offer passengers to offset their own carbon footprint. Ukrainian airlines are considering the possibility of implementing a similar scheme.
- **Only foreign verifiers of GHG emission under CORSIA are available to aeroplane operators at this current time.** Currently, Ukrainian airlines co-operate with foreign verifiers as there are no local certified verifiers in Ukraine. Support will be necessary in order to implement the development of local certified verifier in Ukraine.
- **Absence of a carbon trading market in Ukraine.** Business companies, investors, and the Ukrainian government have been increasingly interested in a local carbon trading market, have raised this issue for discussion, and work is starting in this direction.

- **A global carbon offsetting market is still underdeveloped and not fully standardized, but is developing at a high pace; fueled by increasing regulatory pressure.**
  Offsetting project certification systems are quite diverse and require harmonisation. Offsetting projects differ greatly in terms of the price of carbon credits, the needs and motivations of credit buyers, geographic coverage of projects, types of projects, methodologies used, etc. The prospects of specific external offset projects are not clear enough for implementing projects in Ukraine, considering the wide variety of options available for their implementation. Implementation would require extensive testing and piloting in different industries to fully clarify the processes involved and the economic feasibility of certification.
- **The most promising sectors for generating carbon credits in Ukraine are agriculture, forestry, renewable energy, and energy efficiency projects.** Considering Ukrainian specifics, namely the presence of a sufficient area of forests, agricultural land, large vertically-integrated agricultural holdings, and the development of organic agriculture; the possibility of introducing new production technologies related to decarbonisation in agriculture, natural resources for renewable energy, and a high energy consumption economy; Ukraine has a number of promising sectors for generating carbon credits. Companies are already working in to develop capacities in these areas.
- **Prospects for Ukrainian producers that can generate carbon credits.** After implementing offsetting according to CORSIA, Ukrainian producers will have the option to generate and sell carbon credits to airlines. As the price of carbon credits under CORSIA are expected to be higher when compared with voluntary schemes, a CORSIA market would be considered more attractive. Furthermore, after implementing carbon absorption calculation, verification, and certification according to international standards, producers will be able to enter the international market.
- **Prospects for the growth of biofuel and SAF production.** Ukraine has the potential to produce biofuels and SAF in accordance with the requirements of CORSIA.
- **All stakeholders agree that the topic of decarbonisation and climate change in general is important and needs attention.** The issue of offsetting is relevant and promising, especially for potential producers of carbon credits. All major stakeholders are already taking some of the necessary steps to decarbonise and implement the necessary programmes.
- **Need to raise awareness regarding the carbon credit market among key stakeholders.** While the main stakeholders are aware of the main issues regarding decarbonisation, it will be necessary to raise awareness for carbon credit market implementation and development given the specificity of the topic and the lack of such a market in Ukraine.

Considering all the aforementioned assessments of the implications of implementing CORSIA on aviation and carbon market development, we propose three key action streams that will be necessary for implementing CORSIA and developing the local carbon offset market:1

- Stream 1: Aeroplane operators' integration into the existing international carbon offset market
- Stream 2: Ukrainian-based offset projects entering the international offset market
- Stream 3: Creation of a national carbon offset market and integration with international markets

More details on the conclusions, findings, and recommendations in this report are described in more detail in their respective sections.

Introduction

The problem of climate change is on the agenda all over the world and many international and regional efforts are being made to combat climate changes. As a result, the Kyoto Protocol was adopted in December 1997, in addition to the UN Framework Convention on Climate Change, which obliges developed countries and developing countries to reduce or stabilise greenhouse gas emissions compared with 1990. Replace the Kyoto Protocol, the Paris Agreement on the Regulation of Measures to Reduce Carbon Dioxide Emissions from 2020 was adopted on 12 December 2015 as part of the UN Climate Change Convention (UNFCCC).

However, the Paris Agreement does not include international aviation emissions. Emissions from international flights are the responsibility of the International Civil Aviation Organisation (ICAO).

The ICAO is the United Nations' specialised agency established under the Chicago Convention (1944) to manage the administration and governance of international aviation, including responsibility for tackling international aviation emissions (which, as mentioned, fall outside of states' nationally-determined contributions under the 2015 Paris Agreement.

In October 2016, The members of the ICAO agreed and decided to create a global market-based mechanism for aviation emissions called the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). This global market-based mechanism requires qualifying aeroplane operators to offset any growth in international aviation CO_2 emissions covered by the scheme that are above 2019 levels (i.e. acceptable emissions are capped at that year's level). The growth in emissions will be offset by these operators purchasing and cancelling emissions units (with one unit equal to one tonne of CO_2 equivalent emissions avoided or removed from the atmosphere).

The relevant decision to implementing this global mechanism is ICAO Assembly Resolution A.39-3 (Consolidated statement of continuing ICAO policies and practices related to environmental protection – Global Market-based Measure (MBM) scheme).

CORSIA is the first global market-based measure for any sector and represents a co-operative approach. It offers a harmonised means to reduce emissions from international aviation.

Purpose of CORSIA. CORSIA seeks to neutralise international aviation CO_2 emissions from 2021 to 2019–2020 levels via offsetting programmes.

Participants. As of October 2022, there are 118 states who participate in CORSIA. Ukraine is also a participant in CORSIA.

Timeline. CORSIA is implemented in three phases:

- **Pilot phase** (2021–2023). Voluntary participation.
- **First phase** (2024–2026). Voluntary participation. Operators will offset emissions based on the average CO_2 growth of the aviation sector, compared to the established baseline.
- **Second phase** (2027–2035). Participation is mandatory.
    - (2027–2029) Operators will offset based on the average CO_2 growth of the sector.
    - (2030–2032) Offset obligations shift to include over 20% of individual operator growth.
    - (2033–2035) Offset obligations shift to be over 70%, based on individual operator growth.

All growth is according to the baseline established in 2019–2020.

From 2027 onwards, participation will be determined based on 2018 Revenue Tonne Kilometers (RTK) data, exceeding 0.5% of the total number of RTK or those whose combined share in the list of states from the highest to the lowest amount of RTK reaches 90% of the total number of RTK.

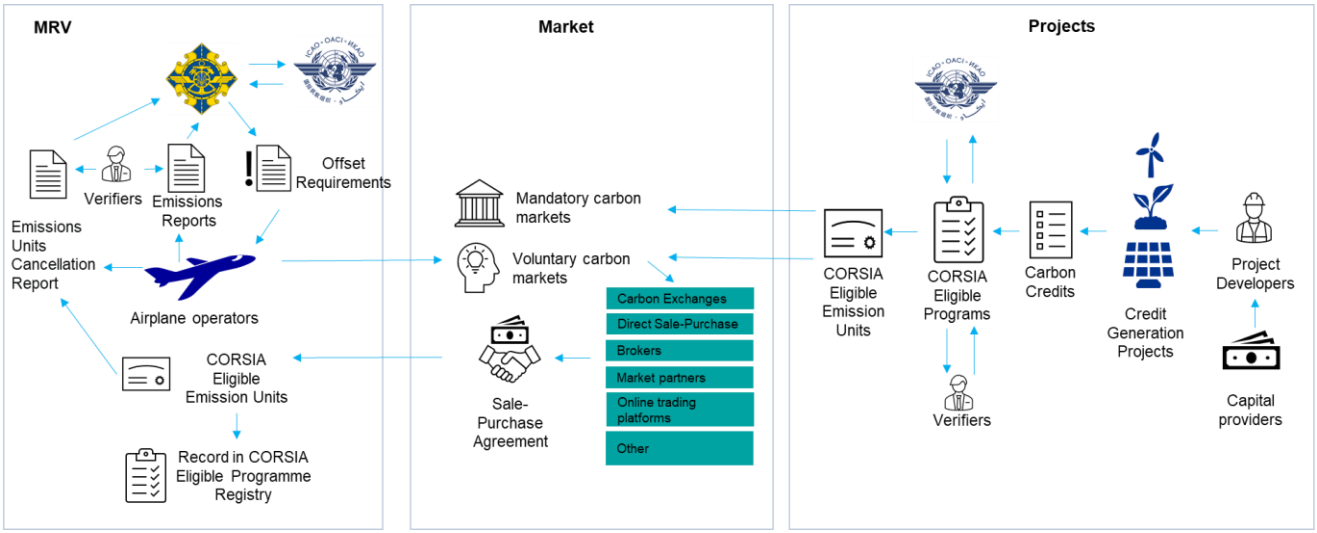
Legal Basics. The main act that regulates this carbon offset mechanism in the aviation sector is laid out in the ICAO International Standards and Recommended Practices (ICAO Standards), Annex 16 Environmental Protection, Volume IV Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to The Convention on the International Civil Aviation (Chicago Convention), effective from January 2019.

This act covers all aspects of the scheme, including the offsetting itself, and monitoring, reporting, and verification (MRV) requirements.

On 13 April 1948, a resolution was adopted that invited the attention of Chicago Convention Contracting States to the desirability of using the precise language of the ICAO Standards in their own national regulations, as far as is practicable. ICAO Standards have a regulatory character. Therefore, as stated, the provisions of Annex 16 Environmental Protection can be incorporated into national legislation without major textual changes. In order to build a national offsetting system, it important to take into account other ICAO decisions, documents, or systems that are needed to implement CORSIA. These include:

- The ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT), a simplified tool for small operators to monitor and report their CO_2 emissions.
- CORSIA Eligible Fuels. There are five guidance documents regarding reduction of eligible fuels under the offsetting requirements under CORSIA:
  - Eligibility Framework and Requirements for Sustainability Certification Schemes
  - Approved Sustainability Certification Schemes
  - Sustainability Criteria for CORSIA Eligible Fuels
  - Default Life Cycle Emissions Values for CORSIA Eligible Fuels
  - Methodology for Calculating Actual Life Cycle Emissions Values
- CORSIA Eligible Emissions Units (CEEUs) and CORSIA Emissions Unit Eligibility Criteria.
- The CORSIA Central Registry (CCR): Information and Data for the Implementation of CORSIA and CORSIA Central Registry (CCR): Information and Data for Transparency.

CORSIA offsetting scheme:



Methodology description

1. List of Key Activities

Stage 1: Study implementation

A. Desk research

This activity involves exploring legislative requirements, and any cases of successfully attracting carbon financing and realising carbon offsetting both worldwide and in Ukraine specifically.

Conducting desk research by availing of existing documentation:

1. CORSIA documents, including international regulations and relevant analytics, including:

- SARPs: Annex 16 Volume IV.
- Training Material on Model Regulations to Assist States in the Implementation of CORSIA.
- CORSIA offsetting requirements.
- CORSIA Emissions Unit Eligibility Criteria.
- Methodology for ICAO-level Gap Filling.
- Analysis and assessment of the design of an offsetting system for international aviation.

2. Ukraine legislative and other documents, and relevant assessments:

- Air Code of Ukraine № 3393-VI, dated 19 May 2022.
- Aviation Rules of Ukraine, Order №1001 "Technical requirements and administrative procedures for the monitoring of emissions (emission) by civil aircraft operators".
- Aviation transport strategy of Ukraine for the period up to 2030.
- Report on strategic environmental assessment of the Aviation Transport Strategy of Ukraine for the period up to 2030.
- Law of Ukraine “On monitoring, reporting and verification of GHG emissions” and secondary legislation (for ex. CMU Resolution “On approval of the Procedure for Monitoring and Reporting on Greenhouse Gas Emissions” No.960 dated 23 September 2020).

3. Relevant materials about practical cases of CORSIA carbon credit purchasing models.

4. Any other relevant documents, online and offline publications, and websites locally and internationally, which may be relevant.

5. Standards applying to high-quality credits, description of assurance mechanisms.

B. Interviews with stakeholders

Conducting interviews with stakeholders and communication with other identified stakeholders at the international level and in Ukraine to solicit, acquire, or follow up on information identified in order to validate hypotheses or findings.

A preliminary list of stakeholders targeted by implementer and that would be additionally involved in discussions regarding the United Nations Development Programme (UNDP) reads as follows:

- ICAO / CORSIA and UNDP
- State Aviation Administration of Ukraine (SAAU)
- State Energy Efficiency Agency of Ukraine (SAEE)
- State body representatives (the Ministry of Environment and Protection of Natural Resources, State Forestry Agency of Ukraine, Ministry of Agrarian Policy and Food of Ukraine, and other relevant ministries or state authorities)
- Private sector (airlines: SkyUp, Ukraine International Airlines, Wizz Air, Lufthansa, Ryanair, Turkish Airlines, and others)
- Expert community (Oleksiy Khabatiuk, Vladyslav Zhezherin, Mykola Shlapak, Kyrylo Tomliak, Iryna Gruzynska)
- Banks and financial institutions (Ukrgasbank, Ukrsibbank)
- International financial organisations (EBRD, IFC, GEF, NEFCO)
- Project ETS
- Agricultural holdings (Kernel, Astarta-Kyiv, Arnika)

The above interviews are specifically focused on understanding the following:

- Monitoring, reporting, and verification systems used or intended to be used in aviation
- Worldwide carbon credit sales practices in aviation
- Carbon credit sales models currently under consideration for aviation
- Consideration of models in Ukraine, including carbon offset schemes which involve the agricultural sector, forestry, and other sectors
- Consideration of credit quality, specifically how to assure the quality of local Ukrainian credits.
- Legal obstacles to implementing carbon credit sales practices in Ukraine.

Given the ongoing nature of the 2022 escalation of the Russian war against Ukraine and the short period of the assignment, we expect that number of interviews would be around 10. Interviews will help to obtain both valuable context for the final report, as well as identifying existing and potential gaps and issues to be taken into consideration in the future.

After the interviews, the results will be analysed and the data carefully aggregated and prepared for the next stage.

Output 1: Main stage of desk research and interviews when bulk information will be gathered and analysed, and hypotheses established.

Stage 2: Reporting

A. Report on carbon offset models.

Main tasks of the Section:

- Needs assessment and recommendations regarding any key gaps, obstacles, opportunities, and incentives needed to develop carbon offsetting in aviation in Ukraine. International lessons studied and used as the foundation for preparing a detailed concept for carbon offsetting models. For this purpose, other countries' strategies, plans, and legislation for implementing state policy

in the sphere of market mechanisms for compensating CO_2 emissions from civil aviation will be considered. Desk review will include consideration of at least two countries' relevant experiences. This includes a list of available financing options, a long list of investment areas and possible targets to be defined in consultations with reform owners, international financial institutions, and financial market players.

- Creation of a map of carbon offsetting models and instruments available internationally, to address sensitivity perspectives by considering the local Ukrainian agricultural sector, forestry, and other sectors as relevant targets of the Project.
- Development of criteria / map of carbon offsetting models and instruments for Ukraine. Exploring potential areas and recipients of carbon offsetting in Ukraine and developing criteria / map of instruments that would be reasonable to use by different kinds of recipients. Studying green financing and greenhouse gas reduction provided by International Financial Institutions (IFIs), banks and financial market players.
- Development of recommendations to improve access and use of carbon offsetting based on research and consultations. Analysis of the Ukrainian experience and assessment of the scope of legislative changes, international best practices, and the regulatory environment, along with consultations with IFIs, financial market experts, representatives from the agricultural and forestry sectors, and other stakeholders; providing for identification of existing gaps and elaborating recommendations for improving access to carbon offsetting.

Developing a Report on Carbon Offset Models in Aviation currently being practiced or under development for use in global aviation with suggested applications in Ukraine. The Report will consider the best-case scenarios for Ukraine to practice carbon offsetting. The document will include the following, at a minimum:

- Monitoring, reporting, and verification systems used or intended to be used in aviation. Key challenges and relevant conclusions and recommendations.
- Carbon credit sales practices in aviation worldwide, if any. Key challenges and relevant conclusions and recommendations.
- Carbon credit sales model currently being considered in aviation, along with conclusions and recommendations.
- Consideration of models in Ukraine, including carbon offset schemes with involving the agricultural sector, forestry, and other sectors.
- Consideration of credit quality: specifically, how to achieve assurance regarding the quality of Ukrainian credits.

This stage will result in the preparation of a Report on Carbon Offset Models in Aviation with relevant projections in Ukraine.

B. Preparation of a Study Consolidated Report.

Preparation a Study Report on the implications on aviation of implementing CORSIA and the development of a Ukrainian carbon market development. The final structure and content of the Report will be agreed with the UNDP. The Report will include the following sections at a minimum:

- Findings and recommendations.
- Methodology description.
- Detailed analysis of CORSIA specifics and its impact on the Ukrainian aviation industry.
- Assessment of carbon offset models.

- Summary of consultations with stakeholders.
- Analysis of possible short-term and long-term actions by the Government of Ukraine and industries to pursue carbon credit markets with the involvement of aviation.
- Key data sources (to be presented in an annex).
- Discussion of credit quality and proposal to ensure that only high-quality credits can enter the offset system in Ukraine.

Output 2: Answers to main questions regarding which carbon offsetting model and instruments in aviation are eligible / acceptable for Ukraine.

Stage 3: Validation of Study Result with Key Stakeholders

A. Preparation of Presentation.

Preparation of a presentation which will cover methodology, assessment results, and recommendations. The document will include the following sections at a minimum:

- detailed analysis of the impact of CORSIA specifics.
- concrete recommendations regarding carbon offset initiatives.

Presentation materials will be prepared after UNDP review and comment on our study report in both English and Ukrainian and will be reviewed by UNDP as well. The presentation will be prepared in Microsoft PowerPoint format using the template provided by UNDP and will be submitted to the UNDP in electronic form (*.pptx, *.pdf, or other formats acceptable to UNDP).

B. Public event(s)

Presentation of the developed materials, project findings, and recommendations to a wide range of stakeholders in a minimum of one public event in order to seek feedback, provide additional information and answers to possible questions, and receive requests for clarification.

The target date for the public event(s) is December 2022. However, as a result of the ongoing Russian invasion of Ukraine and the short-term nature of the Project and with UNDP approval, public event(s) may be postponed to a more suitable time (i.e. January).

It is currently expected that an event or events will be organised online (virtually), although there is also the option to potentially hold events offline. This will depend on adequate security due to the ongoing Russia's ongoing invasion of Ukraine and any relevant restrictions related to preventing the spread of COVID-19 prior to organising the event.

Envisioned participants of the event(s) would be the main stakeholders, as well as other representatives of state bodies, and from the private sector and expert community.

Output 3: Validation of Study Results with Key Stakeholders.

Stage 4: Study Report Finalisation and Submission.

A. Finalisation of the Study Report.

Relevant comments and suggestions by UNDP and other stakeholders will be processed and amendments will be included in the final study report.

The Final Study Report will also contain information related to the overall organisation and execution of the study, data entry, and organisation of the output files highlighting any potential considerable difficulties, challenges, and deviations from the original plan, as well as any other notable occurrences or points of interest.

2. Tools, models, and risks

Study tools

The project should include the following key components:

- **Desk Research:** Desk research and project-related materials, as well as documents related to Ukrainian and international experience.
- **Interviews:** Interviews conducted with project staff, project partners, and main stakeholders to determine and clarify project issues, as well as the vision for the future.
- **Carbon offset models in aviation:** Elaborating carbon offset models in aviation using global best practices and with close engagement with banks, lawyers, and industry professionals.
- **Validation:** Validation of study results with key stakeholders.
- **Reporting:** Preparation and submission of final reports.

Carbon offset models and instruments

The approach to the assignment includes an assessment of the procedures and practices as part of CORSIA and ICAO, voluntary and obligatory carbon offset models from around the world, and a feasibility study for implementing such a market in Ukraine, namely:

- Obligatory schemes: emission trading schemes (i.e. a potential future Ukrainian national ETS and integration with the EU ETS).
- Voluntary schemes: implemented carbon trading schemes already applied in aviation and other sectors.
- Best available practices of implementing CORSIA requirements; including institutional, legal, and financial benchmarks.
- Monitoring, review, and verification systems (MRV).
- Offsetting project implementation mechanisms.
- Quality assurance, etc.

The assignment will also include an analysis of potential or proven effective offsetting projects, such as the following:

- Renewable energy (wind power, solar power, biomass and biofuel) .
- Methane collection and combustion (landfill, farm animals, industrial waste).
- Energy efficiency (co-generation, fuel efficiency, energy-efficient construction).
- Destruction of industrial pollutants (hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)).
- Transport (cycling, public transport, car-pooling, car sharing, electric transport).
- Agriculture (soil carbon storage).
- Land use, land-use change, and forestry (deforestation, reforestation, afforestation, soil management).
- Small-scale schemes.

The assessment will involve conducting an analysis of needs, provide an overview of carbon offsetting instruments, and capture lessons learnt from their prior use in Ukraine and other countries. It will additionally include analysis of the legal, technological, and financial dimensions of the carbon market for better understanding of the formal and informal stakeholders, factors and the decision-making processes of markets which influence carbon offsetting models. Such an approach will also contribute to better alignment with other strategic carbon policy documents like the State Climate Change Policy Concept to 2030, the Action Plan on implementing the State Climate Change Policy Concept to 2030, Ukraine's low emission development strategy to 2050, the Energy Strategy of Ukraine to 2035, the national economic strategy to 2030, the National Transport Strategy of Ukraine to 2030, and the Law of Ukraine "On monitoring, reporting and verification of GHG emissions", amongst others.

Employing a collaborative approach with the SAAU, SAEE, and other stakeholders as the agencies involved in driving the introduction of carbon offset models to aviation in Ukraine. The introduction of new financial instruments (obligatory or voluntary) necessitates early engagement with other relevant responsible Ukrainian ministries, such as the Ministry of Finance, the Ministry of Economy, Ministry of Environment and Protection of Natural Resources, as well as the National Bank which would act as the major financial regulatory body. We will engage with these stakeholders, starting with a needs and gaps assessment, and the development of recommendations.

Approach to risk

The project will effectively employ a risk management system aimed at identifying and assessing risks and uncertainties that may potentially impact the project, determining an applicable risk management strategies and reporting on their status from project design to close-out. The project will make sure that appropriate risk management processes and tools are put in place and linked to decision making and adaptive project management from design to implementation, monitoring, evaluation, and learning.

The most severe risks (those that have the highest residual impact score after mitigations) are specified below, along with the planned mitigation measures. The risks and mitigations are subject to review and monitoring during implementation:

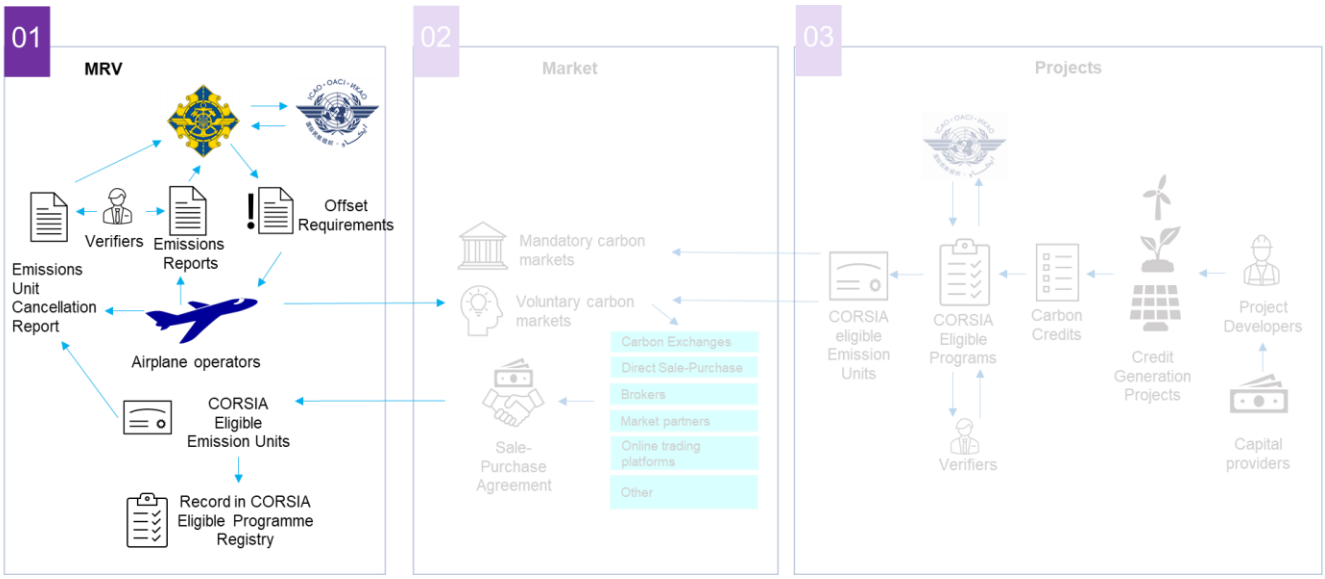
- **Risk of the scope of the assignment and understanding of objectives and tasks**. This risk is expected to be mitigated by presenting and further compliance of the approach, methodology, and work plan to be reviewed, agreed-upon, and approved. Moreover, the first stage of the assignment will be used to clarify and prepare a detailed methodology and specific tasks for the Project.
- **Risk of uncoordinated or poorly coordinated efforts from various Government of Ukraine (GoU) agencies and international donors in assessing the carbon offsetting market**. GoU agencies and international donors may operate in silos, leading to conflicting project activities. This risk is expected to be mitigated through the work of the project team and proactive co-operation with key players to ensure their active involvement and ownership of the results of the project.
- **Risk that Reform owners may disagree and not accept the recommendations or approach proposed by the Project team due to having a different vision that potentially results in not approving an output deliverable**. As mitigation, the project team will rely on international best practices and work with other donor organisations in the field to ensure the alignment of

approaches and strengthen project implementation position. Any potential disagreements will be properly discussed in order to find a consensus agreement.

- **Risk of assessment results skewed to favour certain market players with knowledge, skills, and resources who can cement unfair competitive advantage in the early stages of developing a carbon offset market in Ukraine**. This risk is planned to be mitigated by applying a balanced approach in terms of involving different groups of stakeholders and will have a special focus on providing recommendations based on the fairness of the approach selected.
- **Risk of the situation deteriorating in connection with the ongoing Russian invasion of Ukraine and escalation of military violence on the frontlines (including the risk of project team member mobilisation).** This risk will be mitigated by the project team working remotely as applicable. The risk of project team member mobilisation will be mitigated by the presence of a large local team with gender parity, as well as the involvement of specialists with experience in decarbonisation projects from European offices.
- **Risk of COVID cases in Ukraine resulting in interpretation and disruption of business processes.** This risk will be mitigated by the project team working remotely as applicable. Projects are already enabled to use 100% online tools for consultations and awareness-raising activities.
- **Risk of lack of interviews from main stakeholders.** This risk will be mitigated by greater and deeper research, as well as the significant expertise of KPMG's global decarbonisation office and their relevant existing and potential research materials.
- **Risk of short-term assignment and lack of sufficient time.** This risk will be mitigated by focusing on the major relevant topics, and collaborating with KPMG's global decarbonisation office to involve their expertise.
- **Risk of the Project remaining incomplete.** This risk will be mitigated by holding regular meetings with UNDP to identify, raise, and discuss potential and realised risks in a timely fashion.

Assessment of CORSIA carbon offset model

1. Monitoring, reporting and verification (MRV) systems



CORSIA requires aeroplane operators conducting international flights to monitor, report, and verify (MRV) related CO2 emissions. This system helps to ensure the integrity of carbon credits, including those under CORSIA.

The MRV system is a key component of CORSIA implementation. The main purpose of the MRV system is to collect data on international aviation CO2 emissions on an annual basis and compare present emissions against the established baseline. The detailed requirements of the MRV system are detailed in Chapter 2 of Annex 16 Environmental Protection, Volume IV to The Convention on International Civil Aviation. The rules are important to ensure that states and airlines comply with CORSIA terms.

In this section, we will consider the essence of MRVs, the main components, criteria, monitoring methods, and the MRV process.

1.1. MRV systems implemented in aviation, aspects of design and implementation

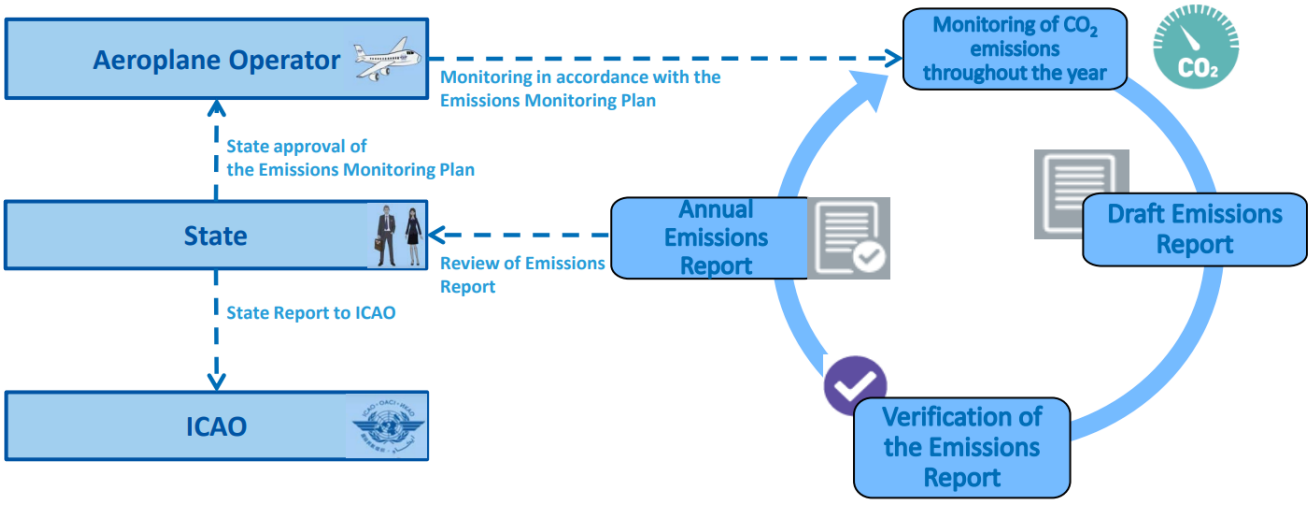
CORSIA presents an opportunity to develop the institutional capacity of an MRV system at an industry-level. Aviation is highly consolidated, with a limited number of individual operators. This makes generating useful knowledge viable on how an MRV system can be successfully and cost-effectively implemented in other industries and sectors.

Key features of CORSIA MRV

CORSIA's MRV system started in 2019, 2 years before CORSIA's pilot phase (2021–2023). The MRV system involves calculation of a baseline level of emissions in order to track progress in the sequential phases of the scheme's functioning. This baseline informs the scheme administrator regarding the scale and distribution of GHG emissions by parties covered by the scheme (1).

The MRV process itself requires monitoring fuel use involved in every international flight and calculating the CO2 emissions related to individual flights, reporting CO2 emissions data between aeroplane operators, states, and the ICAO, and verifying reported emissions information to guarantee completeness and avoid mistakes (1).

Figure 1. MRV Scheme



Source: ICAO Secretariat, "CORSIA MRV System: Monitoring of CO2 Emissions" report

MRV of an aeroplane operator's annual CO2 emissions standards are presented in Annex 16, Volume IV, Chapter 2 of "International Standards and Recommended Practices Environmental Protection" document.

Monitoring
Aviation activity is covered by CORSIA monitoring requirements, if the activity involves:

- The use of an aeroplane with a maximum certificated take-off mass of greater than 5,700 kg.
- International operations on or after 1 January 2019.

- Exceptions for humanitarian, medical, and firefighting operations.
- Operators that produce annual CO_2 emissions greater than 10,000 tonnes.

In order to prepare for MRV of CO_2 emissions, each operator will need to develop an Emissions Monitoring Plan (EMP). An EMP is a collaborative tool between the State and the aeroplane operator.

EMPs should include information on the operator, its fleet, and operations. The EMP will also detail the methods the operator will use to monitor fuel use and calculate emissions, as well as all associated data management.

According to SARPs Annex 16, the aeroplane operator should submit an EMP to the State to which it is attributed for approval by said State, and this plan shall include the following details:

- Aeroplane operator identification.
- Fleet and operations data.
- Methods and means of calculating emissions from international flights.
- Data management, data flow, and control.

Calculation of CO_2 Emissions and Monitoring of CORSIA Eligible Fuels

After an aeroplane operator monitors its fuel use in accordance with an approved EMP, it needs to calculate CO_2 emissions from fuel burn. ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) automatically estimates the CO_2 emissions for aeroplane operators who have been approved to use the CERT. This tool can be used by an aeroplane operator to support monitoring and reporting their CO_2 emissions where annual CO_2 emissions from international flights are less than 500,000 tonnes (for more details, please refer to ICAO SARPs Annex 16, Volume IV, Part II, Chapter 2, 2.2 and Appendix 3).

According to Annex 16, Volume IV, aeroplane operators (with the exception of aeroplane operators eligible to use CERT) should choose one from the following fuel-use monitoring methods:

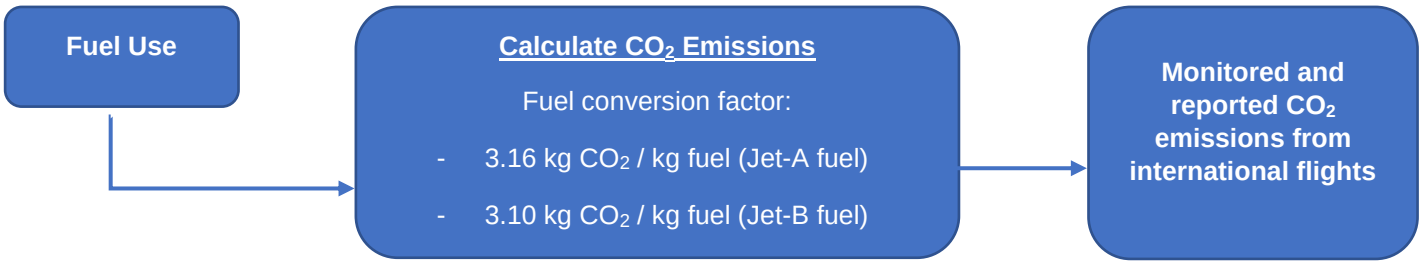
a) Method A.
b) Method B.
c) Block-off / Block-on.
d) Fuel Uplift.
e) Fuel Allocation with Block Hour.

Each aeroplane operator chooses a preferred fuel-use monitoring method during EMP approval. For more details on calculation specifics for each method, please refer to ICAO SARPs Annex 16, Volume IV, Appendix 2.

Operators using a Fuel Use Monitoring Method will need determine CO_2 emissions by using the following equation:

$$\boldsymbol{CO_2 \text{ Emissions} = \text{Mass of fuel} * \text{Fuel Conversion Factor of given fuel type}}$$

Figure 2. Scheme of Fuel Use Monitoring Method



Source: Source: ICAO Secretariat, "CORSIA MRV System: Monitoring of CO_2 Emissions" report

Information on CO_2 emissions will be reported as part of a participating aeroplane operator's Emissions Report.

Reporting

The aeroplane operator must submit Annual Emissions Report to the State. This report includes detailed aeroplane operator information (fleet, fuel mass per type of fuel, eligibility for CERT, number of international flights, CO_2 emissions, information on verification body).

Aeroplane operators can report on CORSIA eligible fuels in two different ways:

- Yearly, or
- One-time reporting within a given compliance period (e.g. 2021–2023).

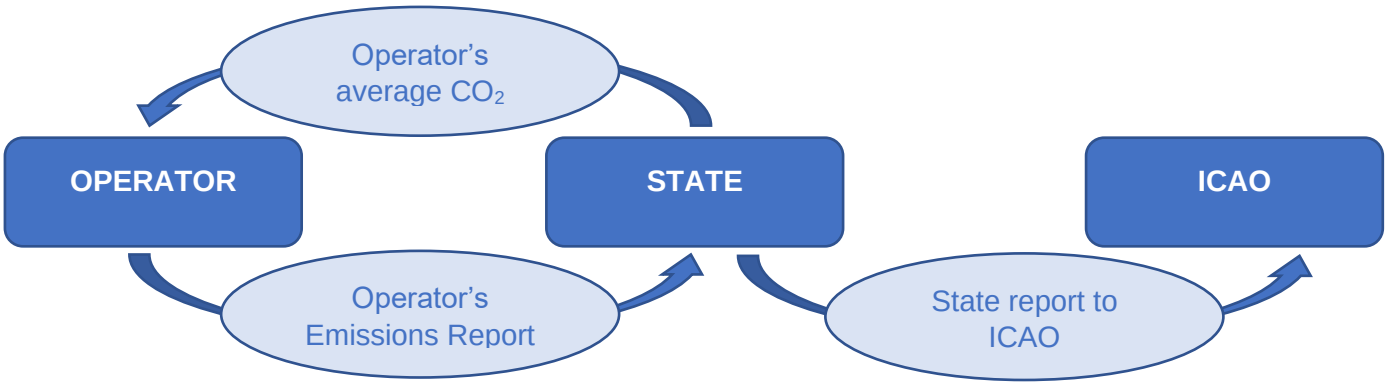
Information that needs to be included in an operator's annual Emissions Report when claiming emissions reductions from CORSIA eligible fuels is detailed in ICAO SARPs Annex 16, Volume IV, Chapter 3.

So that reports can be standardised, ICAO has developed report templates and published them on official website.

CORSIA requires States with aeroplane operators conducting international flights to report on related CO_2 emissions information:

- **First reporting year:** 2020 (for data related to 2019 international flights)
- **Frequency of reporting:** Yearly
- **Reporting recipient:** ICAO

Figure 3. CORSIA Reporting scheme:



Source: ICAO Regional Workshop on CORSIA, "Session 3: CORSIA MRV System: Reporting of CO_2 Emissions"

VERIFICATION

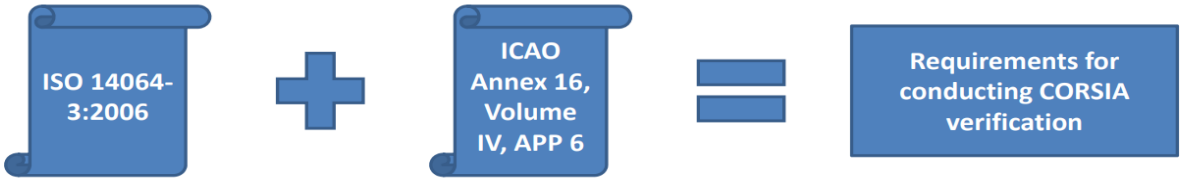
Verification is a process that ensures the information supplied is accurate and error-free prior to an aeroplane operator reporting to the State. Verification requires an independent third-party to be involved and is already in use in various forms (financial auditing, greenhouse gas inventories, emissions reduction projects, etc.)

Verification is an essential part of CORSIA as it ensures the accuracy of information related to:

- Amount of CO_2 emissions from international flights.
- Purchase of emissions units from eligible programmes to address offsetting requirements.
- Cancellation of eligible emissions units.

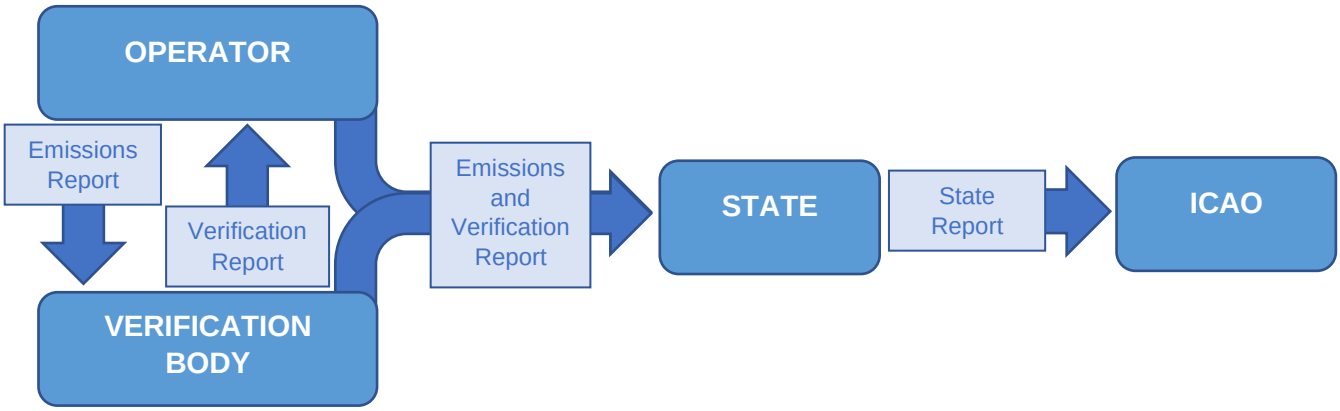
Aeroplane operators must engage an accredited verification body to verify their annual Emissions Report. A verification body needs to conduct said verification according to ISO 14064-3:2006 and the CORSIA-specific requirements described in Annex 16, Volume IV, Appendix 6.

Figure 4. Requirements for conducting CORSIA verification



Source: ICAO Regional Workshop on CORSIA, "Session 4: CORSIA MRV System: Verification of CO_2 Emissions"

Figure 5. CORSIA Verification process :



Source: ICAO Regional Workshop on CORSIA, "Session 4: CORSIA MRV System: Verification of CO2 Emissions"

It is also vital for verification bodies to be accredited by a national accreditation body that observes ISO 14065:20132 (General principles and requirements for bodies validating and verifying environmental information) and meet relevant additional requirements in order to be eligible for verifying Emissions Reports and, where applicable, the Emissions Unit Cancellation Report of an aeroplane operator. Such additional requirements are specified in Appendix 6 Section 2 of SARP Annex 16, Volume IV. National accreditation bodies must also work in accordance with ISO/IEC 17011.

Once a verification body has been accredited, the State must then submit a list of verification bodies accredited in the State to ICAO. ICAO will then publish this information in the CORSIA Central Registry (CCR) which is available on the ICAO CORSIA website.

An aeroplane operator may engage a verification body accredited in another State, subject to rules and regulations affecting the provision of verification services in in the state to which the aeroplane operator is attributed.

ICAO therefore envisages verification of aeroplane operator's emissions data that involves the following steps:

- A voluntary internal pre-verification of data by the aeroplane operator.
- Verification of the data submitted by a verification body.
- Magnitude check of data submitted by an aeroplane operator, conducted by the relevant state authority, against other data sources that the authority has access to.

CORSIA global MRV application

CORSIA provides a standardised approach to MRV implementation based on the standards presented in SARPs Annex 16, Volume IV, Part 2, Chapter 2. Each participating state co-operate with aeroplane operators to determine Fuel Use Monitoring Methods that are most suitable in each particular case and ensures the functioning of MRV to achieve a high level of data quality, information exchange, etc. For this purpose, standardised templates have been developed to facilitate uniform reporting of information.

Below you can find examples of CORSIA MRV implementation in different countries:

Japan Experience

Japan implemented CORSIA MRV requirements into national legislations in 2018 and announced its willingness to voluntarily participate in the pilot phase from 2021.

In order to ensure that aeroplane operators responsibly implement CORSIA requirements, Japan incorporated compliance with CORSIA MRV in its national Ordinance as an additional requirement for international aeroplane operators to obtain a certificate stipulated in the Civil Aeronautics Act. This enables strict operation of CORSIA MRV, including punitive provisions such as withdrawal of a certificate in case of material violations.

Furthermore, Japan has legally mandated all international aeroplane operators, including those whose annual CO2 emissions are less than 10,000 tonnes and having no obligation under SARPs, to at least internally monitor the annual emissions and subsequently report to the Japan Civil Aviation Bureau (JCAB) when approaching the threshold (the difference has already been notified to ICAO). This gives any aeroplane operator a responsibility related to CORSIA and enables JCAB to implement CORSIA more strictly by preventing any operators from unintentionally falling into the scope of CORSIA.

Japan fully recognised the importance of providing stakeholders with sufficient explanation of CORSIA at an early stage so as to appropriately implement a completely new scheme within a limited time. For this purpose, Japan took responses by holding explanatory meetings and training workshops for various stakeholders on several occasions, including the National Accredited Body and possible candidates for verification bodies, as well as aeroplane operators. This process led to better understanding from an early stage on the part of stakeholders regarding the system. This enabled the completion of approval of EMPs without delay, as well as timely amendments to national regulations.

UK Experience

In June 2020, the UK reconfirmed to ICAO its participation in CORSIA from the start of the pilot phase. The UK approach to CORSIA aims to uphold the UK's international obligations by implementing CORSIA as closely as possible to the globally agreed ICAO SARPs and uphold the UK's domestic obligations. Domestic obligations include the UK's commitment in the 2017 Clean Growth Strategy to ensure the post-Brexit approach to carbon pricing is at least as ambitious as the EU ETS.

CORSIA is being implemented in the UK through two statutory instruments (SIs). Firstly, through an Air Navigation Order (ANO) under the Civil Aviation Act 1982. Secondly, through an amendment to the above Order.

The UK Government recognises that implementing CORSIA's offsetting requirements needs to work in conjunction with the UK Emissions Trading Scheme (UK ETS), as legislated for by the Greenhouse Gas Emissions Trading Scheme Order 2020 (UK ETS Order). The UK Government is holding a consultation on how CORSIA could interact with the UK ETS in relation to flights within the scope of both schemes. Without policy action, CO_2 emissions above the CORSIA baseline on flights from the UK to the EEA would incur obligations from both the UK ETS and CORSIA. Currently, the UK Government does not have a solution to this problem.

1.2. MRV systems in Ukraine

CO2 emissions MRV's in other sectors

Ukraine ratified the United Nations Framework Convention on Climate Change on 29 October 1996 as an Annex I country. One of the commitments of parties to the Convention is to compile national inventories of their emissions sources.

For domestic flights, emissions are considered to be part of the national inventory of the country within which the flights occur. For international flights, inventories are also calculated and reported to UNFCCC under the terminology "emissions from international aviation bunker fuels".

Ukraine also adopted the Kyoto Protocol to the United Nations Framework Convention on Climate Change in 2004.

Due to this, the calculation of the Baseline for Ukraine has been based on available information on National Inventories reported to UNFCCC and provided by the Ministry of Ecology and Natural Resources of Ukraine. The methodology used for calculating those inventories follows IPCC 2006 Guidelines for National Greenhouse Gas Inventories.

On 12 December 2019, the Law of Ukraine "On Principles of Monitoring, Reporting, and Verification of Greenhouse Gas Emissions" No.377-IX (GHGs monitoring law) was adopted.

This is an important step for some potential Credit Generation Projects. Sectors that have MRV obligations include the following:

- Combustion of fuel in installations.
- Oil processing.
- Coke production.
- Firing or sintering, including agglomeration of metal ore (in particular sulfide ore).
- Iron or steel production.
- Processing of iron-containing alloys production (including ferroalloys).
- Cement clinker in rotary kilns production.
- Lime or calcination of dolomite or magnesite production in furnaces.
- Nitric acid production.
- Ammonia production.

Some industries and companies have already applied MRV systems. In 2008, Metinvest Group joined the Worldsteel Global Sectoral Approach initiative, according to which companies must calculate their carbon intensity index which measures the amount of greenhouse gas emissions per tonne of steel produced. This calculation projects greenhouse gas emissions from the steel industry until 2050 and identifies priority measures and technologies to reduce these emissions. According to this initiative, Metinvest annually reports on the cumulative emissions of greenhouse gases from its activities. Some agricultural companies (such as Astarta-Kyiv and Kernel) also calculate their GHG emissions but so far without verification.

MRV establishment in Ukraine upon CORSIA requirements

Ukraine voluntarily participates in the experimental (2021–2023) and first (2024–2026) stages of the CORSIA programme which has entailed a need to start monitoring emissions from international flights by Ukrainian operators since January 2019. The monitoring system for all international flights has been in the process of implementation from 1 January 2019 in order to determine a basic emission level (2019–2020).

On 2 August 2019, the Order of the State Aviation Administration of Ukraine No. 1001 approved the Aviation Regulations of Ukraine "Technical requirements and administrative procedures for monitoring emissions by civil aircraft operators" (Aviation Regulations).

These Aviation Regulations establish requirements for civil aviation aeroplane operators and the authorised civil aviation authority regarding planning, monitoring and reporting of annual carbon dioxide (CO2) emissions of aircraft during flights. The Aviation Regulations apply to all individuals and legal entities operating civil aircraft with a maximum certified take-off weight of more than 5,700 kg and are applied to the operation of civil aviation aircraft conducting international flights (with the exception of humanitarian flights for medical or fire-fighting purposes and transportation of senior officials).

In Ukraine, eight Ukrainian aeroplane operators are subject to CORSIA and submit Emission reports and verification reports for the approval of the State Aviation Administration of Ukraine (SAAU) for monitoring emissions of CO_2. These operators are:

- Windrose Airlines.
- Motor Sich JSC.
- Maximus Airlines LLC.
- SkyUp Airlines LLC.
- ZetAvia Airline LLC.
- Azur Air Ukraine Airlines LLC.
- Ukraine International Airlines.
- Antonov Company.

The following monitoring methods are available to Ukrainian operators Method A, Method B, Block-off / Block-on, Fuel Allocation with Block Hour, and CERT in cases where annual CO_2 emission are less than 50,000 tonnes. Ukrainian operators use Method B as this system of control and calculating fuel use has worked historically prior to the implementation of CORSIA and is most convenient for operators. However, despite historical monitoring implementation, the process of fuel information collection and monitoring is mostly manual and could be improved.

In 2021, eight verified Reports were submitted to the SAAU for approval and subsequently uploaded to the CCR.

During the reporting period, there were no violations by aeroplane operators regarding the provision of these reports, and the terms of provision and quality of reports. Calculation discrepancies in the reports by the aeroplane operators and the verifier are within the permissible limits (up to 5%). Ukrainian aeroplane operators therefore passed verification successfully.

Table 1. Statistics of CO_2 emissions of Ukrainian airlines for 2021

No.	Airlines	CO_2 emission, tonnes
1	Ukraine International Airlines PJSC	404,930
2	SkyUp Airlines LLC	361,244
3	Antonov Company SC	343,268
4	Azur Air Ukraine Airlines LLC	340,721
5	Wind Rose Aviation Company LLC	152,709
6	Maximus Airlines LLC	52,116
7	ZetAvia Airline LLC	49,635
8	Motor Sich JSC	13,218

Source: SAAU

Verification is carried out by international verification companies, though as of today there is no national verifier in Ukraine. As mentioned above, aeroplane operators may engage a verification body accredited in another State, subject to rules and regulations affecting the provision of verification services in in the state to which the aeroplane operator is attributed. However, this issue is currently not addressed in Ukrainian rules or regulations.

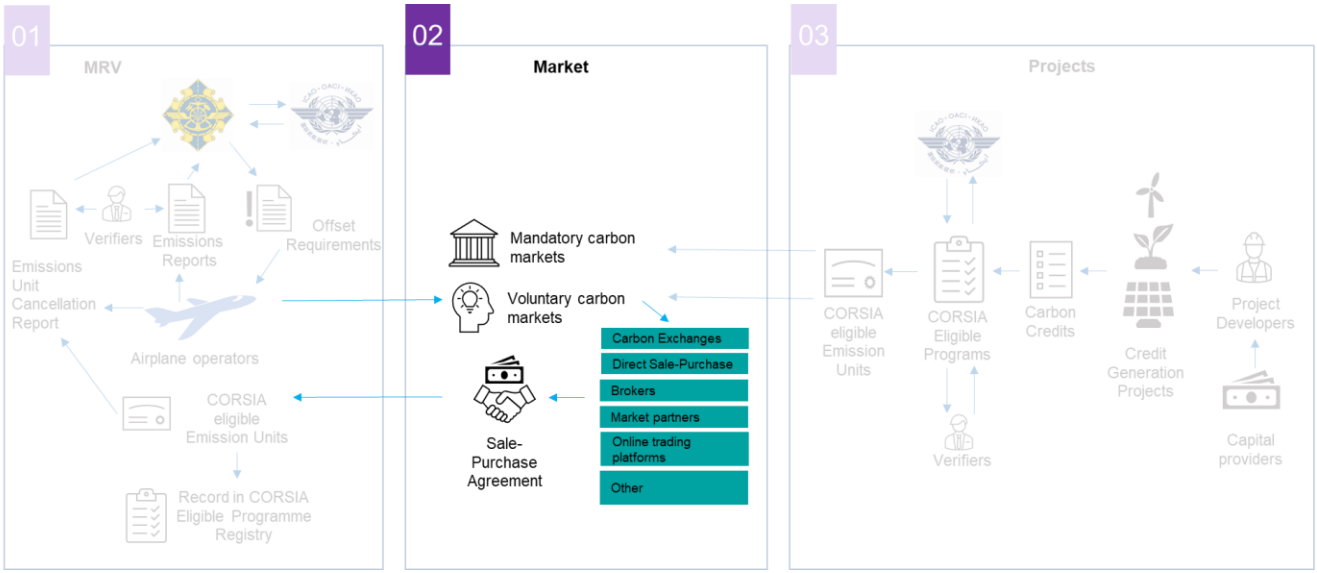
Airlines co-operated with the following verifiers:

- ETSverification GmbH.
- Verifavia (Singapore).
- VERIFIKACE CZ (Czech Republic).

Once the MRV process is finished, States must calculate the operator's final annual CO_2 offsetting requirements based on the reported data and inform the aeroplane operator.

National rules or regulations for establishing legal offsetting relations have not been implemented yet.

2. Carbon credit sales practices, markets applied in aviation worldwide



After the MRV process, it is now possible to assess whether baseline emissions have been exceeded. If this occurs, the airline must compensate the excess through purchase and cancelation of emission units (the year of such obligation is detailed according to CORSIA implementation phases).

In terms of emission trading systems operators that pollute are awarded credits that allow them to continue to pollute up to a certain limit. Operators may also sell any unneeded or unused credits to another company that needs them. Operators are thus doubly incentivised to reduce greenhouse emissions. Firstly, operators must spend money on extra credits if their emissions exceed the cap. Secondly, operators can make money by reducing their emissions and selling their excess allowances.

One emission unit (carbon credit) equals to reductions, avoidance, or removals of one tonne of CO_2 emissions or the equivalent in other GHGs.

This section looks at how carbon credits are traded, trading patterns, major markets and players, and prices.

2.1. Key market players and drivers

There are three main carbon credit market players: business companies, investors, and governments. Carbon emitting companies use carbon offset credits as a short-term measure ahead of greater emissions reduction plans. Big corporations that are required by their governments to calculate and decrease their carbon footprint usually use carbon credits as offsets. Some companies may also want to invest their money in projects that create carbon credits (2).

The demand for quality carbon offset projects is at an all-time high due to the strong willingness of different companies across the globe to decrease humanity's impact on climate change. This factor explains the quick development of the carbon offset market. Apart from this socially motivated demand, there are additional factors that drive the growth of the carbon market: more ambitious climate goals, growing regulatory requirements (compliance), and growth in the trading market (2).

More ambitious climate goals

Each of the key carbon market players mentioned above has an impact on growing climate ambitions.

Currently, there is a rapidly developing increase in offsetting demand from corporations. This is mainly due to an increase in pressure on their responsibility to commit to climate goals. The number of businesses that have committed to net zero pledges keeps growing. According to the Carbon Credits report published in June 2022, 702 companies on the Forbes Global 2000 have net zero targets (compared to 417 companies in 2020) (2).

Similarly to corporate climate pledges, governments and countries also want to decarbonise. States that joined the Paris Agreement have set and submitted their plans for decreasing their carbon emissions.

According to Carbon Credits.com, 18 out of 20 top emitters have declared their carbon neutrality or net zero pledges. There is also a growing number of national policies governing net zero targets. This has increased from just 10% of national carbon emissions in 2020 to 65% in June 2022 (2).

Carbon emissions are hardly related to the asset management industry, but there is increasing attention to how asset managers or institutional investors contribute to climate change. Asset manager involvement in carbon production is determined through their allocation of funds to carbon intensive issuers. As such, there is an increasing awareness of responsibility on the part of asset managers to address climate change through net zero initiatives. For example, according to Carbon Credits.com, the Net Zero Asset Managers (NZAM) Initiative now has 273 signatories that represent ~USD60 trillion in assets under management. All participating companies commit to support investing aligned with the goal of net zero emissions by 2050 or sooner (2).

Across all key net zero strategies that asset managers can make, it is unlikely that they will see zero emissions across all portfolios. This means carbon offsets can also play an important role in executing asset management strategies (2).

Growing regulatory requirements (compliance)

There are two major aspects involved in the growth of the carbon offset market related to the compliance market: an increasing number of markets permitting the partial use of carbon offsets, and growth in number of different sectors joining carbon markets.

Carbon offset credits used to be common in the voluntary carbon market, but there is now a rising trend in their inclusion in compliance markets (2). The China ETS, and Singapore and California carbon markets offer good examples of this trend.

China expressed an intention to include high quality carbon offset credits in its market mechanisms. Similarly, California's compliance market also plans to change the proportion of carbon offsets from 4% in 2022 to 6% in 2026. However, the EU ETS has maintained in its stance of not allowing the use of carbon offsets and credits in its low carbon transition between 2020–2030 (2).

According to CarbonCredits.com data, many compliance markets will cover new sectors in the long run in order to reach net zero emissions. In effect, the emissions covered will also grow and so there is an increasing need for carbon offsets (2).

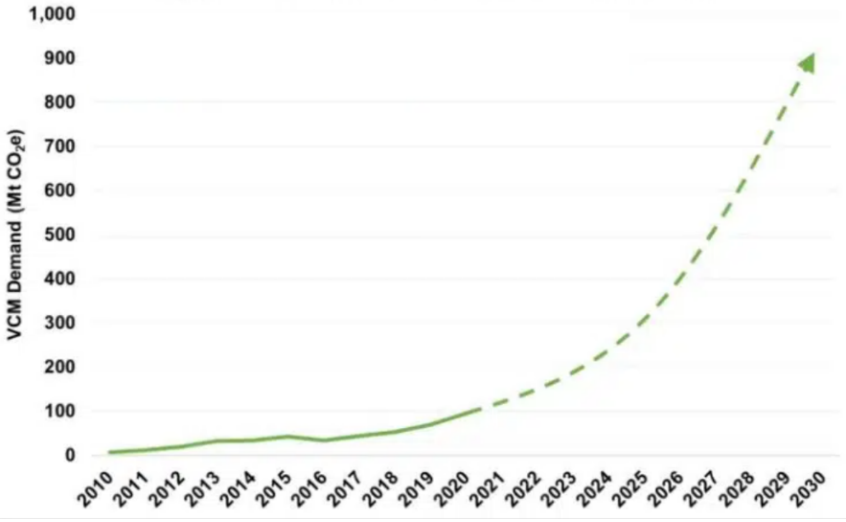
Growth in the trading market

The number of buyers of carbon offset credits is rapidly increasing, and buyers are using credits to increase exposure to the market. Buyers are purchasing offsets to retire them in exchange for their environmental impact later on.

This is where carbon offset futures become an available option. For direct exposure to the voluntary carbon market, buying futures offers a viable option as a retail investor. Market players for this purpose continue to grow as forecasts see the price of carbon offsets rising over time (2).

As a result, buyers want more exposure and new investors keep adding exposure with the goal of selling futures at a higher price later (2). For more details, refer to the Figure 6.

Figure 6. Project Growth of Carbon Offset Demand



Source: Carbon Credits.com (2)

2.2. Aviation sector in mandatory schemes

EU ETS

The EU ETS is a fundamental EU policy for fighting climate change and is the main tool for cost-effective reduction of GHG emissions. The EU ETS is the world's first major carbon market and remains the largest.

The EU ETS:

- operates in all EU countries plus Iceland, Liechtenstein, and Norway;
- limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries;
- covers approximately 40% of the EU's GHG emissions.

The EU ETS commenced in 2005, with the aviation sector included in the scheme in 2012. The EU ETS works on the “cap and trade” principle. A cap is set on the total amount of certain GHGs that can be emitted by installations covered by the system. This cap is reduced over time so that total emissions fall.

For the aviation sector, the cap is determined based on the average emissions for the 2004–2006 period, but the free allocation to aeroplane operators is based on activity data in 2010. The cap for aviation operation for the 2013–2020 phase of the ETS was set at the level of 95% of historical emissions. Beginning from 2021, free allocation to aeroplane operators was reduced by a linear reduction factor (currently 2.2%) and is now applicable to all ETS sectors. Aeroplane operators have free allocation based on a benchmark but this does not cover all emissions. Operators need to buy the remaining allowances from the secondary market or in auctions. This system allows aeroplane operators to use aviation allowances or general (stationary installations) allowances to cover their emissions.

Currently, 82% of aviation allowances are distributed through free allocation, 15% are auctioned, and 3% are part of a special reserve for new participants and those who develop rapidly.

Following the 2013 ICAO resolution on developing CORSIA, the EU decided to set a restriction for the scope of the EU ETS to flights between destinations located in the European Economic Area (EEA) for the 2013–2016 period, and to conduct new revisions in the light of the outcome of the 2016 ICAO Assembly. The European Commission assessed the outcome of the 39th ICAO Assembly and, in this light, a new Regulation was adopted in 2017.

The legislation maintains the scope of the EU ETS for aviation limited to intra-EEA flights and sets out the basis for CORSIA implementation. This provides for European legislation on MRV rules through a delegated act under the July 2019 EU ETS Directive. This directive foresees the need for a further assessment to take place and a report be presented to the European Parliament and the Council that takes into consideration how to best implement CORSIA in EU law through revisions to the EU ETS Directive. The European Green Deal and 2030 Climate Target Plan clearly set out the Commission’s intention to propose reductions to EU ETS allowances allocated to airlines. This work is currently ongoing and is part of the “Fit for 55 package” (the Proposal), a European climate law proposal that determined that the EU's climate goal should be to reduce overall EU GHG emissions by at least 55% by 2030.

Currently, the main idea of the Proposal is to apply CORSIA to extra-European flights by European aviation companies, in addition to applying the EU ETS to intra-European flights (the system currently in force). The Proposal envisages that European aviation companies (i.e. those registered in or certified by EU Member States), when flying to or from third countries that apply CORSIA, will be able to use international credits to offset emissions from such flights. The Proposal also introduces eligibility criteria for such credits. Credits should originate from states that: (i) are parties to the Paris agreement, and (ii) participate in CORSIA. The second criterion will not be applied before 2027, nor apply to Least Developed Countries and Small Island Developing States.

In order to implement the Proposal, the Commission is supposed to adopt an act with listed countries (other than EU countries) which are considered to be applying CORSIA.

EU legislation foresees a situation where third states take actions to decrease the climate change impact of flights departing from their airports. The EU will facilitate interaction between the EU scheme and third states' actions, where flights arriving from a third state could be excluded from the scope of the EU ETS. This is the case between the EU and Switzerland following an agreement to link their respective emissions trading systems, which entered into force on 1 January 2020.

As a result of the linking agreement with Switzerland, the EU ETS widened to all departing flights from the EEA to Switzerland from 2020, and Switzerland would apply its ETS to all departing flights to EEA airports. This would ensure a level playing field for both directions of routes. According to the EU-UK Trade and Co-operation Agreement reached in December 2020, the EU ETS continues to apply to departing flights from the EEA to the UK, while a UK ETS will apply effective carbon pricing on flights departing from the UK to the EEA (3).

UK ETS

The UK Emissions Trading Scheme (UK ETS) went live on 1 January 2021, following the UK's exit from EU and replaced UK participation in the EU ETS. The programme covers electricity generation, heavy industry, and the aviation sector.

The UK ETS is very similar to the EU ETS, except for the fact that the EU ETS applies to all countries in the EEA while the UK scheme applies to the UK only. This means that UK only covers domestic flights, flights between the UK and the EEA. and flights between the UK and Gibraltar.

Another difference between UK and EU schemes is that the UK ETS is more ambitious because the initial cap for the UK ETS in 2021 was for 5% lower than the UK's share of the EU ETS cap would have been.

China ETS

In 2017, the People's Republic of China decided to implement a national ETS to limit and reduce CO2 emissions in a cost-effective manner. China's ETS covers coal- and gas-fired power plants and allocates allowances based on a plant's generation output; with a different benchmark for each fuel and technology. When implemented, China's ETS, set to expand to seven more sectors (including aviation and sustainable aviation fuel (SAF)), will be the world's largest by a significant margin: covering one-seventh of global CO2 emissions from fossil-fuel combustion. The initial years of operation are crucial to test the ETS's design and establish trust. Given the dominance of coal power in China's power sector and in its overall CO2 emissions, how China's coal-fired power plants are managed will be essential for China to meet its climate goals and other sustainable energy goals (4).

California Carbon Market

Launched in 2013, California's cap-and-trade programme is among a suite of major policies the state is using to lower its GHG emissions. California's emissions trading programme is the fourth-largest in the world, following the cap-and-trade programmes in China, the European Union, and the Republic of Korea. In addition to driving emissions reductions in one of the world's largest economies, California's experience has provided valuable insights into creating and managing an economy-wide cap-and-trade system (5).

California's system is a central component of the US state's broader strategy to reduce greenhouse gas emissions to 1990 levels by 2020, 40% below 1990 levels by 2030, and 80% below 1990 levels by 2050. California also has additional goals of 100% carbon-free electricity by 2045 and economy-wide carbon neutrality by 2045 (5).

The programme covers entities that include large electric power plants, large industrial plants, and fuel distributors (e.g. natural gas and petroleum). In total, about 450 businesses responsible for approximately 85% of California's total GHG emissions must comply. California has also linked its system with the Canadian province of Quebec's cap-and-trade program, meaning that businesses in one jurisdiction can use emission allowances (or offsets) issued by the other for compliance. This increases the number of businesses under the cap, reducing compliance costs by creating more options for companies to reduce their emissions (5).

The California Air Resources Board (CARB) implements and enforces the programme. The cap-and-trade rules first applied to electrical power plants and industrial plants that emit 25,000 tonnes or more of CO_2 equivalent per year. Starting in 2015, the programme was extended to fuel distributors meeting the 25,000-metric tonnes threshold. The programme's overall GHG emission cap declined annually by 3% from 2015–2020 and is designed to decrease an additional 5% from 2021–2030. Emission allowances are distributed by a mix of free allocation and quarterly auctions. The portion of emissions covered by free allowances varies by industry and by how efficient each facility is relative to industry benchmarks (5).

New Zealand ETS (NZ ETS)

The NZ ETS was enacted in September 2008 after more than a decade of consideration of emissions pricing by successive governments. Under the amended Climate Change Response Act 2002, the NZ ETS has the dual purpose of:

1. Assisting New Zealand to meet its international obligations under the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement.

2. Assisting New Zealand to meet its 2050 emissions reduction target and emissions budgets (6).

The system was the first ETS in the world intended to eventually cover all economic sectors and major GHGs. It took effect retrospectively from 1 January 2008, with sectors assuming emissions reporting and unit obligations in stages. As of February 2022, the system applied unit obligations to about 52% of New Zealand's gross emissions. The NZ ETS covers almost all emissions from fossil fuels, industrial processes, and waste. It applies to both unit obligations for deforestation and credits for eligible afforestation. Unit obligations for biogenic emissions from agriculture, which account for about 48% of New Zealand's gross emissions, have been deferred to date. Those emissions will face pricing under the NZ ETS or an alternative system starting no later than January 2025. The New Zealand ETS allowed trading of units to and from the international Kyoto market from 2008 to mid-2015, after which it was de-linked. The NZ ETS currently operates as a domestic-only system (6).

2.3. Voluntary schemes applied by avia companies

Some passengers (and companies) wish to offset their own emissions by paying extra for their flight to provide funding for projects to reduce CO_2 emissions. According to Air Transportation Action Group data, over 30% of passengers fly with an airline that offers some kind of carbon offsetting program. However, uptake by passengers is generally very low: regular programmes see 1–3% of passengers purchasing offsets for their flights, with some airlines seeing higher levels of uptake typically linked to: improved visibility of offset functionality and ease of use in the airline booking process, perceived project quality, cultural environmental consciousness, and other factors that attract passengers to make this investment (7).

Voluntary carbon markets (VCM) allow carbon emitters to offset their emissions by purchasing carbon credits emitted by projects targeted at removing or reducing greenhouse gas from the atmosphere. Historically, voluntary demand has led to a proliferation of privately governed certification standards. Those standard organisations issue carbon credits for certain project activities (project-based). As a result, different types of carbon credits with different qualities exist. Carbon credits can be broadly grouped into two main categories: reduction credits and removal credits (8).

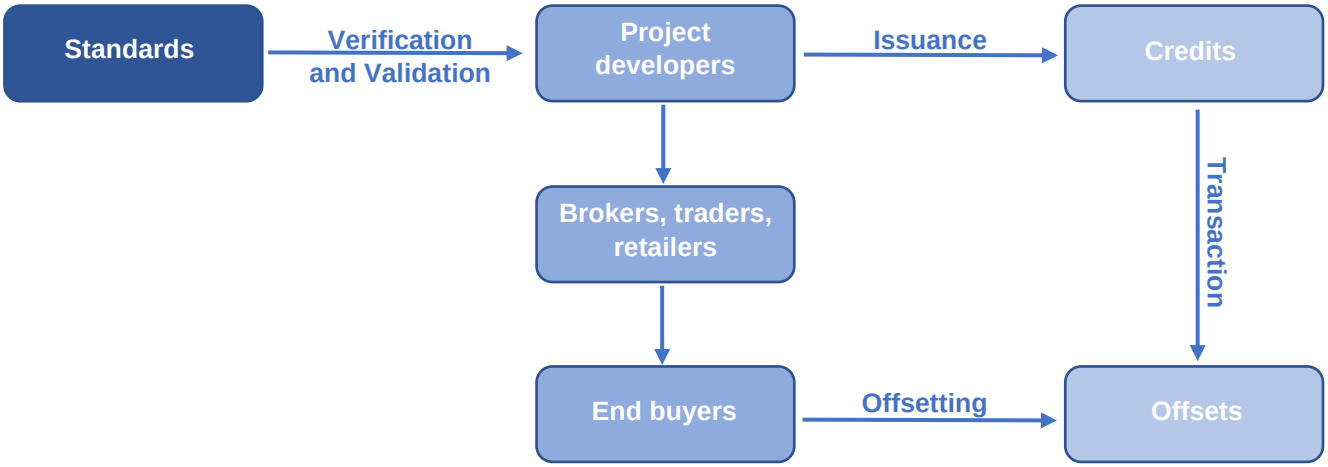
Each credit, corresponding to one metric tonne of reduced, avoided, or removed CO_2 or equivalent GHG, can be used by a company or an individual to compensate for the emission of one tonne of CO_2 or equivalent GHG. When a credit is used for this purpose, it becomes an offset. It is moved to a register for retired credits, or retirements, and is no longer tradable (9).

Companies can participate in the VCM either individually or as part of an industry-wide scheme, such as CORSIA which was set up by the aviation sector to offset its GHG emissions. International aeroplane operators taking part in CORSIA have pledged to offset all the CO_2 emissions they produce above a baseline (set at the 2019 level) between 2021–2035 (timeline of CORSIA programme duration) (9).

While mandatory carbon markets are currently limited to specific geographic areas, voluntary carbon credits do not have boundaries set by States or political unions. They could also be accessed by every industry instead of being limited to a number of sectors (9).

The size of the VCM increased from USD 199 million in 2016 to USD 1,985 million in 2021. The Taskforce on Scaling Voluntary Carbon Markets estimates that the market for carbon credits could be worth of USD 50 billion as soon as 2030 (9).

Figure 7. The structure of the voluntary carbon market



Source: S&P Global (9)

Standards

Carbon standards are very important for the functioning of the VCM. Carbon standard organisations create and manage the rules and requirements for carbon projects, certify issuance, and facilitate the trade of carbon credits. Carbon standards are created and managed by standards organisations (usually international non-governmental organisations) that consist of a standard-setting arm, a regulatory arm, and a validation and verification system (often outsourced). Carbon standards use registries to trace all credits that were created, transfer credits that can be traded, and track transactions between buyers and sellers.

The main carbon standards are the Verified Carbon Standard (VCS), the Gold Standard (GS), the American Carbon Registry (ACR), and the Climate Action Reserve (CAR).

Standards have a number of methodologies for each type of carbon project. For instance, a reforestation project will maintain a specific procedure when calculating the level of CO_2 absorption of planned forestation and therefore the number of carbon credits produced over time (9).

Standards' certifications are responsible for core principles or requirements of carbon credits to be respected:

- **Constancy**: GHG emission reduction must be permanent and cannot be reversed.
- **No overestimation**: the number of issued offset credits should match GHG emission reduction.
- **Exclusive claim**: GHG emissions of one tonne of CO_2 equivalent can only be claimed once and must include proof of the credit cancellation upon its usage.
- **Environmental and social benefits**: projects must be compliant with all legal requirements of their jurisdiction and should provide additional benefits according to the UN's Sustainable Development Goals.

Project developers

Project developers are entities / companies that create carbon credits and represent the upstream part of the VCM. They have multiple tasks to develop the VCM, including sourcing carbon offset projects, working with carbon credit standards and verification bodies and other partners, and taking on the financial risks of developing carbon projects.

Project developers create projects by issuing carbon credits which can vary from big industrial-style projects (e.g. a high-volume hydro plant) to smaller community-based projects (e.g. cleaner cooking stoves) (9).

Some projects have a goal to pull down or manage direct emissions coming from industrial processes such as: fugitive emissions management, ozone-capture or destruction of ozone-depleting substances, etc. Environmental projects include REDD+ (avoided deforestation), soil sequestration, or afforestation. Other types of carbon projects could be tech carbon capture such as direct air capture, while new categories are being added constantly (9).

The biggest project developers include Anew (providing offset credits from improved forest management, carbon capture, and other projects), Finite Carbon (focusing on improved forest management projects), 3Degrees (including landfill gas capture projects), Forest Carbon (restoring degraded tropical forest and wetland ecosystems), and C-Quest Capital (transforming the lives of families in poor communities).

Retail traders and brokers

To connect supply and demand, there are retail traders and brokers available on the carbon market. Retail traders buy credits directly from the supplier, group those credits into portfolios (ranging from hundreds to thousands of tonnes of CO_2 equivalent), and sell those credits to end buyers, often with additional commission (9).

Brokers purchase carbon credits from a retailer trader and re-sell them to an end buyer, often with additional commission (9).

End buyers

The downstream market consists of end buyers: companies (or individual consumers) that have committed to offset some or all of their emissions. Among the early buyers of carbon credits were tech companies such as Apple and Google, oil and gas major players, airlines, and now include new industry sectors, including finance, that are joining the market as they set own net-zero targets (9).

According to IATA data, global aviation is responsible for 2% of carbon dioxide. In 2021, at the 77th IATA annual meeting, the industry committed to achieve net zero CO_2 emissions by 2050 (10).

Companies in the aviation sector are confident that technology, infrastructure, and operations measures will help them to achieve sustainable long-term growth. However, to complete these measures and take actions with a more instantaneous effect, an offset programme could be aimed at reducing the net impact of flying by achieving equivalent carbon reductions from actions taken outside the aviation sector (10).

These are the main stakeholders that are interested in carbon offset programme development:

- Governments want to see airlines work on keeping their long-term position in a sustainable society.
- By using an offset programme, passengers can make an impact on emissions reductions and simultaneously be informed about aviation's climate impact.
- Corporate clients will assess their "need to fly" or order air cargo services that take into account the airlines' position in terms of climate change impact, as well as the cost of available offset programmes.
- NGOs will keep pushing for responsible action by airlines.
- Employees will want to work for the companies that are environmentally responsible.
- Travel agencies are looking to offer an emission compensation mechanism to their clients.
- Corporations are more actively compensating their employees travel emissions as part of their corporate social responsibility strategy.
- Offset providers will want to take part in a responsible offset programme (10).

Below you can find what voluntary carbon offset programmes airlines already offer:

- **Aer Lingus**
  Aer Lingus offers carbon offsetting via partnership with Pure Leap Frog. In order to calculate their emissions, passengers go to the website of Pure Leap Frog and enter their flight details, after which they pay for the offset (11).

- **Air France**
  Air France has had an offset programme for its domestic flights since 2020. The company offers its passengers the opportunity to offset flights, both domestic and international, in partnership with A Tree for You. The programme allows passengers to choose the amount of donation dedicated to offsetting (11).
- **American Airlines**
  American Airlines carbon offset programme works through partnership with Cool Effect. The money that passengers pay for their offsets go to one of three projects:
  - Mexico: preventing deforestation.
  - Indonesia: protecting and restoring peatlands.
  - Honduras: clean cooking stoves (11).
- **British Airways**
  British Airways, similar to Aer Lingus, works with Pure Leap Frog on their carbon offset programme. Passengers go to the Pure Leapfrog website and then enter their flight details, after which they pay for the offset (11).
- **Finnair**
  Finnair offers an offset programme with their partner Choose. Passengers can calculate their flight's emissions and offset their trip by choosing a mix of sustainable aviation fuels (SAF) and certified offset projects (11).
- **Delta**
  Delta's offset projects include projects in Cambodia and Indonesia that are aimed at protecting biodiversity and with helping local communities (11). In 2021, Delta invested a total of USD137 million in carbon offsets to balance 27 million Mt of unavoidable CO_2 emissions. Delta's 2021 carbon offsets projects include renewable energy, landfill gas, and preventing deforestation (12). These offset projects come in three types:
  - **Avoidance**
    Includes projects that work to avoid the release of emissions:
    - REDD+: Reducing Emissions from Deforestation and Forest Degradation.
    - LULUCF: Land Use, Land Use Change, and Forestry.
  - **Reduction**
    Includes technologies or projects that increase the availability of renewable energy and convert waste into energy:
    - Energy Capture.
    - Renewable Energy: projects like solar- and wind-generated power installations.
  - **Removal**
    Involves projects to remove CO_2 from the atmosphere and store it:
    - Carbon Capture and Storage (CCS).
    - Afforestation.

2.4. Overview of the airline experiences in relation to CORSIA activities

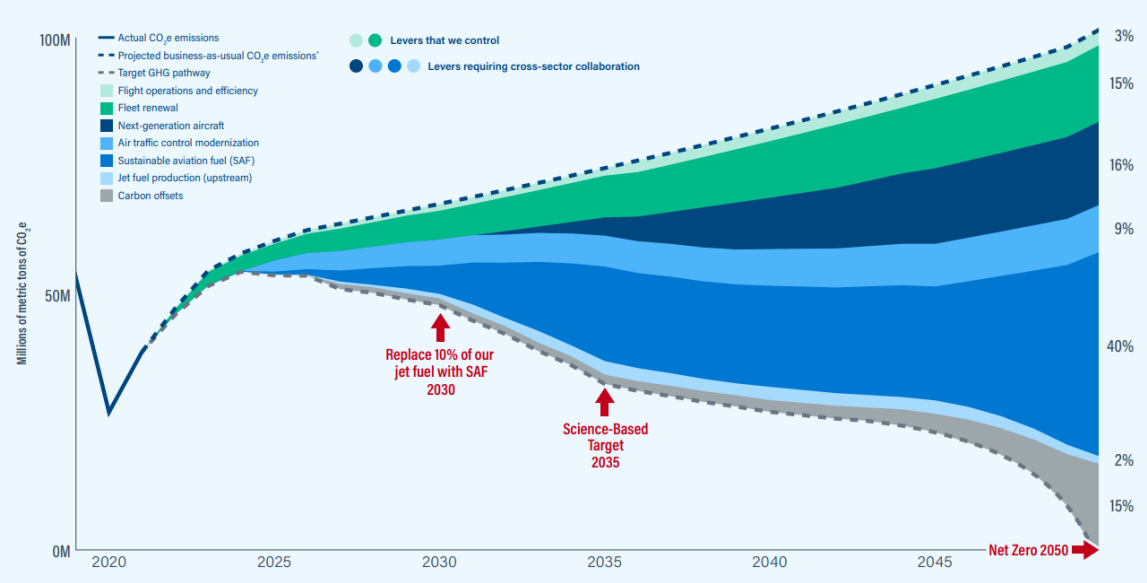
The aviation industry aims to achieve net zero emissions by 2050. Many airlines offer their customers the opportunity to purchase carbon offsets when purchasing a ticket. Airlines faced no compensation obligations under CORSIA in 2021 as international flight volumes were still below pre-pandemic levels.

American Airlines (USA)

In 2021, American Airlines committed to the following activities:

- Used 1.4 million gallons (5.3 million litres) of SAF (0.05% of total) with a target of replacing 10% of jet fuel used with SAF by 2030.
- Purchased 237,000 metric tonnes of CO_2 offsets.

Figure 8. American Airline's pathway to Net Zero 2050



Source: ESG Report of American Airlines 2021.

For American Airlines' Net Zero 2050 goals, carbon offsets account for 15% of all activities.

Going forward, American Airlines aim to meet CORSIA obligations by increasing their use of SAF but are also considering additional offsetting. The company plans for their carbon offset to be 15% of their pathway to Net Zero 2050.

Funds from carbon offsetting go to the following projects:

- Seeing the Forest for the Trees (Mexico).
- For Peat's Sake (Indonesia).
- Mirador Clean Cookstoves (Honduras).

Delta Airlines (USA)

In 2021, Delta Airlines invested USD137 million to purchase and retire offsets relating to 27 million metric tonnes of CO_2 equivalent carbon emissions.

Delta Airlines has allocated a portion of its offset portfolio in 2021 to combatting climate change by preventing deforestation. Additionally, Delta Airline's carbon offset portfolio for 2021 included projects in renewable energy and landfill gas. To achieve a net zero goal by 2050, Delta Airlines plans to use removal-based projects to help develop and implement direct air capture and carbon sequestration technologies.

United Airlines (USA)

In March 2022, United Airlines announced an investment in the production of revolutionary new process using CO_2 and synthetic microbes. In 2020–2021, United Airlines invested in an electric aircraft startup and in direct air capture, carbon capture, and sequestration technology.

There was no carbon offset in 2021, although in 2020 and 2019 United Airlines' carbon offset was 4,106 and 15,425 equivalent metric tonnes of CO_2, respectively.

Lufthansa (Germany)

The Lufthansa Group participates in climate protection projects around the world. Such projects include:

- the restoration of peatlands and forest management in Germany.
- afforestation in Italy.
- the construction of biogas plants in Brazil.
- the use of energy-saving cooking stoves in Rwanda, Nigeria, Burundi, and Kenya.
- more efficient and solar stoves in Madagascar.
- community reforestation in Nicaragua.
- biogas plants in India, and the protection of endangered forests in Tanzania.

All projects are aimed at reducing CO_2 emissions or removing CO_2 from the atmosphere. Projects are certified according to the following international standards organisation: Gold Standard or Plan Vivo.

Singapore Airlines (Singapore)

Singapore Airlines participates in the following projects:

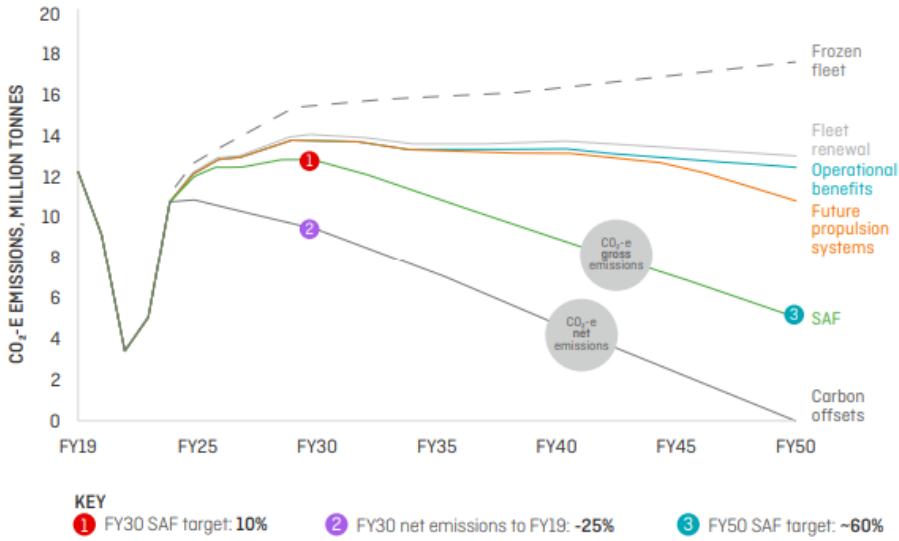
- Rainforest Preservation (Indonesia).
- Solar Power: building solar energy projects across India.
- Cleaner Cooking: distribution of efficient, clean-burning cooking stoves (Nepal).

In June 2021, Singapore Airlines launched the Voluntary Carbon Offset Program (VCOP), where customers can fly carbon-free by purchasing carbon offsets to reduce carbon emissions during travel.

Qantas Airways (Australia)

Qantas Airways participates in offsetting emissions by investing in Australian and international projects. Qantas Airways plans for their carbon offset to be 25% by 2030 on their pathway to net zero by 2050. For more details of Qantas Airways plans for reach their net zero goal, please see the chart below.

Figure 9. Group Emission Pathway



Source: Qantas Sustainability Report 2022.

The Qantas Group has invested in carbon offset projects since 2007.

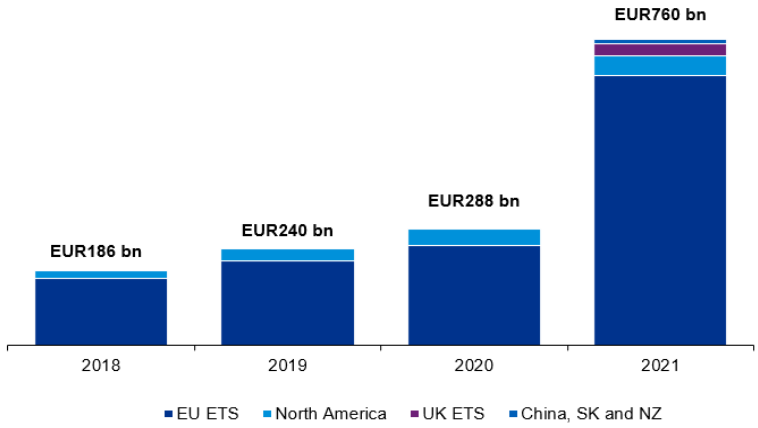
The Qantas Airways programme supports Aboriginal and leading Australian projects, and the North Kimberley Fire Fighting Project (NKFAP). This program employs Aboriginal and Torres Strait Islander rangers in Northern Australia to help restore native vegetation.

Ensuring the highest quality and integrity of the Group's carbon offset portfolio is a key investment driver. Carbon offsets received by the Group are verified at several levels. As a baseline, all projects are accredited by verified registries. Domestic Australian CCUs are certified by the national Clean Energy Regulator, while international offset projects are verified via the Verified Carbon Standard (Verra) or Gold standard.

2.5. Market size, forecasts (world)

Reuters reports that in 2021 the value of traded global markets for carbon dioxide permits grew by 164% to USD 851 billion, or EUR 760 billion. Most of this increase was caused by progress of the EU ETS, launched in 2005.

Figure 10. Traded global markets for carbon dioxide permits



Source: Refinitiv

Carbon markets or ETS are market-based instruments that are supposed to limit GHG emissions. These tools put a cap on the amount States or businesses can emit. If they exceed these limits, they can purchase permits from other entities to offset their extra emissions.

According to Reuters, the two regional carbon markets in North America, the Western Climate Initiative and the Regional Greenhouse Gas Initiative, grew by 6% in 2021 to a combined ~EUR 49 billion (13).

China's national ETS was launched in July 2021. Unlike other schemes, China's emission cap is based on emissions intensity. Around 179 million tonnes of CO_2 equivalent Chinese emissions permits were traded during the first five and a half months of 2021, a smaller amount compared to the more liquid carbon markets in North America and Europe (13).

The UK also launched a carbon market in 2021, following its departure from the EU. The UK scheme is different from the EU ETS in that it has a price floor of around EUR 25/tonne, which is meant to help move investment away from fossil fuels. However, some corporations say that this puts them at a disadvantage in the global market. British carbon market turnover amounted to around EUR 23 billion in 2021 (13).

According to a report from Coherent Market Insights, the carbon offset market is expected to grow substantially over the next few years. As stated in the report, the carbon credit market is expected to grow between 2020–2027 at a CAGR of 31%, with market value reaching USD 2,407.8 billion compared to a market value of USD 211.5 billion in 2019 (14).

2.6. Carbon pricing (CORSIA, allowances, voluntary schemes)

Carbon pricing is a policy tool to lower emissions of carbon dioxide and other GHGs. The goal of carbon pricing is to shift the responsibility for costs to those who produce the emissions. When producers and consumers have to pay for each tonne of CO_2 they emit, they have an economic incentive to shift away from fossil fuels, improve their energy efficiency, and invest in low-carbon technology (15).

Theoretically, a carbon price should be equal to the "social cost of carbon". For example, if one tonne of CO_2 emissions costs the public USD 100, it should cost the emitter USD 100 to create that tonne of CO_2. However, prices are difficult to determine so carbon prices are usually set at levels that policymakers decide will help them meet certain emission or temperature target (15).

There are two main approaches to carbon pricing:

- **Carbon taxes**: these directly set a specific price per equivalent tonne of CO_2 emissions. The subsequent decline in emissions depends on whether and to what extent emitters change their behaviour as a response to the carbon tax (15).
- **Cap-and-trade systems** (or ETS): cap-and-trade systems set a specific total amount of emissions that may be released. States then issue a limited number of emissions allowances, either giving allowances away to emitters freely or through a system of auctions. In essence, for each equivalent tonne of CO_2 emissions released, emitters must have an allowance or credit. These can be traded so that emitters who lack the ability to lower their emissions in a cost-effective manner are required to purchase extra allowances from emitters who are able to lower their emissions (and thus have a surplus of credits). The resulting carbon price in this system depends on a balance of supply and demand for credits and allowances (15).

There are two means of determining the prices of carbon credits:

- **Internal pricing.**
- **External pricing.**

Table 2. Carbon price as of 26 November 2022

CarbonCredits Live Carbon Prices	Price
Compliance Markets	
European Union	EUR 75.24
California	USD 28.27
Australia (AUD)	USD 29.25
New Zealand (NZD)	USD 82.00
South Korea	USD 15.11
China	USD 8.09
Voluntary Markets	
Aviation Industry Offset	USD 3.27
Nature Based Offset	USD 6.37
Tech Based Offset	USD1.73

Carbon credit prices are market driven (i.e. prices change depending on demand and supply). However, States control how many units / credits are assigned to each industry or stakeholder, thereby determining how many credits are available for sale. Prices depend on the place where the market is located, legislation, local requirements, capacity for decrease, and the level of technological or industrial development in countries where the market is located.

Figure 11. Dynamics of Carbon prices on Mandatory (Compliance) market: European Carbon Credit Market

EU ETS: the European carbon credit contract which is exchange traded. The EU ETS is a Futures contract for the purposes of trading and delivering European Union Allowances (EUAs), the official name for the EU's emission allowances. One EUA permits the holder to emit one tonne of CO_2 or CO_2 equivalent GHG.

Figure 12. Dynamics of Carbon prices on Voluntary market: Aviation Industry Carbon Offset

GEO's (Global Emission Offset) futures contracts follow the ICAO CORSIA standard. These carbon offsets come from three major registries: Verra, the American Carbon Registry, and the Climate Action Reserve. GEO's choice of registries is based on the need for high-quality carbon credits that adhere to the international aviation industry standard for emissions offsetting.

The price of an aviation carbon credit currently averages USD 3–USD 5 per tonne of CO_2 of CO_2 equivalent. However, prices should start to rise as demand increases. ICAO estimates that carbon prices under CORSIA will range from USD 6 to USD 40 per tonne of CO_2 in the future and by 2050 these prices may be as high as USD 90 (16).

As prices of carbon credits under CORSIA are expected to be higher compared to voluntary schemes, this market is more attractive for producers who intend to generate and offer carbon credits.

2.7. Carbon Credits Sale-Purchase Practice

There are several means of buying carbon credits to offset emissions:

Buying credits directly from developers: The most direct way to purchase credits is at the so-called "source", from an organisation responsible for a project emitters are interested in supporting. In this case, a company can choose one of two options. They can choose to invest in the development of the project for returns in the form of future carbon credits. However, companies may also opt to buy "Emission Reduction Purchase Agreements" (ERPAs), an upfront payment for carbon credits that will be delivered as and when such credits are generated. The second option is more typical when a company's project is already underway and in a later development stage (17).

Direct purchase from credit-generating projects has some advantages and disadvantages:

Advantages:

- Direct purchase enables a deeper understanding of the nature of a project that can offset potential emissions and promotes involvement in management.
- Direct purchase secures lower prices than with a credit reseller (17).

Disadvantages:

- Direct purchase requires research and knowledge to identify and engage with suitable offset projects.
- Direct purchase carbon credits are not immediately available as and when they are purchased (17).

Purchase carbon credits through a broker: Project developers may choose to work with brokers to arrange selling their carbon credits. In this scenario, an emitting company needs to contact a broker and discuss the specifics of their project (location, price, etc.). Brokers then determine what kind of credit-generating project is most suitable and act as a middleman: purchasing carbon credits before reselling them to emitters with their own mark-up (17).

However, a disadvantage of this system is that brokers do not typically disclose pricing structures. Emitters therefore lack clarity on the actual price of a carbon credit. Some brokers have been recorded as charging companies as much as three times as much as the “true” price of credits that they have purchased from project developers (17).

Buy carbon credits on the marketplace itself: Emitters can browse projects by type, country, and Sustainable Development Goal. They then choose carbon offsets most suited to their expectations and purchase credits through the marketplace platform itself. One of the major advantages of this system is price transparency and ease of purchase (17).

CORSIA-approved carbon offset certification schemes offer a variety of approaches for Sale-Purchase practices, with multiple approved carbon credit exchanges (17):

AirCarbon Exchange (ACX)

AirCarbon Exchange was established in Singapore in 2019 as a digital exchange platform for airlines to trade carbon credits. This carbon exchange uses blockchain technology to create securitised carbon credits. ACX initially based its distributed ledger technology (DLT) exchange for the aviation industry through information and resources determined by CORSIA (18).

For every credit, a Token is assigned corresponding to one tonne CO_2 of GHG equivalent CO_2. These Tokens resided on the ACX and are defined below:

- CORSIA Eligible Tokens (CET).
- Global Nature Token (GNT).
- Global Nature+ Token (GNT+).
- Sustainable Development Goal Token (SDGT).
- Renewable Energy Token (RET).
- Household Offset Token (HOT).
- Global Emission Reduction Contract (GER).

Carbon Trade Exchange (CTX)

Carbon Trade Exchange (CTX) was established in 2009. CTX enables trading of credits from several different industry standards including: Gold Standard, Verra's Verified Carbon Standard, and the United Nations' Clean Development Mechanism (UNFCCC). The BioCarbon Registry was also recently added to CTX in April 2022.

Credits tradable on CTX include these five major allowances (18):

- Voluntary Emission Reduction (VER).
- Certified Emission Reduction (CER).
- Verified Carbon Units (VCU).
- EUA (EU Allowance).
- EUAA (EU Aviation Allowance).

Xpansiv

Xpansiv is a marketplace based on trading various data-driven, ESG-inclusive commodities. Xpansiv processes carbon, energy, and water-based transactions. Partnered with Chicago Mercantile Exchange (CME Group), Xpansiv have launched three offset contracts (17):

- CBL GEO: Global Emissions Offset.
- CBL N-GEO: Nature-Based Global Emissions Offset.
- CBL C-GEO: Core Global Emissions Offset.

Aviation Carbon Exchange (ACE)

The IATA Aviation Carbon Exchange, or ACE, is a centralised marketplace for CORSIA-eligible emission units. Airlines and other aviation stakeholders trade CO_2 emission reductions for compliance or voluntary offsetting purposes (19).

ACE enable the use of electronic interfaces with registries to facilitate the trade of:

- American Carbon Reserve (ACR).
- Climate Action Reserve (CAR).
- Gold Standard (GS).
- Verified Carbon Standard (VCS / Verra).
- UNFCCC Clean Development Mechanism (CDM).
- Environment Management Account (EMA).

2.8. Prospective carbon credit sales models

Digital Carbon Credits Trading

A blockchain is a digital ledger of transactions that cannot be tampered with by any one entity due to of its decentralised design: as there is no one centralized database, the ledger is maintained and cross-checked between a number of different resources. A blockchain is made up of blocks chained together cryptographically. Each block contains a hash pointer (a number) linking it to the previous block, as well as a timestamp, transaction data, and transaction fees (18).

Blockchains provide two crucial benefits with widespread real-world uses:

- Blockchains enable co-ordination between large groups of disparate users.
- Blockchains can guarantee ownership transparently and trustlessly (i.e. ownership can be verified without reference to an intermediary human authority) (18).

The application of blockchain technology to carbon credits is especially promising. In a global carbon market affected by problems related to quality assurance, blockchain technology provides the potential to tie one credit inextricably to one project (18).

An emerging carbon crypto environment has been dominated by several trends coming together at once and not all are directly aimed at tokenisation (i.e. creating a digital token as a representative of the carbon credit in question) (18).

Here are three of the biggest trends affective the development of the crypto carbon ecosystem:

- **Trend 1: Carbon-friendly Crypto**

Bitcoin employs a “Proof-of-Work” consensus mechanism to operate. This mechanism is energy-intensive and not environmentally friendly. It is difficult to calculate the exact impact, but research in 2019 determined that Bitcoin mining was responsible for 22 million metric tonnes of CO_2 emissions: approximately the same amount of carbon dioxide emissions as the Netherlands (19). However, even these higher numbers are relatively low when compared to overall global emissions. Bitcoin mining has historically accounted for less than 0.1% of annual global CO_2 emissions, less than the CO_2 emissions produced by mining and printing traditional currency (18).

- **Trend 2: Tokenised Carbon Offsets**

The global market for carbon offsets has increased rapidly and is projected to be worth billions of US dollars or euros by 2030. However, this rapid growth and greater potential for further growth has created new challenges in verifying and enforcing offsets. “Tokenisation” has been considered as a means of tackling some of those challenges. “Non-fungible tokens” (NFTs) are a form of minting digital records that are unique by nature of the technology that create them. This enables some crypto carbon projects to issue NFTs for specific offset projects or even sub-sections of projects (18).

- **Trend 3: Blockchain-powered Carbon Exchanges**

Carbon NFTs and tokenized offsets are often sold on blockchain-powered carbon exchanges. Abu Dahbi attributes its achievement of carbon neutrality to purchasing offsets on AirCarbon Exchange: an exchange which offers offsets from projects around the world but conveniently tokenises them on its own exchange. AirCarbon follows the same model as a traditional commodities exchange to facilitate effective and accessible carbon trading (18).

Notable Carbon Offset Crypto Projects

- **Moss**

Moss combines two projects: a climate-based NFT project and the MCO_2 token. Both projects rely on the concept of tokenisation to incentivise carbon offset production and emissions reduction (18).

- **KlimaDAO**

KlimaDAO is a project built on the common crypto carbon model of tokenised carbon offsets. KlimaDAO aims to increase the trending price of offsets on the Voluntary Carbon Market (VCM). This is done by purchasing carbon offsets, tokenising them, and then selling or "burning" (destroying) them to influence market dynamics through trade and scarcity (18).

- **Toucan**

Toucan helps bridge carbon credits on- and off-chain. The core of Toucan's project is the TCO_2, which stands for Tokenized CO_2. Each TCO_2 represents one verified, real-world carbon credit. TCO_2's are semi-fungible, meaning they can be substituted for one another but have unique information about each project encoded on Toucan's blockchain. The tokens are Verra verified, linking Toucan to one of the most well regarded global carbon offset standards (18).

2.9. Carbon market in Ukraine

Potential Market Size

The economy of Ukraine has significant potential for decarbonisation. In Ukraine, GHG emissions occur in principally the following sectors: energy; industrial processes and product use (IPPU); agriculture; land use, land use change and forestry (LULUCF); and waste. Excluding the LULUCF sector which is difficult to calculate in a given year, the largest recent GHG emissions in 2019 are attributed to the energy sector at around 66% of the total output), while IPPU GHG emissions accounted for 17.5%, Agriculture: 12.8%, and Waste: around 3%. There has been a significant reduction in the total volume of GHG emissions over time, down by 68% compared to 1990 levels in these sectors (20).

Table 3. Aggregate direct action GHG Emissions by sector, Mt CO_2-eq.

Sector	1990	2019	2019 year compared to 1990, %
Energy	725.3	219.2	-69.8%
Industrial Processes and Product Use (IPPU)	118.0	58.2	-50.6%
Agriculture	86.8	42.5	-51.1%
Land Use, Land Use Change, and Forestry (LULUCF)	-58.4	0.0	-100.1%
Waste	12.4	12.2	-1.6%

Source: Ministry of Environmental Protection and Natural Resources of Ukraine (20).

As a signatory to the Paris Climate Agreement since 2016, Ukraine has made a commitment to work on climate change mitigation. The Ukrainian Government has set a specific commitment to reduce GHG emissions by 65% by 2030 (compared to 1990 levels) and to achieve climate neutrality no later than 2060, according to the Updated Nationally Determined Contribution to the (NDC2) adopted in July 2021 (21) (22).

Ukraine's GHG emissions reductions that are likely to happen in future can be transformed into carbon credits and sold on carbon credits markets, including credits for future cancellation of CORSIA offsetting requirements for the aviation industry. Development of emission reduction projects and issuance of credits may create additional incentives for the decarbonisation of the Ukrainian economy by raising funds from international carbon markets.

However, a national carbon market in Ukraine is currently undeveloped at this time.

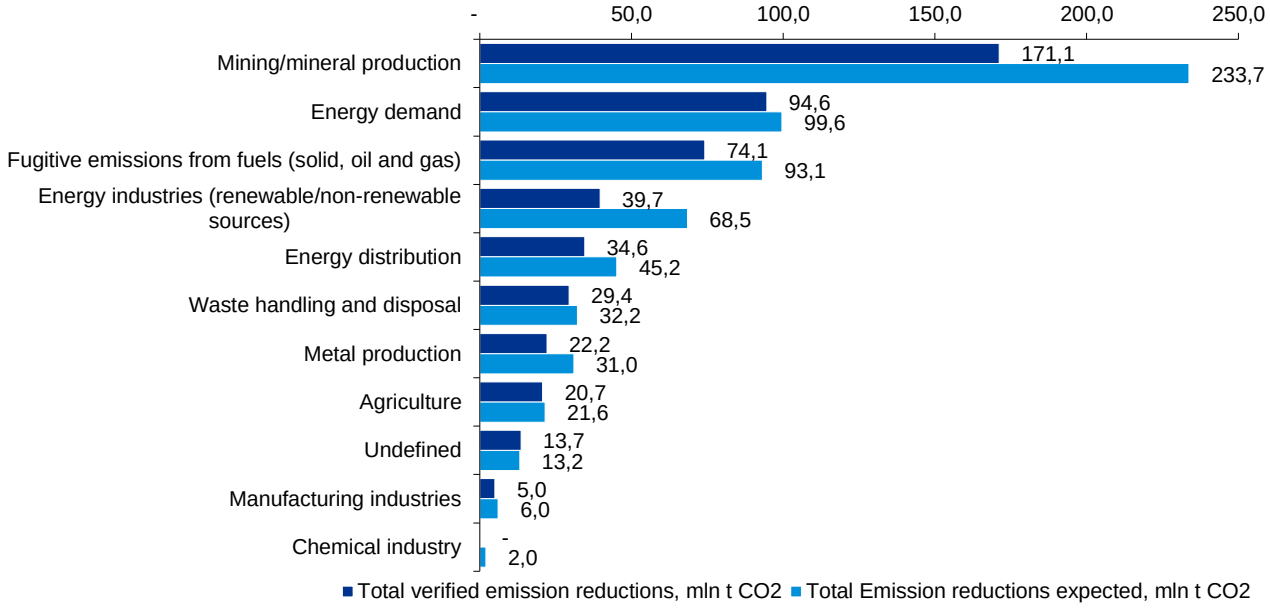
Previous experience and preconditions for green market development

Joint implementation projects under the Kyoto Protocol

Ukrainian companies and government institutions have experience in implementing projects related to the generation of carbon credits within the framework of the mechanisms of the Kyoto Protocol (20).

Ukrainian governmental institutions and the private sector have played a vital role in Joint Implementation project execution. There were 251 registered Track 1 (Table 1) projects that were expected to reduce more than 646 million tonnes of CO_2 emissions (Figure 13). This expectation was fulfilled up to 78.2% and amounted to 505 million tonnes of CO_2. Projects were especially focused on the Ukrainian mining and mineral production sector, where energy demand and fugitive emissions from fuels represented the majority of projects by quantity (66.1%) and verified emission reductions (63.7%) (23). These are large-scale projects aimed at transforming and modernising industrial processes for the most energy intensive sectors of the Ukrainian economy. Many of these projects were executed on facilities located in the Donetsk and Luhansk regions that are temporarily occupied by the Russian Federation.

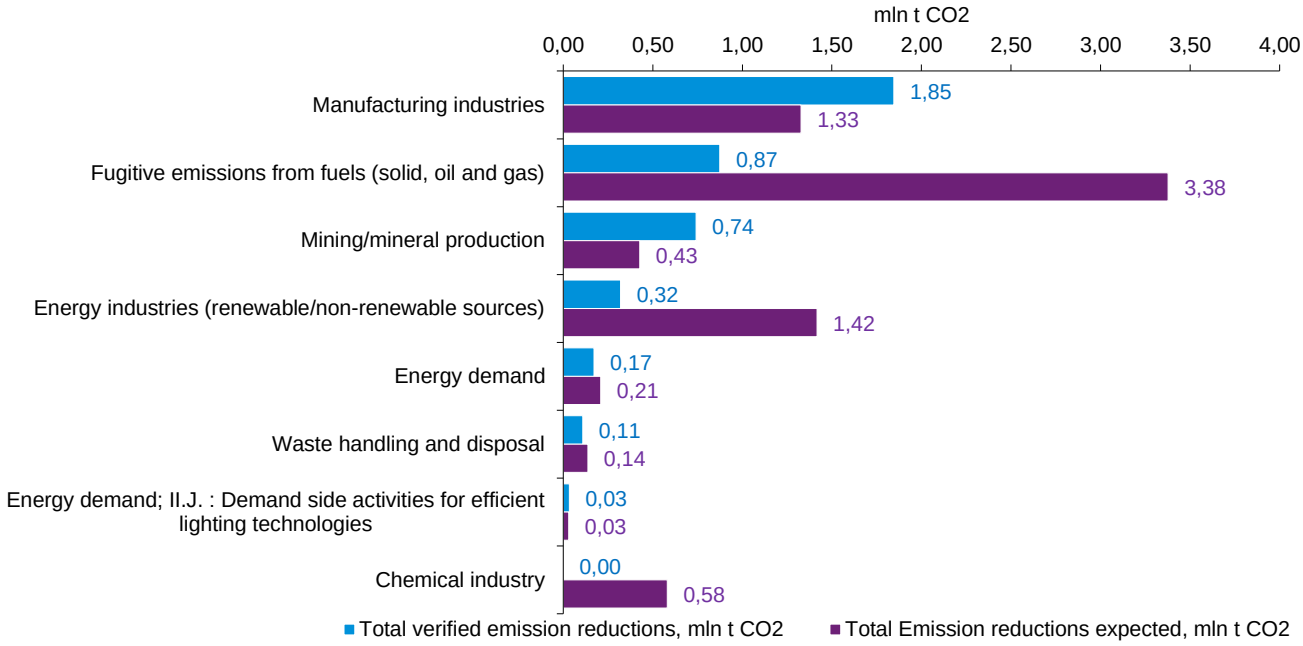
Figure 13: Expected and verified emission reductions by sector, mln t



Source: UNFCCC (23)

There were also 27 registered Track 2 projects that have resulted in verified emissions reduction of only 4.1 million tonnes of CO_2 (54.5% of expected reduction), mainly achieved via energy efficiency improvements and changes to manufacturing processes in manufacturing industries (Figures 14).

Figure 14: Expected and verified emission reductions by sector, mln t CO2



Source: UNFCCC (23)

There are some criticisms that have been lobbied regarding carbon reduction project execution and its effectivity. Such issues as lack of environmental integrity of projects, lack of additionality, frequent delays due to bureaucracy, preferential treatment of some projects, and the use of intermediaries in Ukrainian projects have been noted (24) (25). There were also sanctions imposed on Ukraine due to failure to implement projects to reduce GHG emission in an effective and timely manner (26). Corruption crimes related to Kyoto protocol projects have been investigated and prosecuted (27). A significant portion of the projects registered (21%) have not resulted in any verified emissions reduction, and their implementation status remains unknown.

Table 4. Kyoto Protocol Track 1 and Track 2 Joint Implementation Projects.

	Number of projects	Number of projects with no verified reductions	Verified emission reductions, mln t CO_2	Expected emission reductions, mln t CO_2
Track 1	251	54	505.0	646.1
Track 2	28	5	4.1	7.5

Source: UNFCCC (23)

The potential to generate carbon credits was not widely implemented in Ukraine as completing the main bulk of projects' financing under Kyoto Protocol mechanisms was hampered due to a lack of financing sources. This prior experience should be taken into account in the further implementation of any carbon market in Ukraine in order to avoid the risks and shortcomings identified during the implementation of Kyoto Protocol projects.

Private sector experience in decarbonisation

Individual players in such Ukrainian sectors as renewable energy, agriculture, traditional energy, and manufacturing have experience in implementing emission reduction projects. Companies interest in decarbonization is increased as part of improving their ESG practices, including as a result of demands from investors. Despite this, Ukrainian projects are basically unrepresented on the international market.

Environmental tax

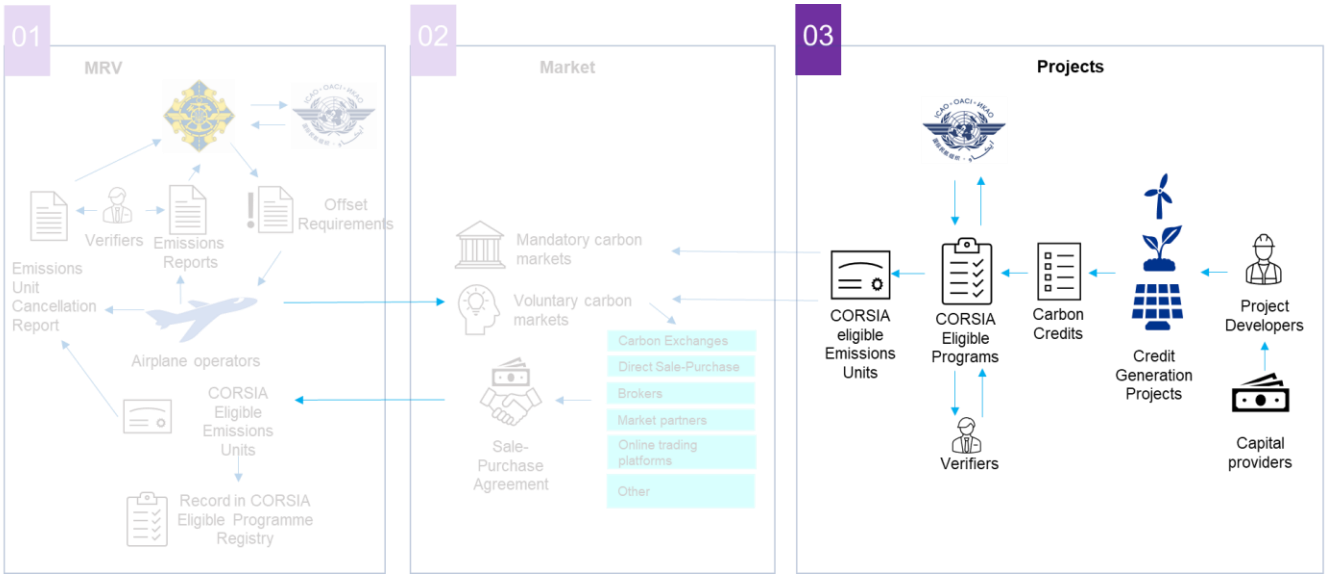
Ukrainian companies that generate more than 500 tonnes of CO_2 emissions per year must pay an environmental tax in the amount of UAH 30 per tonne of CO_2. The tax is also levied on other types of emissions. Currently, the tax is not paid by taxpayers who are registered in the territories where hostilities are being or have been conducted and in temporarily occupied territories until the end of martial law. The mechanisms of accumulation and distribution of funds from the environmental tax and the use of funds to combat climate change have been discussed, as well as the potential for creating a tool for implementing measures within the framework of the European Green Deal (including decarbonization). However, concrete decisions have not yet been made.

Post-war reconstruction processes should be considered as one of the drivers of carbon market development in Ukraine. Reconstruction projects will need to be implemented on the basis of best practices in the field of sustainable development and decarbonisation, meeting the expectations of potential investors (28). This will contribute to GHG emissions reduction and entry into international markets which may induce the launch of a national carbon market.

Development and implementation of ETS in Ukraine is currently underway (29). Within this framework, offsetting mechanisms may be viably applied, through integration with and imitation the EU ETS.

The prospects of creating a carbon market in Ukraine in the conditions of the current war are doubtful due to the associated risks. Moreover, the war in Ukraine is still having a powerful impact on international carbon market, caused by: significant changes in the global energy market, sanctions, policy changes, etc. Estimating the potential size of the market, supply and surveys, price forecasting, research of prospective financing, and project implementation mechanisms requires stabilisation of the situation.

3. Eligible Programmes: sectors, technologies, and projects



Over the past two centuries, the global economy has heavily depended on the overexploitation of natural resources and processes in the biosphere. Ongoing demand after a period of heavy dependency on the use of petroleum resources, fossil fuels, and subsequent deforestation for resource extraction and agriculture corresponds to pressures to meet the growing demand for energy, food, and other commodities. These are considered primary drivers of increased global GHG emissions and, consequently, climate change. Combined efforts to reduce CO_2 emissions and increase CO_2 sequestration must therefore to be employed through a number of different interventions: technology, social and behavioral response, and economic incentives.

Emissions reduction in the aviation industry is considered a particularly challenging task. Currently, sustainable aviation fuels (SAFs) are being developed as an alternative fuel source in order to lower GHG emissions but this is an expensive and difficult process. Due to the cost of SAF and the technological investment needed to develop alternative fuels, carbon offsets are considered a more readily available and effective means of dealing with climate change.

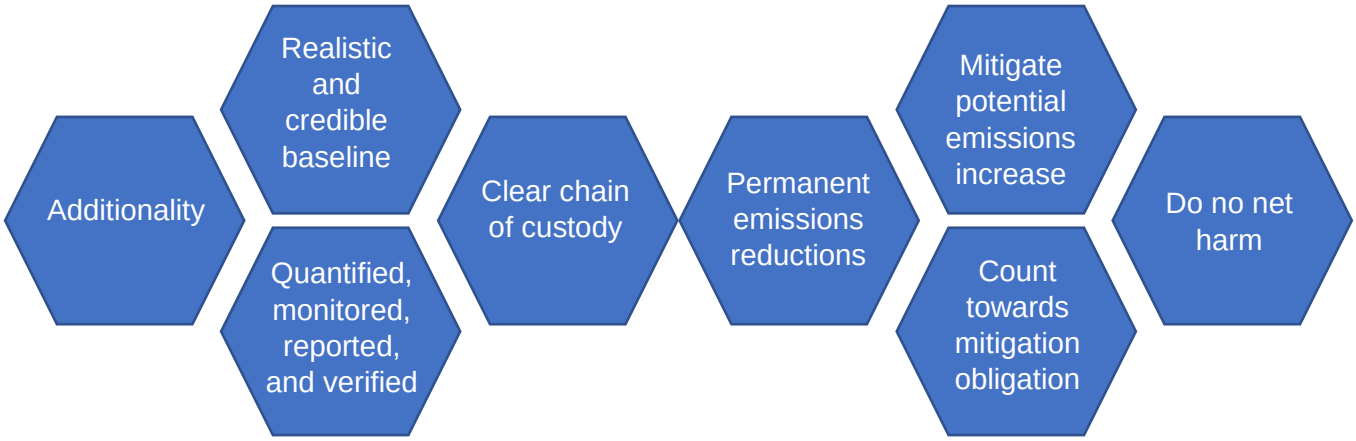
In this section, we will consider sectors of the economy, technologies, and projects that can be used for offsetting within the framework of CORSIA.

3.1. CORSIA credit quality concept and requirements

Carbon credits can have different levels of quality and verification, and not all of the credits available on the market are backed by real CO_2 emission reductions. As CORSIA aims to reduce emissions from international aviation, carbon projects should be carefully selected in order to maintain quality assurance. In order for a project to be officially approved by CORSIA, it must meet strict criteria.

General principles can be applied to mandatory and voluntary offset credit programmes aim to achieve environmental and social integrity. These principles state that offset credit programmes should create credits that represent reductions, avoidance, or sequestration of emissions. These principles are presented in the Figure 15.

Figure 15. General principles in offset credit programmes.



Source: ICAO - CORSIA Emissions Unit Eligibility Criteria

CORSIA developed its Emissions Unit Eligibility Criteria document, published on ICAO website, which contains all the requirements that offset credit programmes must meet in order to be officially approved by CORSIA and added to the "CORSIA Eligible Emissions Unit Programmes" registry.

Eligibility criteria should apply at the programme level, as considerable expertise and resources are likely to be needed in developing and implementing ICAO emissions criteria at a methodology and project level (30):

- Carbon offset programmes must generate units that represent emissions reductions, avoidance, or removals that are additional (they go beyond what is legally mandated in law, regulations, or other international agreement).
- Carbon offset credits must be based on a realistic and credible baseline
- Carbon offset credits must be quantified, monitored, reported and verified.
- Carbon offset credits must have a clear and transparent chain of custody within the offset program.
- Carbon offset credits must represent emissions reductions, avoidance, or carbon sequestration that are permanent.

- A carbon offset credit system must have measures in place to assess and mitigate incidences of material leakage.
- Carbon offset programme credits are only counted once towards a mitigation obligation. Measures must be in place to avoid:
    a) *Double issuance* (which occurs if more than one unit is issued for the same emissions or emissions reduction)
    b) *Double use* (which occurs when the same issued unit is used twice, for example, if a unit is duplicated in registries)
    c) *Double claiming* (which occurs if the same emissions reduction is counted twice by both the buyer and the seller (i.e., counted towards the climate change mitigation effort of both an airline and the host country of the emissions reduction activity)).
- Carbon offset credits must represent emissions reductions, avoidance, or carbon sequestration from projects that do no net harm (i.e. not in violation of any "not violate local, State provincial, national or international regulations or obligations or laws).

We will continue by elaborating on how this quality verification procedure works in practice.

Aeroplane operators must meet offsetting requirements once the State is informed about the total final offsetting requirements during a given compliance period. To meet its offsetting requirements, the aeroplane operator shall:

a) cancel such CORSIA Eligible Emissions Units within a registry designated by a CORSIA Eligible Emissions Unit Programme

b) request each CORSIA Eligible Emissions Unit Programme registry to make visible on the registry's public website information on each of the aeroplane operator's cancelled CORSIA Eligible Emissions Units for a given compliance period.

After the CORSIA Eligible Emissions Units are cancelled, aeroplane operators must submit a copy of the verified Emissions Unit Cancellation Report to the State for approval and a copy of the associated Verification Report. A verification body should conduct the verification according to ISO 14064-3:2006.

It is essential that the CORSIA Eligible Emissions Units are only those units described in the ICAO document entitled "CORSIA Eligible Emissions Units" and are therefore EEUs that meet CORSIA Emissions Unit Eligibility Criteria.

3.2. CORSIA programmes certification process

A Technical Advisory Body (TAB) has been created for the purposes of monitoring applicant programmes' compliance with CORSIA Emissions Unit Eligibility Criteria. The TAB is mandated to make recommendations to the Council on eligible emissions units for use by CORSIA. According to Terms of Reference of the TAB, there are two main tasks:

- undertake an assessment of emissions unit programmes against the emissions unit's criteria,
- develop recommendations for the list of eligible emissions unit programmes (and potentially project types) whose emissions units would be eligible for use under CORSIA, for consideration by the Council.

More details on TAB responsibilities can be found in the "Terms of Reference (TOR) for the Technical Advisory Body (TAB)" document.

In order for a participant to apply for CORSIA, they need to fill out application forms. These documents are listed on the CORSIA TAB webpage.

From 26 January to 26 February 2022, ICAO invited emissions unit programmes to apply for assessment by TAB against CORSIA Emissions Unit Criteria (EUC). ICAO received seven responses to the call for applications. The responses provided are mentioned below (more details can be found on TAB page of CORSIA website):

1. BioCarbon Fund Initiative for Sustainable Forest Landscapes.
2. BioCarbon Registry.
3. Cercarbono.
4. International Carbon Registry.
5. J-Credit Scheme.
6. Joint Crediting Mechanism between Japan and Mongolia.
7. SOCIALCARBON Standard.

These programmes are being assessed by TAB and have not yet been officially approved. The next call for applications will start in January 2023.

According to ICAO CORSIA Emissions Unit Eligibility Criteria, ICAO should ensure that eligible offset credit programmes meet requirement at the programme level in regard to key design elements.

The following aspects of these design elements have been reviewed in terms of the programme assessment and validation process undertaken by TAB (30):

- ***Clear Methodologies and Protocols, and their Development Process***: Qualification and quantification methodologies and protocols, methodologies development procedures, as well as public disclosure.
- ***Scope Considerations***: Programmes should define and publicly disclose the level at which activities are allowed under the programme and the eligibility criteria for each type of offset activity.
- ***Offset Credit Issuance and Retirement Procedures***: Programmes should have in place and publicly disclose procedures for how offset credits are issued, retired, if they are a subject to any discounting, the length of the crediting period, and whether that period is renewable.
- ***Identification and Tracking***: Programmes should have in place and publicly disclose procedures that ensure that units are tracked, individually identified, the registry is secure, and units have clearly identified owners or holders.
- ***Legal Nature and Transfer of Units***: The programme should define and ensure the underlying attributes and property aspects of a unit, and publicly disclose the process by which it does so.
- ***Validation and Verification procedures***: Programmes should have in place and publicly disclose validation and verification standards and procedures, as well as requirements and procedures for the accreditation of validators and verifiers.
- ***Program Governance***: Programmes should publicly disclose who is responsible for administration of the programme and how decisions are made.

- ***Transparency and Public Participation Provisions***: Programmes should publicly disclose what information is available to different stakeholders, local stakeholder consultation requirements, and public comment provisions and requirements.
- ***Safeguards System***: Programmes should have in place and publicly disclose safeguards to address environmental and social risks.
- ***Sustainable Development Criteria***: Programmes should publicly disclose the sustainable development criteria used.
- ***Avoidance of Double Counting, Issuance, and Claiming***: Programmes should provide information on how they address double counting, issuance, and claiming in the context of evolving national and international regimes for carbon markets and emissions trading.

3.3. Carbon emissions reduction projects by programmes and sectors

The Emissions Unit Programmes described below have been approved by the ICAO Council to supply CORSIA Eligible Emissions Units. There are also additional limitations regarding the eligibility of units approved by respective programmes. These limitations concern the scope of eligibility, in particular: eligible dates, activities, unit types, methodologies, etc. Currently approved programmes and respective limitations are available in the most recent version of the CORSIA Emissions Unit Programmes document on the ICAO official website (31).

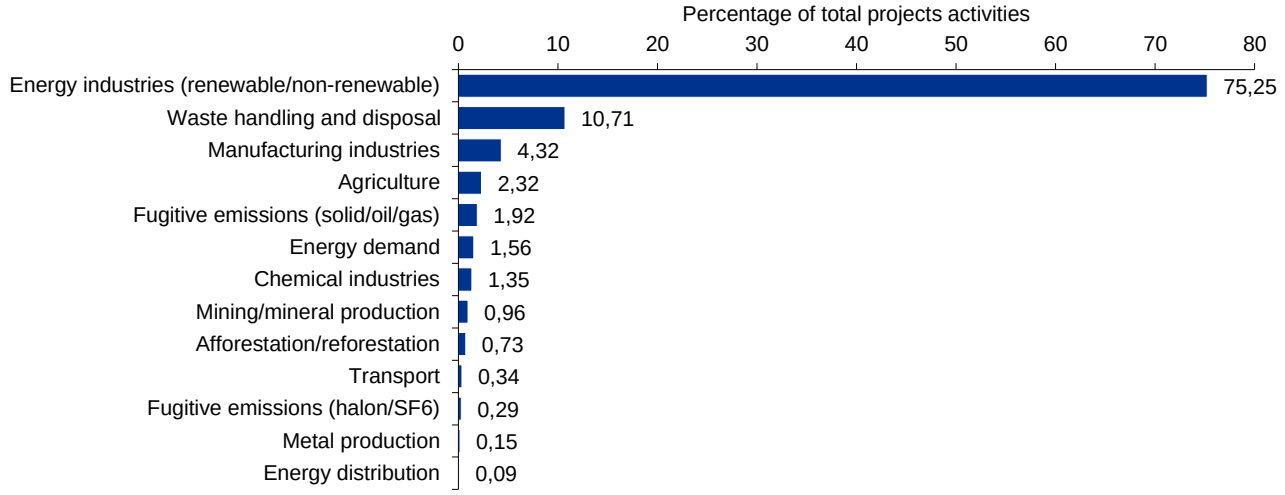
We will now discuss some of the carbon offsetting programmes approved under CORSIA:

Clean Development Mechanism (CDM)

The Clean Development Mechanism (CDM), created by the United Nations carbon offset scheme, enables countries with commitments under the Kyoto Protocol to implement projects for emissions reduction and generate certified emission reduction (CER) credits which can then be sold as needed.

Starting from 2005, the CDM covered more than 3,400 implemented project activities that have issued a total of CERs 2,253,904,383 CDRs as of 30 September 2022. The CDM is one of the largest and oldest offsetting programmes to be implemented. Most CDM projects were executed in the energy industry (both in renewable and non-renewable sectors) as this sector generates the major part of overall emissions globally, hence the principal focus of efforts is dedicated to emissions reduction and sustainable transformation in this sector. In general, of among overall amount of 7,844 CDM registered projects, more than 90% are dedicated to the energy industry, waste handling and disposal, and manufacturing industries (Figure 16) (32).

Figure 16. Project activities undertaken in CDM as of 30 September 2022.



Source: UNFCCC (32)

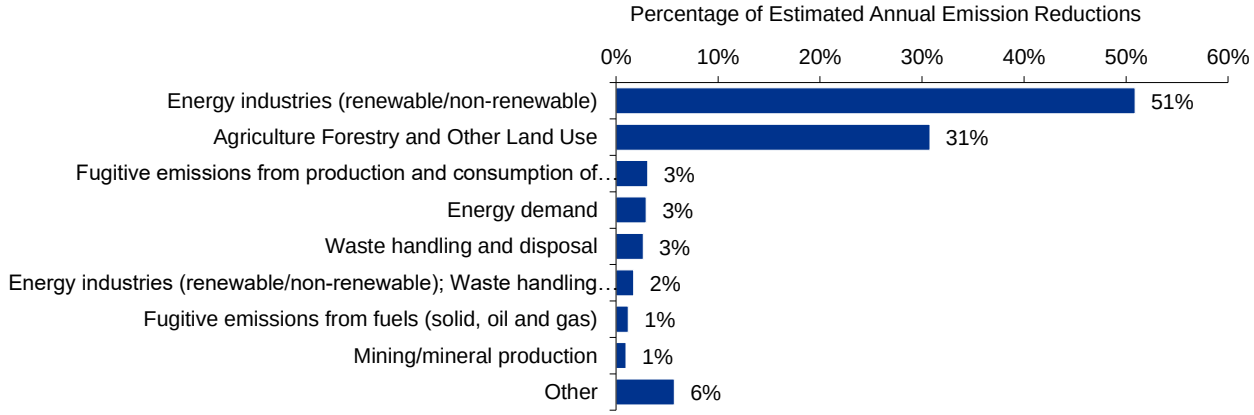
- **VERRA - VCS Program**

The Verified Carbon Standard Program is one of the most widely used voluntary GHG programmes. VCS projects include dozens of technologies and measures which result in GHG emission reductions and removals, including forest and wetland conservation and restoration, agricultural land management, transport efficiency improvements, and others (33).

There are currently 1,876 registered projects in more than 88 countries that are expected to generate more than 330 million carbon credits (34).

The majority of projects are focused on the following industries: energy (renewable and non-renewable) (169.6 million carbon credits), agriculture forestry and other land use (102.6 million carbon credits), fugitive emissions from halocarbons and sulphur hexafluoride (10.4 million carbon credits). These industries comprise than 85% of all estimated carbon emission reductions generated by VCS registered projects (Fig.17). The majority of projects (1,876, or >72%) are located in India (31%), China (23%), Turkey (8%), Brazil (6%), and the United States (5%).

Figure 17. Registered VCS Projects as of 25 October 2022



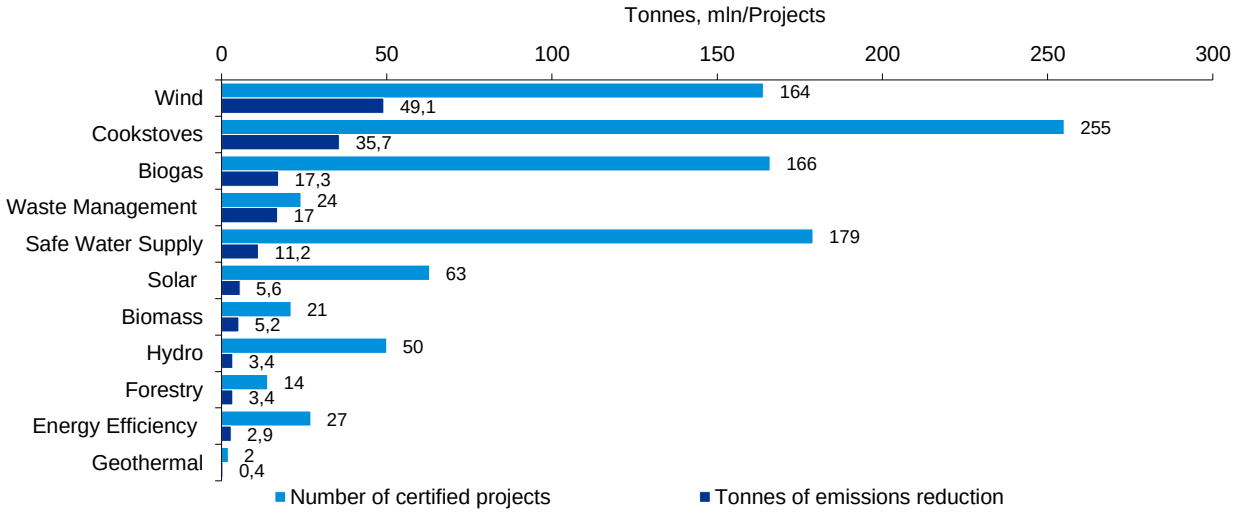
Source: Verra (34)

- **Gold Standard (GS)**

Gold Standard is the one of the oldest initiatives aimed at high quality assurance of CDM (Clean Development Mechanism) and JI (Joint Implementation) offset projects. It was established in 2003 by the World Wildlife Fund in co-operation with other sectoral NGOs (35).

Under Gold Standard, more than 960 projects have been issued that resulted in more than in 151 million CO_2 tonnes of emissions reduction in more than 65 countries as of the end of 2020. This includes over 126.1 million Verified Emissions Reductions (VER) and 24.9 million GS labelled Certified Emission Reductions (CER) (Fig.18). The majority of total carbon emission reduction resulted from projects in: alternative energy sector (wind and biogas projects; 32% and 11% respectively), improved cooking solutions (24%), and waste management improvement (11%). These projects are mostly based in Asia (65%) and Africa (24%). It is worth noting that only VER with specific limitations are eligible under CORSIA (36).

Figure 18. Scope of GS certified projects as of end of 2020.



Source: Gold Standard (36).

- **American Carbon Registry (ACR)**

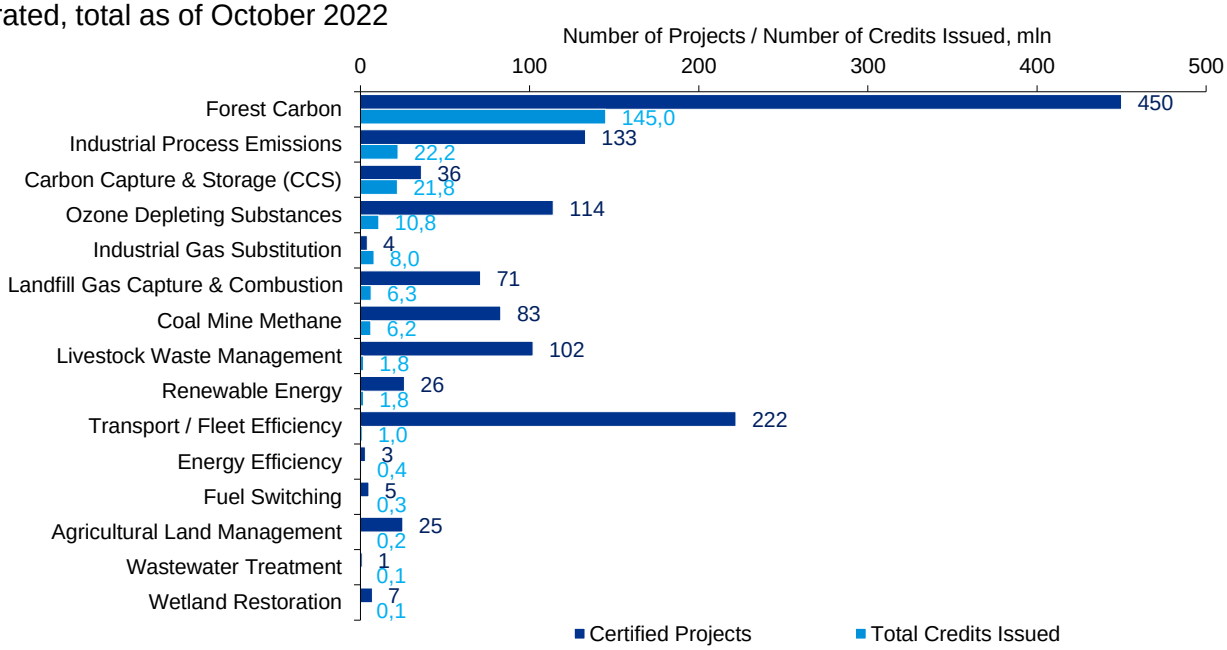
The American Carbon Registry operates both in regulated and voluntary carbon markets. Projects certified under the ACR Standard are eligible to supply emission reduction units for the California Cap-and-Trade programme and, starting from 2020, for CORSIA. ACR oversees registration and verification of USA, Canada, and Mexico-based offset projects from a various project type in Land Use, Land Use Change and Forestry, GHG emission reductions from industrial processes, Carbon Capture and Storage, and Waste Handling and Disposal (37). CORSIA eligible emission units are represented by industrial projects aimed at the improvement of foam manufacturing processes (63%), sustainable reclamation of refrigerants, (23%) and refrigerator technology renewal (9%)(Figure 19). CORSIA eligible carbon credits issued consist of only 10% of the overall ACR carbon credits issued (Table 5).

Table 5. CORSIA eligible emission units by industrial projects.

Sectors	Number of projects	Total Credits Issued, mln
Forest Carbon:	**15**	**1.09**
Afforestation and Reforestation of Degraded Lands	2	0.02
Improved Forest Management (IFM) on Non-Federal U.S. Forestlands	13	1.07
Industrial Process Emissions:	**84**	**20.43**
Advanced Refrigeration Systems	15	2.00
Certified Reclaimed HFC Refrigerants, Propellants, and Fire Suppressants	21	4.99
Transition to Advanced Formulation Blowing Agents in Foam Manufacturing and Use	48	13.43
Total	**99**	**21.52**

Source: American Carbon Registry (38)

Figure 19. American Carbon Registry carbon offset projects and credits generated, total as of October 2022



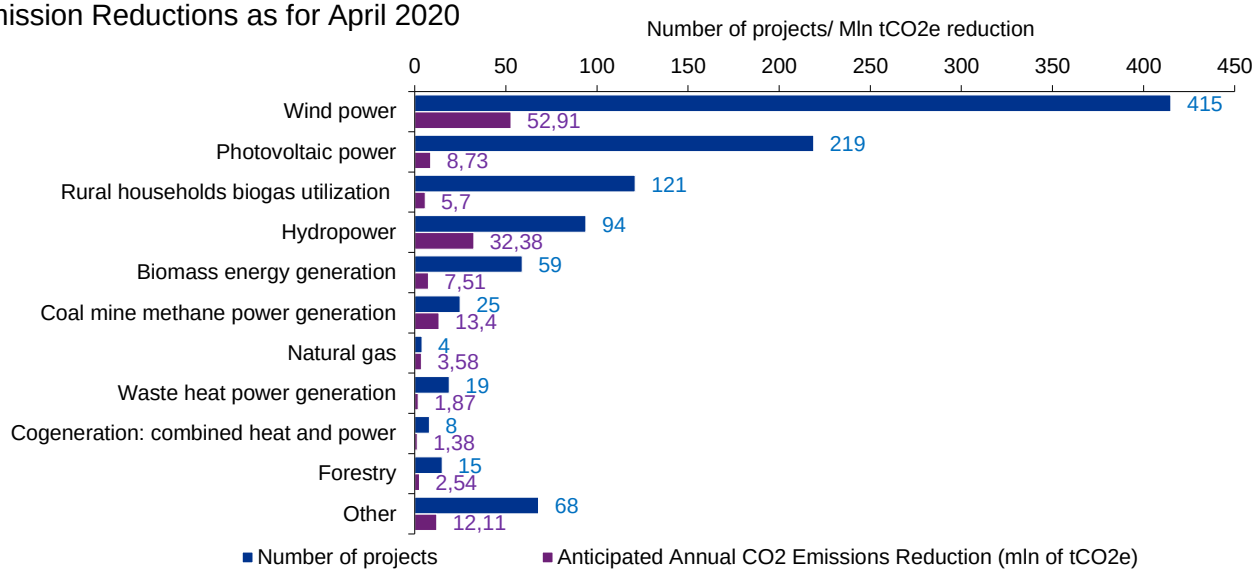
Source: American Carbon Registry (38)

- **China GHG Voluntary Emission Reduction Program**

Starting from 2015, the Voluntary Carbon Emission Reduction registry was launched in China and started trading as part of China's GHG Voluntary Emission Reduction Program. Under this programme, China Certified Emission Reduction (CCERs) became available for local carbon markets. More than 2,800 CCER projects have been validated, and more than 1,000 CCER projects have been registered by the programme. However, only 287 emissions reduction projects have been approved for issuance as of April 2020 (Figure 20).

Anticipated annual emissions reduction from 1,047 registered projects is expected to exceed 140 million tonnes of CO_2. A significant portion of anticipated reductions are dedicated to alternative energy projects (wind, 37%; hydropower, 24%; photovoltaic, 6%) and industrial process power generation projects (9%) (39).

Figure 20. China GHG Voluntary Emission Reduction Program Projects and Emission Reductions as for April 2020



Source: Environmental Defense Fund Beijing Representative Office, Sino Carbon Innovation & Investment Co, Ltd (39).

- **Global Carbon Council (GCC)**

The Global Carbon Council (GCC) is a voluntary carbon offsetting programme under which emission reduction units, or Approved Carbon Credits (ACCs) are issued after being generated by projects in a specific monitoring period. These projects and credits are ensured by monitoring and independent verification carried out with approved standards. Moreover, GCC accepts projects from other carbon credit standards that use CDM methodology (40).

The majority of projects submitted for registration by GCC projects represent energy industries, namely energy generation from renewable and non-renewable sources. There is publicly available information on 557 submitted projects, among which 553 are potentially CORSIA eligible[1]. Most of the projects are solar, wind, hydroelectric power, and biomass power generation projects. Additionally, there are also projects concerning Combined Heat and Power (CHP) power generating facilities, waste handling and disposal, etc. Projects are mostly submitted from locations based in India, China, and Turkey (41).

- **Architecture for REDD+ Transactions (ART)**

The Architecture for REDD+ Transactions (ART) is a programme that develops and administers carbon reductions crediting standard and procedures for national and sub-national programmes[2] aimed at reducing emissions from deforestation and forest degradation (REDD+), and forest restoration and conservation. The REDD+ Environmental Excellence Standard (TREES) is a core ART standard that

[1] As of 27 October 2022, Public Registry of Submitted Projects, Global Carbon Council.

[2] Sub-national programmes should cover a minimum area of 2.5 million hectares of forest.

has established requirements for measurement, monitoring, reporting, and verification of emission reductions and removal credits generated (TREES Credits).

There are three categories of activities eligible to generate TREES Credits:

- **Removals** (credits for carbon removal from the establishment of new forests on land without forest cover)
- **Reducing deforestation and degradation** (credits for emission reductions from reducing deforestation and forest degradation)
- **High Forest Low Deforestation Areas** (HFLD, credits for emission reductions and removals in jurisdictions that have high forest cover and low rates of deforestation) (42).

Table 6. ART programme countries

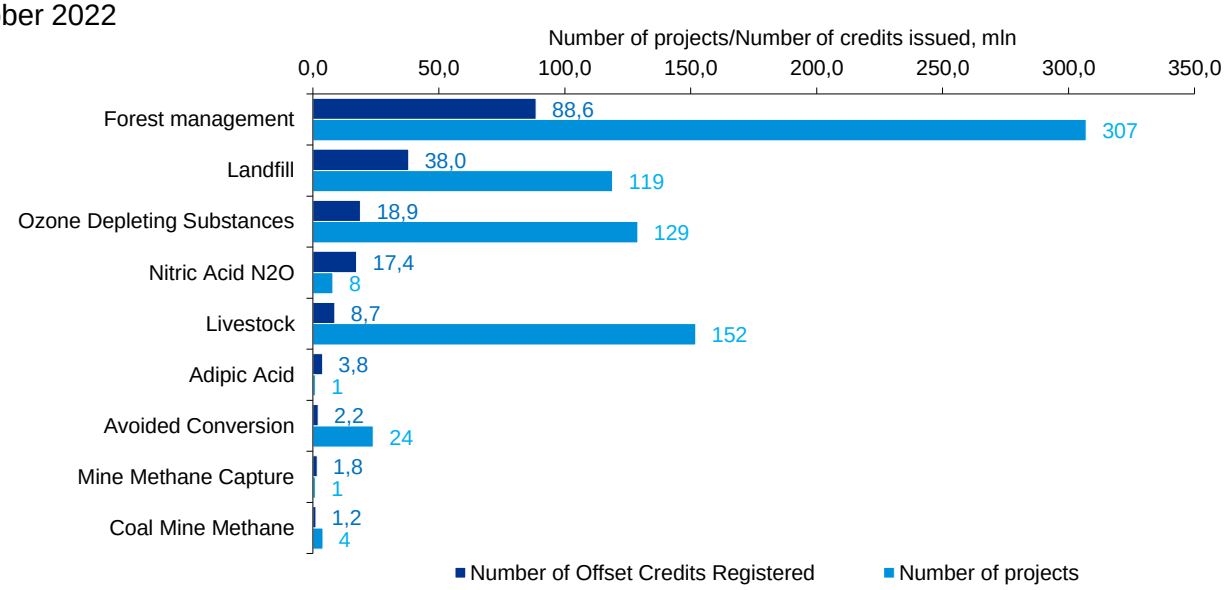
ART programme countries, October 2022				
Brazil	Costa Rica	Ghana	Nepal	Vietnam
Colombia	Ecuador	Guyana	Papua New Guinea	-
The Democratic Republic of the Congo	Gabon	Mexico	Peru	-

Source: Architecture for REDD+ Transactions (43)

- **Climate Action Reserve (CAR)**

The Reserve serves as an approved Offset Project Registry (OPR) for the State of California's Cap-and-Trade Program. Launched in 2008, CAR is a US-based voluntary offset programme for projects are implemented within North America. The Reserve operates with carbon credits called Climate Reserve Tonnes (CRTs). More than 80% of the 181 million offset credits registered were generated by the projects in forest management (49%), landfill gas capture and combustion (21%), and ozone depleting substances management (10%) (Figure 21).

Figure 21. Climate Action Reserve Projects, by types and credits issued, as of October 2022



Source: Climate Action Reserve

3.4. Promising technologies and projects for carbon market

For CO_2 neutrality and sustainable development, it is important to reduce CO_2 emissions from fossil fuels and food while simultaneously increasing CO_2 sequestration in terrestrial and marine ecosystems. In this regard, investment in research and implementation of renewable energy from carbon-free sources and biomass is key.

Food production management also needs increases to production efficiency optimisation to reduce CO_2 emissions. This can be achieved by developing new technologies for fertiliser and precision farming, integrating in crop and livestock production systems, and developing CO_2-neutral food production systems.

To combat climate change, various strategies are being explored to capture CO_2 from the atmosphere using industrial tools and to sequester CO_2 in terrestrial and marine ecosystems. This consists of bioenergy with CO_2 capture and storage; increased weathering of rocks due to the spread of crushed minerals capable of adsorbing CO_2 on land or in the ocean; afforestation and reforestation; absorption of CO_2 in the soil using biochar, compost, and direct application of biowaste and conservation tillage; ocean fertilisation by applying iron and/or other substances to promote the growth of photosynthetic plankton; restoration of coastal wetlands; and air capture using chemicals to remove CO_2 from the atmosphere.

3.4.1. Technologies for renewable energy

Solar energy. Installing solar panels on the roofs of buildings can reduce GHG emissions by 57% in the short term (10 years) and achieve CO_2 neutrality in the long term (30 years) (44).

Solar energy production technology includes: (1) *photovoltaic technology*: the conversion of solar energy into electricity using inorganic semiconductors, and (2) *solar thermal technology*: photothermal conversion to produce heat, steam, and electricity (44).

A new concept of “liquid sunshine” has emerged to combine solar energy with captured CO_2 and water to produce an environmentally friendly liquid fuel (methanol and alcohol), as well as feed for livestock (44).

Wind energy. Wind energy is traditional renewable energy technology produced by windmill technology.

Ocean energy. There are five different forms of energy: (1) tidal energy, (2) wave energy, (3) ocean current energy, (4) thermal energy, and (5) osmotic energy.

The energy of tides, waves and currents is mechanical energy.

Thermal energy comes from the heating of the upper layers of sea water, and the difference in temperature from the water in the lower layers. Such temperature differences can be used to generate electricity based on thermal cycles.

Osmotic energy, or salinity gradient energy, is the energy that exists between bodies of water with different salt concentrations. For example, a salinity gradient is formed in estuaries where fresh water meets salt water.

Bioenergy. The most common sources of biomass are agricultural and forestry waste, solid household waste, livestock waste, sewage and industrial waste. Biomass provides 13–14% of annual global energy consumption. The following processes are used to convert biomass into energy: (1) *Thermochemical conversion* of biomass includes gasification, pyrolysis, and combustion. (2) *Chemical conversion* of vegetable oils and animal fats into fatty acid esters by esterification and/or transesterification for biodiesel production. (3) *Biochemical conversion* of biomass into liquid fuels (alcohols and alkanes), natural gas (hydrogen and methane), and various types of bioproducts (carotenoids, omega-3 and omega-6 fatty acids).

H_2 energy. Hydrogen fuel cell technologies have developed rapidly and are ready for commercialisation.

Nuclear energy. Nuclear power accounts for 40% of the world's low-CO_2 electricity production.

Geothermal energy. Geothermal energy production uses natural geothermal steam to generate electricity.

3.4.2. Technologies for enhanced carbon sink in global ecosystem

Carbon emission reduction in agricultural food production systems

Crop production management. (1) Optimisation of fertiliser and water use on arable land, (2) development of new types of synthetic nitrogen fertilisers, (3) introduction of new cultivation technologies and use of advanced digital agricultural technologies (use of drones for crop management), (4) breeding of crop varieties from high efficiency of nitrogen use.

Animal production management. (1) management of ruminant gut fermentation through vaccination to suppress methanogens, (2) breeding of new highly digestible forages, (3) manure management through pasture optimization, on-farm energy production and low-emission organic fertiliser production.

Carbon sink in terrestrial ecosystems

The global absorption of CO_2 by forests is estimated at 10.7 Gt CO_2-eq per year. Grasslands store about 34% of the global Earth's CO_2. The soils of these meadows store 343 Gt of CO_2, which is 50% more than that stored in forest soils, and absorb 1.83 Gt of CO_2-eq per year. The main technologies for increasing carbon sinks are reforestation and afforestation, sustainable forestry, and absorption of CO_2 by the soil.

Carbon sink in marine ecosystems

The amount of CO_2 stored in the ocean is 44 times more than in the atmosphere and has been stored for several hundred years.

Tackling the carbon footprint of global waste

Zero waste biochar as a carbon-neutral tool: thermochemical conversion of solid waste into biochar.

Biochar for sustainable development: biochar becomes an effective and natural adsorbent that can trap CO_2 and remove various organic and inorganic pollutants.

Carbon sequestration in bio-based products: using biomass to convert, reuse, and recycle CO_2.

3.4.3. Technologies for CO_2 capture, utilisation, and storage

CO_2 capture and storage:

Carbon capture technologies: (1) post-combustion capture, (2) pre-combustion capture, and (3) oxygen-fuel combustion.

CO_2 transportation: the process of transporting captured CO_2 for use or to a storage location. Transporting CO2 is similar to transporting oil or gas, involving pipelines, ships, railways, roads, etc.

CO_2 storage: storage of captured CO_2 in geological structures using engineering and technical means. Various geological storage bodies mainly include onshore saline aquifer storage, seabed saline aquifer storage, and spent oil and gas storage, as well as other technologies

CO_2 utilisation

Thermochemical catalysis: In thermochemical catalysis, the integration of CO_2 into certain organic substrates to form new C–X bonds in catalytic sequences.

Photochemical catalysis: In the photochemical reaction, sunlight is used as an energy source and photoreduction of CO_2 is carried out using semiconductor photocatalysts under light irradiation.

Electrochemical CO_2 reduction: An electrochemical CO_2 reduction reaction that can convert intermittently renewable electricity from sunlight and wind into fuel and useful chemicals.

Other catalysis: Enzymatic and organometallic conversions of CO_2.

3.4.4. Carbon neutrality based on satellite observation

Satellite observation assist in CO_2 neutralisation and include fast monitoring of GHG concentrations, satellite monitoring of CO_2 emissions, land cover changes, and CO_2 natural uptake analysis to estimate CO_2 emissions and CO_2 natural uptake potential (45).

Technologies can incorporate large amounts of data obtained from satellite observations, and simulate and predict global ecosystems, visualising the results (45).

New technologies and functions will provide significant benefits for CO_2 neutrality and CO_2 trading by enabling observation and monitoring capacities (45).

3.4.5. Sustainable aviation fuel (SAF)

SAF is defined as renewable aviation fuel that is made from renewable biomass and waste resources that meets sustainability criteria. SAF has notable potential to reduce CO_2 emissions in aviation. A large share of aviation's CO_2 emissions comes from the combustion of kerosene, known as Jet A-1, in aircraft engines. To avoid this tailpipe CO_2 completely, a range of solutions have been proposed, such as hydrogen or batteries. However, these technologies will require a full redesign of aircrafts and new refuelling infrastructure, and it is therefore likely that their widespread potential will only be feasibly realized after 2050.

In the meantime, SAF is available today and can be used without the need to develop new planes or engines. These greener jet fuels seek to reduce the lifetime emissions of engine burn, acting as a drop-in fuel that can be blended in increasingly high proportions with conventional Jet A-1. However, the currently predominant SAF type (i.e. biofuels) faces real availability and scalability challenges, as well as supply chain bottlenecks and questions over the sustainability of feedstocks.

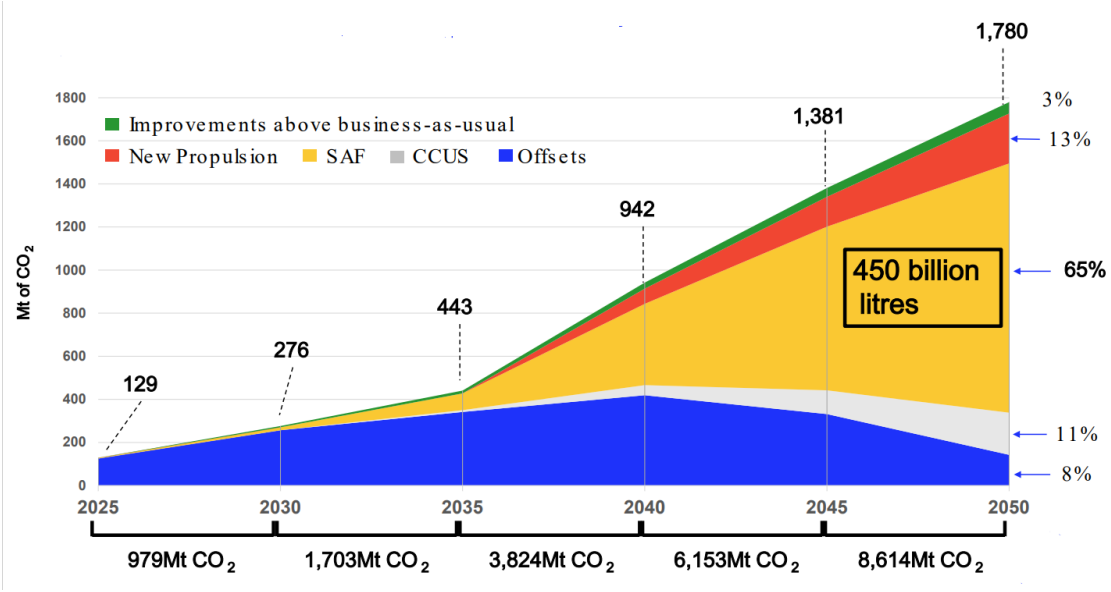
SAF is very similar to conventional kerosene, but it delivers substantially lower GHG emissions than Jet A-1: in some cases up to 80% (46).

In the lead-up to 2030, we expect to see a surge in the supply of fuel made from alternative biogenic and non-biogenic waste feedstocks including: agricultural residues, used tyres, and municipal solid waste. These will be transformed into SAF through more advanced processes such as alcohol-to-jet, pyrolysis, and gasification. GHG savings are more complex to assess in cases where non-biogenic waste is used, though other benefits can be realised such as avoided waste to landfill.

The future cost competitiveness of SAF with Jet A-1 and the timescale at which this is achieved depends heavily on government regulation when pricing CO_2 emissions appropriately, learning the effects, and ancillary instruments such as “book and claim” markets for SAF usage (47).

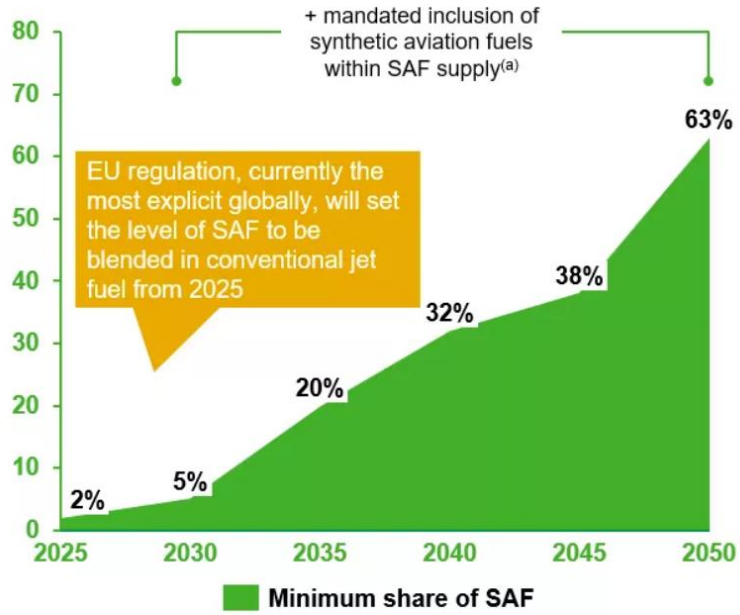
The potential impact and prospects for SAF are detailed in Figure 22 below.

Figure 22. SAF in Net Zero 2050



Source: AFI Sustainable Aviation Fuel Workshop (ICAO)

Figure 23. Minimum share of SAF across EU airports from 2025



Source: (1) European Commission, Proposal for a Regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport (2021) (2) IATA, Fact Sheet: EU and US policy approaches to advance SAF production 2021, UK Government, Mandating the use of sustainable aviation fuels in the UK 2021, other publicly available sources

Today, the overall cost of jet fuel is USD 0.7–0.8 per litre, while the cost of SAF is USD 1.4–1.6 per litre, currently double the price of conventional jet fuel.

3.5. Promising projects for carbon offset by key sectors in Ukraine

A carbon market and offsetting practices have not yet been fully implemented in Ukraine.
There are some basic prerequisites that must be fulfilled for carbon market development. More details on prior experience, state, and the outlook of the carbon market in Ukraine are described in section 2.8.

However, in the context of the prospects for the development of such a market, it is worth considering the potential of the Ukrainian economy to implement decarbonisation projects, including the needs of aircraft operators within CORSIA.

It should be noted that the information described below on the potential of carbon offsetting projects potential is undermined by the consequences of the Russian war on Ukraine. Therefore, for a fair understanding of the potential of the Ukrainian economy to develop decarbonisation projects for the issuance of carbon credits, stabilisation of the situation in Ukraine is necessary. That is why the listed types of projects are generally those that are preliminary in nature.

In order to determine an economic sector's potential for reducing emissions and CORSIA eligible carbon credits issuance, the following information sources were analysed:

- National policies, strategies, and concepts for decarbonisation, sectoral strategies ((48) (49) (50), (51)).
- Results and materials from an update to Ukraine's Nationally Determined Contribution under Paris Agreement ((52) (53)).
- CORSIA Eligible Programmes project portfolio.
- Interviews with stakeholder groups representatives.
- Sectoral reviews, analytical reports (54), etc.

Presented below are a preliminary list of economic sectors and prospective types of projects for carbon credits generation suitable for CORSIA:

Priority Sectors:

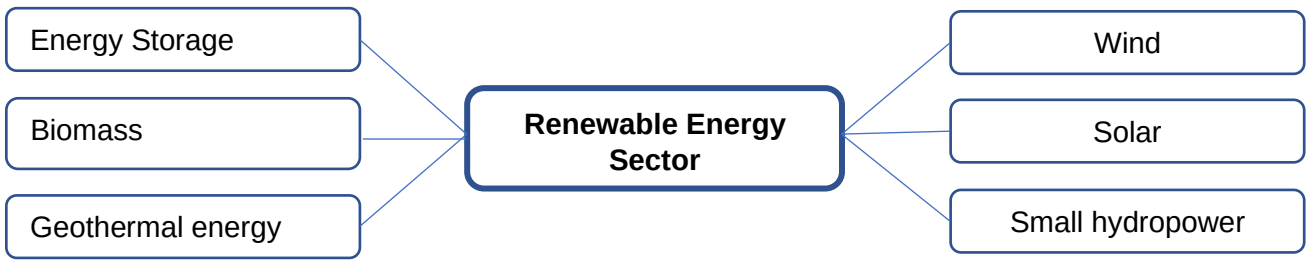
- **Renewable energy**

Overall emission reduction potential for Ukraine in the electricity sector for 2021–2030, based on the Combined NDC Scenario, constituted 391.2 million tonnes of CO_2 ((52) (53)). A significant part of the potential reduction in CO_2 emission could be generated via renewable energy productions projects.

For voluntary carbon markets, the average price for credits issued by renewable projects constituted USD 1.08 in 2020 and USD 2.26 in 2021 (54).

Opportunities:	**Obstacles:**
Considerable expertise in the sector for project development	The need for large-scale projects to generate a significant volume of credits (economies of scale) and reach economic feasibility for credit verification
High demand for new RES generation to balance the needs of the power system	High level of competition in the carbon market, relatively low price for credits
Feed-in tariff (at least until 2030) in RES generation	Requires favorable natural conditions for acceptable efficiency
The vast majority of CORSIA approved certification systems have methodologies for the verification of RES projects	Limitation on grid-connection imposed by the regulators

Figure 24. Perspective projects.

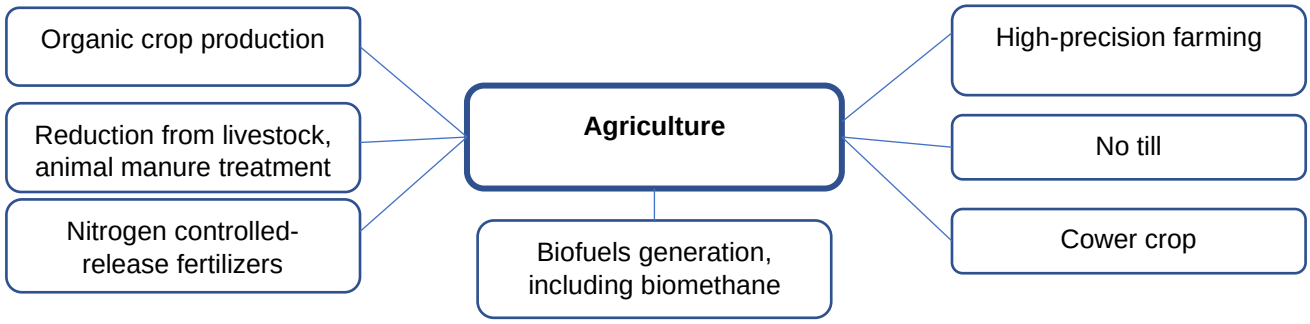


- **Agriculture**

Overall modelled emission reduction potential in the Ukrainian Agriculture and Forestry sector is based on a combined modelling Scenario under NDC for 2021–2030, estimated to be 66.4 million tonnes of CO_2 ((52) (53)). Agriculture is one of the most prominent sectors of the Ukrainian economy for carbon credit generation. On voluntary carbon markets, the average price for credits issued was USD 10.38 USD in 2020 and USD8.81 in 2021 (54).

Opportunities:	Obstacles:
Significant potential for project implementation (large land bank, large-scale livestock)	Complex and expensive verification process
Market players are already implementing emission reduction projects, have experience with verification systems and are interested in implementation	Credit generation potential has already been partially lost due to the implementation of emission reduction projects
Readiness and expertise to transition to new technologies	-

Figure 25. Potential projects.



- **Forestry**

Forestry provided between 50.6–66.4 million tonnes of CO_2-equivalent of GHG that have been removed in the Forest Land category annually between 1990–2019 (55). This amount can be significantly increased in a national policy to increase of forest cover from 15.9% to 18–19% by 2033 and greater potential of forest conservation (49). On voluntary carbon markets, the average price for credits issued (not specific to CORSIA) was USD 5.40 in 2020 and USD 5.80 in 2021 (54).

Opportunities:	Obstacles:
Significant potential and demand for afforestation / reforestation of territories and forest conservation	Lack of experience in implementing of carbon credits generation projects
-	Unfinished process of industry reform, institutional unreadiness

Figure 26. Potential projects

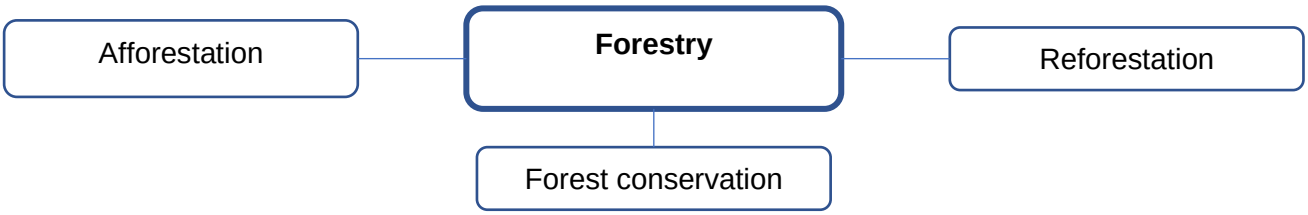


Figure 27. Secondary priority sectors

Chemical Processes / Industrial Manufacturing, Conventional Energy

- Emission reduction technologies application
- Fuel switching projects
- Energy efficiency improvements
- Methane emissions recovering during production of natural gas, crude oil, and coal
- Recovery and decomposition of halocarbons and sulphur hexafluoride
- Hydrogen Deployment

Buildings

- Improving buildings' energy performance

Transportation

- Electric vehicles
- Transport fleet renovation
- Improved transportation infrastructure

Waste Disposal

- Fuel extraction (landfill biogas extraction and combustion)
- Sewage wastewater treatment
- Waste recycling

Household/ Community Devices

- High-efficiency cogeneration deployment
- Fuel switching
- Energy efficiency measures

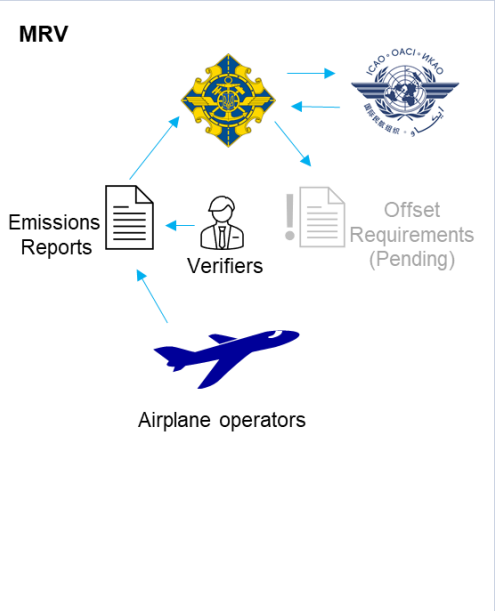
3.6. Proposed carbon offset model for application in Ukraine

The following concepts are presented in this section:

- General overview of current CORSIA implementation status.
- General concept of proposed offsetting model for aeroplane operators in Ukraine.
- General overview of carbon offsetting projects' (CORSIA Eligible) implementation scheme in Ukraine.
- Key issues related to carbon offsetting model implementation, suitable for CORSIA.

General overview of current CORSIA implementation status

It must be noted that the impact of regulations to combat the spread of COVID-19 and then the Russian war on Ukraine have had a significant impact on the amount of GHG emissions produced by the aviation sector. These unforeseen changes may therefore have an impact on aeroplane operators' carbon offset obligations.



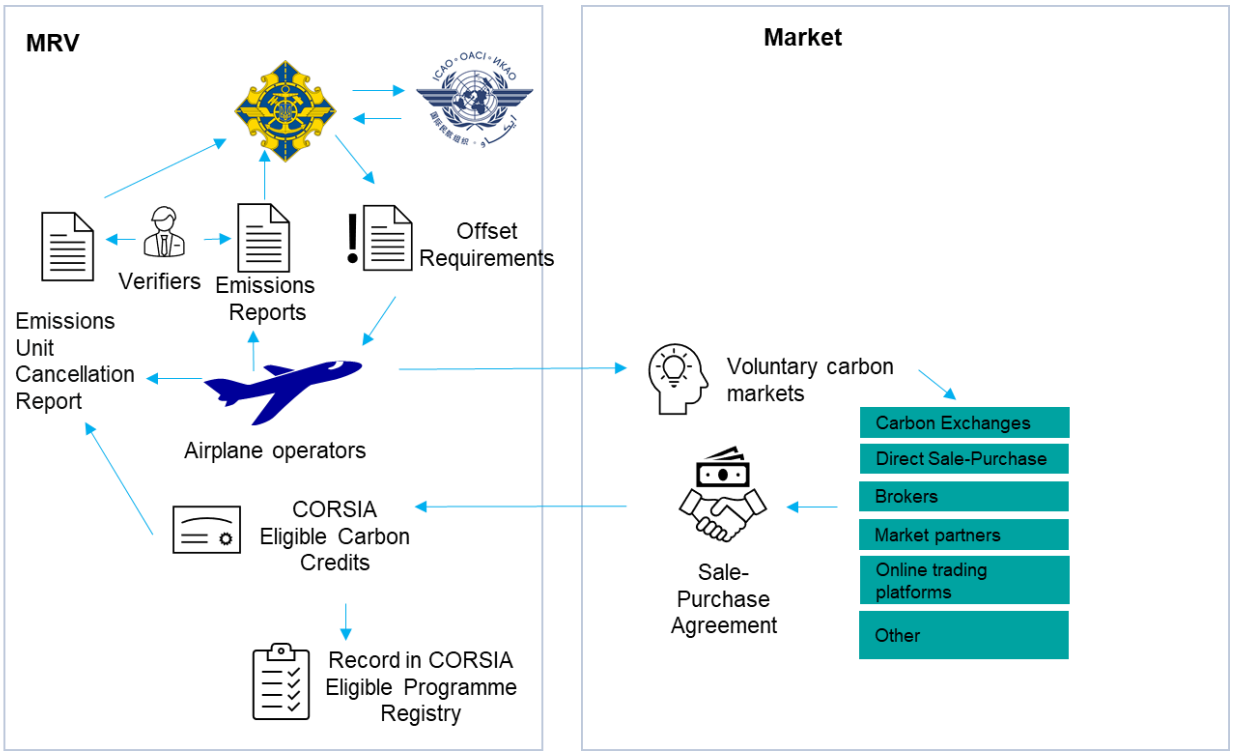
As yet, the implementation status of the CORSIA offsetting scheme in Ukraine is as follows:

- An MRV system was implemented in Ukraine according to CORSIA requirements.
- Aviation Regulations of Ukraine "Technical requirements and administrative procedures for monitoring emissions by civil aircraft operators" were approved in 2019.
- Eight Ukrainian aircraft operators report to SAAU on emissions via Emission reports in accordance with approved plans for monitoring emission.
- Aeroplane operators use Fuel Monitoring Method B since they have historically used a similar calculation method.
- Emission reports are verified by certified verifiers from abroad (Germany, Singapore, France). There are no Ukrainian-based certified verifiers accredited by CORSIA.
- After SAAU receives verified Emission reports from aeroplane operators, it sends the State report to ICAO.

- The following steps are:
  - ICAO provides input data for SAAU on calculations of the annual amount of CO_2 emissions required to be offset.
  - SAAU calculates the annual operator's final CO_2 offsetting requirements based on the reported data and inform aeroplane operator.
- Due to a decrease in the number of international flights, it is likely that Ukrainian-based aeroplane operators will not incur offset obligations over the next few years.

General concept of proposed offsetting model for airline operators in Ukraine

The following concept of offsetting aeroplane operators' emissions within the CORSIA programme in Ukraine has been proposed:



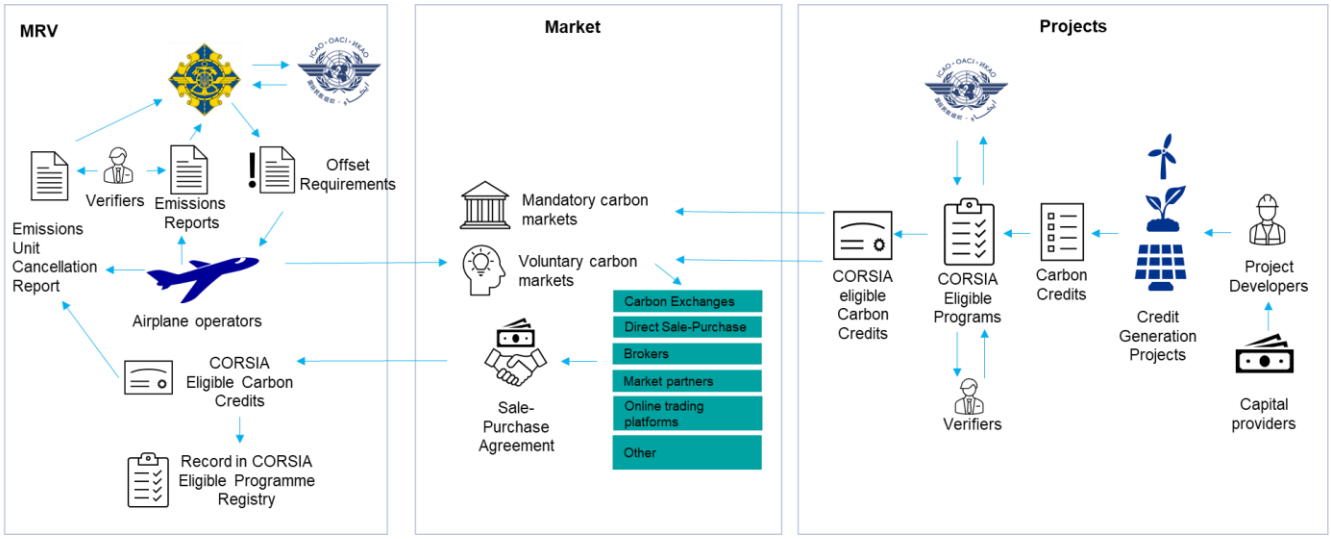
Scheme depicted on the left represents key features of the most efficient way for CORSIA offsetting requirements fulfillment for Ukrainian-based based aeroplane operators.

- After offset requirements were determined, the next step for the company is to find the carbon credits on the market that they can purchase in order to offset their emissions.
- Carbon credits can be purchased on special carbon exchanges, marketplaces, directly from developers, or directly through CORSIA approved Programmes exchange platforms.
- Aeroplane operator needs to verify purchased carbon credits to make sure that they represent actual reduction (avoidance) of GHG emissions.
- The next step is to cancel such CORSIA Eligible Emissions Units within a registry designated by a CORSIA Eligible Emissions Unit Programme and provide to the SAAE verified Report on Emissions Units Cancelation.

General overview of carbon offsetting projects (CORSIA Eligible) implementation scheme in Ukraine

The next step in the implementation of CORSIA is the development of Ukrainian projects for decarbonisation projects that will generate credits for use in the offsetting under CORSIA.

A conceptual diagram is presented below:



- As of now there is no large representation of Ukrainian-based offsetting projects on carbon markets. Ukrainian economy has potential to decarbonisation and hence carbon credits (emission units) generation.
- A sufficient and effective legal, financial and institutional infrastructure needs to be developed in order to be able to apply the carbon offsetting of CO_2 emissions mechanism in Ukraine.
- Project developers and owners interested in emission units generation and subsequent sale on carbon markets should consult CORSIA requirements on emission units, comply with respectful standards on project development, ensure verification and registration of emission units generated.
- Ukrainian-based CORSIA Eligible Emissions Unit Programme will be most likely viable only in long-term perspective, after full-scale successful implementation of CORSIA, development of Ukrainian offsetting projects and extensive experience and expertise of market participants.

Key issues related to carbon offsetting model implementation, suitable for CORSIA

The main issues affecting the implementation of offsetting practices in Ukraine are discussed in table below.

Table 7. Key features of CORSIA implementation related issues

Issue	Gaps, obstacles	Opportunities and incentives	Needs
Aeroplane operators:			
Impact of COVID-19 and war on air transport and related offsetting obligations	Reduced flight intensity of Ukrainian and international airlines due to COVID-19 and the war may lead to low demand for emission units due to the low level of offsetting requirements	Reducing airlines costs of for the purchase of credits, reducing of credits prices	Stabilisation of the situation, the end of the war
Request from Ukrainian aeroplane operators to invest in emission units from offset projects based in Ukraine	Projects that generate emission units for the CORSIA offsetting requirements fulfillment are not implemented in Ukraine	Ukrainian economy has the potential to development of projects for the generation of emission units	Start of offset projects implementation for offsets in future periods
Interest of aeroplane operators in offsetting, including voluntary offsetting	• Low interest in voluntary offsetting of emissions. • Lack of offsetting experience. • Additional costs for the purchase of offsets. • Lack of regulatory obligations for offsetting.	Participation in offsetting may be used by the aeroplane operators in marketing and advertising campaigns and brand promotion	Creation of incentives for offsetting
Regulators (The Government of Ukraine: Sectoral Ministries, SAAU):			
Infrastructure for the launch of the carbon market in Ukraine	• Institutional and legal prerequisites are not provided. • The regulatory framework is not prepared for the full-scale trading of carbon credits. • Offsets as a phenomenon is not introduced.	• An adequate level of preparation for the launch of the market will contribute to the efficient trading of carbon credits, both for the purposes of CORSIA and for other needs. • Carbon market establishment will allow to raise funds from international carbon markets, will contribute to the country's reputation Will contribute to the development of other markets and instruments related to sustainable development.	Provide institutional, administrative, and financial infrastructure for market development
Plans for decarbonisation of the economy	National policies to achieve carbon neutrality do not include launch of offsetting	Offsetting projects can accelerate and simplify the processes of fulfilling commitments and obligations to reduce emissions, accelerate overall green transition	Development of mechanisms to support offset projects

Project developers and owners:			
Experience in implementation of decarbonisation projects	After the completion of the mechanisms of the Kyoto Protocol, projects on the generation of carbon credits did not become widespread	• Players in certain sectors of the economy (energy, industry, agriculture) have experience in implementing large-scale emission reduction projects, have experience working with certification systems and have the potential to reduce. • Opportunities of raising funds, creating a new market and market pioneering.	• Determination of the emission reduction potential. • Raise awareness.
Expertise for certification, verification, auditing, and support of offsetting projects	Absence or insignificant presence on the market of organisations with expertise in certification, verification, auditing, and support of offsetting projects implementation	A new market and growth potential for Ukrainian and international companies	Involvement of qualified market players for high quality offsetting
War risks	Military operations, physical security risks, interruptions in the supply of energy carriers, exchange rate fluctuations, restrictions on activities, limited sources of financing, mobilisation, and other risks endanger the implementation of offset projects	Post-war recovery may facilitate offsetting projects and their entry into the international carbon market, given potential investor interest in recovery	Stabilisation of the situation
Verifiers:			
Representation of verifiers in Ukraine	Ukrainian airlplane operators use the services of foreign CORSIA certified verifiers, including due to the absence of Ukrainian companies	• A source of income for Ukrainian companies that will be able to provide verification services both for domestic and foreign operators. • The expertise of Ukrainian companies will contribute to GHG emissions reduction in other sectors and initiatives (except CORSIA).	Verification services market expansion, reducing prices reduction due to higher competition level
Verification costs	The cost of the verification process may call into question the economic feasibility of project implementation, especially for small-scale projects		
CORSIA Eligible Emission Units Programmes:			
CORSIA Eligible Emission Units Programmes	The list of CORSIA Eligible Emission Programmes is quite limited; The process of approving new programmes for use in CORSIA is complex and lengthy, requiring a high level of program organisation quality	• The creation of a national program that will meet the requirements of CORSIA and other offsetting systems which could perform the functions of a sales platform. • Such Program will contribute to the development of the own market of carbon credits, attracting funds from international carbon markets.	• Establishment of legal, institutional and financial infrastructure for the operation of such program. • Pool of implemented projects for launching such a program.

Finance:			
Project financing	• The need to raise financing for project implementation; emission units generation and their sale is possible over some time after the project implementation. • Limited sources of funding due to the war, unfavorable financing conditions. • Currency risks.	• Financing projects with borrowed funds. • Financing projects from the company's own funds.	• Need to attract and return funds for project implementation. • Need for stabilisation of the economic and political.
Carbon credit prices fluctuation	• Relatively low prices for emission units, together with high costs for the verification process, inhibit the entry of Ukrainian companies that could generate emission units into the carbon markets • The unpredictability of prices at the time of emission generation calls into question the economic feasibility of investing in offsetting projects	Fulfillment of offsetting obligations within the first few next years may stabilise emission units price fluctuations	• Implementation of a transparent market, convenient trading tools. • Adaptation to market conditions.

3.7. Mechanism of pilot carbon offsetting project implementation

Pilot Offset Project Implementation

The Ukrainian economy has significant potential for decarbonisation, which provides the basis for launching offsetting projects. In this section implementation process of biogas production project and as one of the potential types of emission reduction projects for offsetting is considered.

Biogas offsetting potential

In 2020, 15 billion cubic meters of biogas and 3 billion cubic meters of biomethane were produced in the EU. According to REPowerEU plan released in March 2022, European Union is going to increase the production of biomethane to 35 billion cubic meters by 2030.

According to UABIO report, in Ukraine about 260 million cubic meters of biogas were produced in 2021. By the end of 2021, at least 77 biogas plants were built and had operating experience in Ukraine (56).

Biomethane is a close analogue of natural gas, and it can be used for the production of electricity and thermal energy, as fuel for transport, as well as in everyday life and as a raw material for the chemical industry etc.

Biomethane can reduce significant amounts of GHG emissions. As reported by European Biogas Association, when fossil fuels are replaced by biomethane, this change usually gives over 80% GHG emission reduction (some pathways can give up to 200% emission reduction).

According to European Biogas Association report, over 80% of biogas produced today in EU is being used for local electricity and heat generation, rather than upgraded to biomethane and injected into the gas grid. Greater societal benefit can be achieved by transitioning biomethane to the gas grid.

Ukraine has a powerful natural gas transit system, which is connected to the EU natural gas grid. Europe also has a developed gas network with a total length of 2.2 million kilometers. More than 60% of European biomethane producers are currently connected to this grid. With the help of developed and functional gas market and infrastructure biomethane can be traded physically or virtually.

According to the projections of the World Bank the demand for the biogas will significantly increase by 2050. For the details, please, refer to the table 8.

Table 8. Biogas demand projections

			Stated policies scenario		Announced Pledges Scenario		Net Zero Emissions by 2050 Scenario	
Billion cubic meters	2010	2021	2030	2050	2030	2050	2030	2050
Biogas demand	**22**	**35**	**70**	**244**	**123**	**339**	**199**	**404**
Biogas	21	27	46	102	58	142	59	138
Biomethane	1	8	24	143	65	197	140	257

Source: World Bank

According to UABIO, the biggest biogas projects that are being developed in Ukraine have installed capacity of 10-20 MW and need investments of 2-2.5 thousand EUR per each kWh of installed capacity (56).

As reported by UABIO, in case if Ukrainian biogas project sells generated electricity by a feed-in tariff, the payback period of such a project can be from 4 up to 7-8 years. However, these large-scale projects have a limited potential for the construction, and efficiency of existing biogas projects in Ukraine often does not exceed 50-60% (56).

Another prospective way to use the biogas is to use it for biomethane production. This process involves additional expenses for the separation of methane and carbon dioxide. However, biomethane cost more than biogas and it is more energy efficient. Biomethane opens new possibilities, including:

- Electricity and heat generation from biomethane using a gas transmission network.
- Biomethane storage in the natural gas grid for the electricity generation at peak load.
- Biomethane can be used as a motor fuel for agriculture and municipal transport.
- Biomethane can replace natural gas.
- Biomethane can be exported to the EU using the National Register of Biomethane Production and Consumption.

According to UABIO, the total commercial biomethane cost varies from 313 to 1136 EUR/1000 m^3. The main components of biomethane cost are raw materials cost, installation capacity and the logistics to the final consumer costs (56).

Regarding the volume of emission reduction, biogas production projects show high effectiveness in emission reductions.

For instance, 317 manure-based anaerobic digesters reduced greenhouse gas emissions by 5.29 million metric tonnes of carbon dioxide equivalent ($MMTCO_2eq$) in the United States in 2020, due to 4.44 $MMTCO_2eq$ direct methane reductions + 0.83 $MMTCO_2eq$ emissions avoided.

At the same time, an increased reduction from direct (5.07) and indirect emissions (0.88) of 5.95 $MMTCO_2eq$ was achieved from livestock farms-based anaerobic digesters in 2021 (57).

Total emission savings through the use of biogas and biomethane can reach up to – 240% compared to fossil fuels (58).

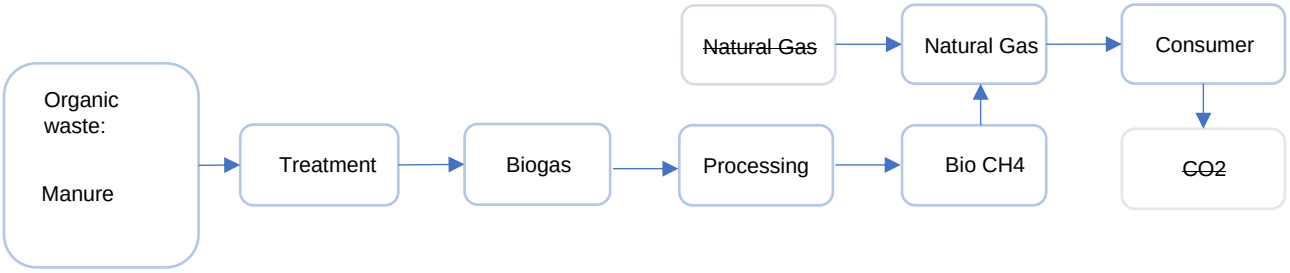
Model project considered

Below described key characteristics of the model project considered for the purpose of CORSIA offsetting potential consideration.

Table 9. Model project key features

Parameter	Value
Type of project	Greenfield, new project construction for biogas production for displacing natural gas in a natural gas distribution system, which includes transportation by trucks and/or pipelines, with upgraded biogas (biomethane)
Project scale	Large scale, more than 60 000 tCO_2 emissions reduction per annum
Productivity	Up to 10 mln m^3 of biomethane annually
Raw materials	Manure

Figure 28. Model project production scheme



Viable certification systems (programmes)

In order for emission reductions to be converted into carbon credits and sold, it is necessary to ensure the project is compliant with the requirements of certification systems throughout the project's life cycle. The project developer, before starting the development of the offsetting project, must choose the framework approach and standards by which the project will be implemented.

For CORSIA purposes, there is a limited number of programmes under which a project can be certified due to different focus, scope, availability of standards, geography of program coverage, etc. The table below describes the possibility of Ukrainian project certification under CORSIA programmes.

Table. 10. CORSIA Eligible Programmes application availability

Program	Can Ukrainian projects be registered under the program	Comment
American Carbon Registry (ACR)	No	Projects from around the world can be registered under ACR if they meet ACR-approved methodology criteria. Some sectors and methodologies require a narrower geographic scope (e.g., United States only).
Architecture for REDD+ Transactions (ART)	No	The ART is available to any tropical forest national or subnational jurisdictions that meet The REDD+ Environmental Excellence Standard (TREES) requirements.
China GHG Voluntary Emission Reduction Program	No	Both generation and purchase of credits is usually being made by domestic participants of the market.
Clean Development Mechanism (CDM)	No	Ukraine is listed in Annex I under UNFCCC, but CDM projects are located in developing non-Annex I countries. Additionally, Ukraine doesn't have a designated national authority (DNA), which is the organisation that is responsible for authorisation and approval of participation in CDM projects.
Climate Action Reserve (CAR)	No	Only projects within the United States and some project types from Mexico are eligible to be registered with the Climate Action Reserve (CAR).
Global Carbon Council (GCC)	Yes	There is no public data that Ukrainian projects were included in program registers
The Gold Standard (GS)	Yes	There is no public data that Ukrainian projects were included in program registers
Verified Carbon Standard (VCS)	Yes	There is no public data that Ukrainian projects were included in program registers=

Considering the above, it is advisable to consider the following certification systems when developing the project:

- Global Carbon Council (GCC).
- The Gold Standard (GS).
- Verified Carbon Standard (VCS).

Among abovementioned Gold Standard is one of the most well-known certification schemes.

Gold Standard and biogas projects

Gold Standard was established in 2003 by World Wildlife Fund and other international NGOs to ensure that projects reduce carbon emissions and ensure environmental integrity and to contribute to sustainable development of CDM (Clean Development Mechanism) and JI (Joint Implementation) offset projects.

There are few types of biogas projects that are eligible for the use under CORSIA (Table 11), listed in Gold Standard public registry: biogas – co-generation (as of now there is no CORSIA eligible projects), biogas-heat and biogas – electricity.

Table 11. Gold Standard CORSIA eligible emission unit projects

Type of project	Biogas – heat	Biogas – electricity
Number of projects	11	5
Country	India – 8 projects Kenya – 2 projects Indonesia -1 project	China -3 projects India -1 project Thailand -1 project
Type of methodology	• GS TPDDTEC[3] v 1. • GS TPDDTEC v 2. • GS TPDDTEC v3.1 • AMS-I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User • Gold Standard for the Global Goals	• ACM0010 GHG emission reductions from manure management systems • AMS-I.E. Switch from Non-Renewable Biomass for Thermal Applications by the User • ACM0014 Treatment of wastewater

Project developers have multiple options for certification of the project under Gold Standard:

- Originate a project.
- Transition an existing project from the UN Clean Development Mechanism or other standards to Gold Standard.
- Certify the sustainable development impacts of a project issued under another standard.

For the purpose of this review of the model project development option of new project certification is considered.

[3] TPDDTEC - Technologies and Practices to Displace Decentralized Thermal Energy Consumption.

General Gold Standard requirement

As of now only Gold Standard verified emissions reductions (VERs) with specific limitations are eligible under CORSIA, with the exclusion of some of the activity and/or unit types.

General framework of Gold Standard certification process includes the following requirements for model biogas project, listed in Table 12.

Table 12. Applicable requirements for model project under Gold Standard.

Gold Standard Document	Description	Model project related requirements
Principles & Requirements:	Specifies scope and applicability of such Principles and Requirements, types of Gold Standard Certification outcomes, General Eligibility Criteria applied to all projects seeking Gold Standard Certification, states Eligibility Principles and Requirements, describes Project Cycle and Project Documentation and Technical Requirements.	Shall be applied
Activity Requirements	Specifies related to the project type requirements. If no Activity Requirements exist for the proposed project type, then the Requirements shall be as per **Principles & Requirements**	There is no project specific Activity Requirements - **Principles & Requirements** shall be followed
Impact Quantification Methodology	Methodologies and/or tools that must be applied to quantify SDG impacts from a specific project type. Multiple methodologies may be applied in one project. There are following instruments to be used: • **SDG Impact Tool** - standardised template to monitor SDG impact of the project. • **Eligible methodologies for Gold Standard** for the Global Goals **-** list of all the methodologies eligible for certification under Gold Standard for the Global Goals	**SDG Impact Tool** shall be applied For instance, **AM0024 Natural gas substitution by biogenic methane produced from the anaerobic digestion of organic waste** standard may be applied
Related Product Requirements	For the purpose of CORSIA eligible Verified Emission Reductions generation there are GHG Emission Reductions & Sequestration Product Requirements	Shall be applied

Described above is a general description of Gold Standard document that shall be followed for project certification. More specific and detailed list of requirements should be thoroughly investigated.

- **Impact Quantification Methodology**

One of the crucial elements for biomethane project certification is a methodology used for project. In particular Clean Development Mechanism ACM0024 methodology in one of the suitable methodologies available for various types of biogas projects (Annex 1).

Table 13. Model project applicable methodology

Reference	Title of methodology	Typical Project activity
ACM0024	Natural gas substitution by biogenic methane produced from the anaerobic digestion of organic waste	This methodology applies to project activities where organic waste is treated by anaerobic digestion and biogas is upgraded and used to replace natural gas. The project activity may claim emission reductions for displacing natural gas in a natural gas distribution system, which includes transportation by trucks and/or pipelines, with upgraded biogas

This methodology is applicable to projects on processing and upgrade of biogas to the quality of natural gas with following distribution of it as energy via natural gas distribution grid. As the source of biogas can be organic waste (manure, liquid waste) which through anaerobic decomposition generate biogas.

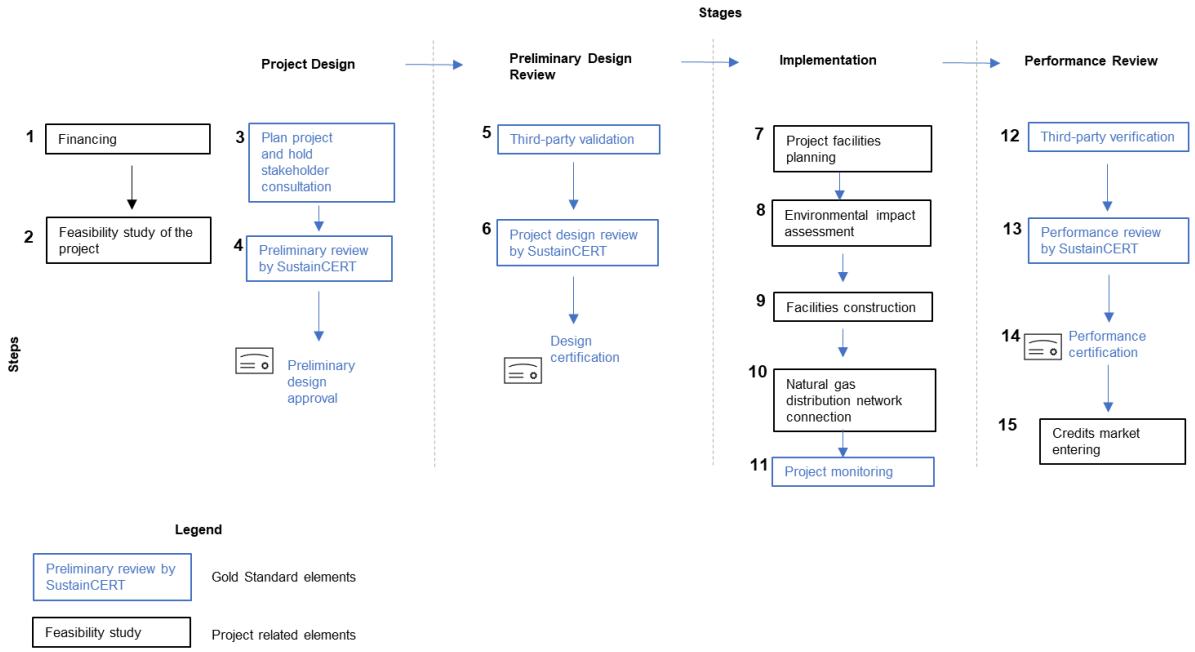
This methodology provides tailored instruction and requirements regarding specifics of:

- Overall project design requirements, terminology, etc.
- Baseline methodology:
  - Project boundaries.
  - Selection of the baseline scenario and additionality demonstration.
  - Baseline emissions calculations.
  - Project emissions calculations.
  - Leakage calculations.
  - Emission reductions calculations, etc.
- Monitoring methodology.

Project implementation and certification process

An approximate typical process of project implementation from certification is considered here, in accordance to the Gold Standard mechanism, taking into account the general needs for the implementation of the model project in Ukraine, as depicted on Figure 29.

Figure 29. Key model project implementation elements



Step 1: Financing

Stakeholders involved: Banks, international financial institution (IFI).

Description: For biogas project financing was took into account loans that could be issued by banks represented in Ukraine and international financial institutions (IFI). It is important to emphasize that the financing programmes listed below are current as of the start of a full-scale invasion. Current financing terms may not apply.

For instance:

- **EBRD:**

EBRD loans to the private sector projects usually start from a minimum of EUR 3 million up to EUR 250 million, average amount is EUR 25 million (59). EBRD financed construction by "MHP Group" of a greenfield 10 MW biogas plant in Vinnitsa region of Ukraine in 2017 with loan of EUR 25 million. It was expected that GHG emission reduction will be approximately 85,500 tonnes of CO_2 equivalent yearly (60).

- **IFC:**

International Financial Corporation has been investing for a long time in Ukrainian projects. In FY2021 IFC Portfolio exposure for Ukraine amounted USD 327 million, while in FY2022 it is USD 274 million (61). IFC finances projects through loans from their own account, typically for 7 to 12 years. It invests in projects that support climate change mitigation, including on biogas. For instance, in 2021 IFC USD20 million loan was announced on construction of two new pig farms, including the installation of biomass boilers and manure disposal systems for JV LLC “Nyva Pereyaslavshchyny”. Also, IFC supported Ukrgasbank to boost financing for green energy projects.

- **Nordic Environment Finance Corporation (NEFCO)**

NEFCO has several financing options, including the Clean Production program - a loan from an investment fund or a share in equity. Each of the options is designed for a specific category of business, taking into account the scale of the project and, accordingly, the amount of the expected loan. In average, all programmes have a starting interest rate of 6% in EUR, but the actual one should be specified additionally.

There are other finance providers for large scale biomethane production projects mainly from International Financial Organisations. Also, there are some Ukrainian banks that also have been providing loans for large scale projects. For each such project funding options should be investigated and agreed with finance provider.

Expected expenses: Depends on project scale. Large scale project will cost approximately from USD 15 mln.

Duration: Unknown, depends on economic performance of the Project Developer.

Step 2: Feasibility study

*Stakeholders involved***:** Consultants with experience in Gold Standard project certification, experts in biogas and biomethane production technologies.

Description: Probably one of the most important stages is the preparation of the technical and economic justification of the project. The success of the project depends on the successful calculation of possible technologies, the economic effect, and the generation of carbon credits. Such a feasibility study should consider at least the following aspects:

General prerequisites of the Project	Human resources
Raw material and supplies	Implementation planning
Location, site, and environment	Budgeting and financials
Engineering and technology	Financial analysis and investments appraisals
Organisation and overhead costs	Gold Standard implications

All the necessary requirements for the project execution process, stipulated by the Gold Standard requirements and the relevant methodologies applicable to the project, must be considered in detail, and compliant with eligibility criteria and other corresponding requirements. This work should be done thoroughly as it directly influences potential of the successful project certification and further project carbon credits issuance.

Expected expenses: Requires further investigation. Price depends on qualification of consultancy services providers, namely consultants on CORSIA Eligible Programmes, scale of the project and other specifics.

Duration: Approximately 3-6 months.

Output: Feasibility study of the Project.

Step 3: Plan project and hold stakeholder consultation

Stakeholders involved: Project Developer, project stakeholders, experienced third-party consultant (Consultant) or expert personnel of Project Developer (Personnel).

Description:

Project Developers should ensure performing the following, prior to the project execution start, specified in Gold Standard Principles and Requirements documents:

- Confirm the basic project design compliance with Gold Standard provisions.
- Assess against Gold Standard Safeguards, detailed description of requirements are stated in "Safeguarding Principles & Requirements" document.
- Estimate climate and sustainable development impacts of the projects via approved tools and instruments (SDG Impact Tool, approved methodologies, other applicable).
- Prepare a Key Project Information note summarizing the abovementioned.

Materials of this planning stage should be incorporated into Draft Project Design Document (PDD).
PDD shall be prepared in accordance with PDD Template and PDD Template Guige.
Project developer shall also hold a Gold Standard Stakeholder Consultation Meeting. Detailed requirements are described in Gold Standard "Stakeholder Consultation and Engagement Requirements document.

Expected expenses: Project developer must open a registry account and pay the annual registry fee that cost 1000 USD to start certification process.

Duration: Approximately 2-3 months.

Output: Preparation of Stakeholder Consultation Report and Draft Project Design Document.

Step 4: Preliminary review by SustainCERT

*Stakeholders involved***:** SustainCERT, Personnel/Consultant.

*Description***:** Project developer must ensure preparation of the following:

- Stakeholder Consultation Report.
- Draft Project Design Document, which includes:
  - Safeguarding Principles Assessment.
  - Estimation of climate and sustainable development impacts.
  - Monitoring Plan.
- Signed GS4GG Cover Letter.
- Signed Gold Standard Terms & Conditions.

Preliminary Review Fee must be paid. Abovementioned documents shall be passed to SustainCERT organisation for reviews of draft documentation and clarifications if needed. SustainCERT is an independent organisation official certification body for Gold Standard which was founded in 2018 by the Gold Standard Foundation.

Expected expenses: Preliminary Review Fee 900 USD.

Duration: 4 weeks.

Output: After completion of preliminary project design approval by SustainCERT the Project receives "Gold Standard Project Listed" status in Gold Standard Impact Registry.

Step 5: Third-party validation

*Stakeholders involved: V*alidation and verification body (VVB), Project Developer (Consultant/Personnel).

Description: After the Project receiving of "Listed" status project validation should be undertaken by accredited validation and verification body. Such validation consists of desk review and field visit for independent review of the Project activities compliance to the Gold Standard Requirements.

For validation process the following should be done:

- Identification, contract, and pay VVB to carry out validation. There is a list of accredited VVBs and the eligible independent third-party auditors within their organisations on Gold Standard official website.
- Provision of completed Project Design Document and relevant supporting documentation to VVB for validation.

Expected expenses: Cost of the validation process is negotiable with VVB due to specifics of the Project - country of location, type and scale of the Project, type of validation, etc. There is limited publicly available information on GS validation prices by VVB and should be additionally requested and negotiated with accredited VVB due to specifics of the Project. There are some data on expected price of 10 000 -15 000 USD for small-scale project validation.

Duration: Approximately 1-2 months.

Output: Validation opinion from VVB.

Step 6: Project design review by SustainCERT

Stakeholders involved: SustainCERT, Project Developer (Consultant/Personnel).

Description: Project developer provide verified documents and supportive materials upon validation completion to SustainCERT for reviews and clarifications and for resolutions of corrective actions where required.

Project Developer must:

- Obtain positive validation opinion from VVB.
- Submit VVB approved Project Design Document (PDD) and all relevant supporting documentation submission to SustainCERT.
- Submit VVB Final Validation Report to SustainCERT.
- Pay Design review Fee.

Expected expenses: At least USD 1000 for Design Review.

Duration: 3 weeks.

Output: Upon successful review by SustainCERT the Project receives «Gold Standard Design Certified» status in Gold Standard Impact Registry.

Step 7. **Project facilities planning**

Stakeholders involved: Design Organisation, Project Developer (Consultant/Personnel), State Authorities.

Description: Completion of the design documentation of the project, on the basis of which the construction of a biogas plant with a plant for refining biogas to the quality of natural gas should be carried out. It is also necessary to design technological solutions for connection to the gas distribution system. The design work must be performed in accordance with the regulatory documents of Ukraine, described in approved PDD and other Gold Standard documents.

Expected expenses: 1,5-2 UAH mln.

Duration: 3-8 months.

Output: Project documentation of the biogas production project, agreed and approved by the competent state authorities.

Step 8: Environmental Impact Assessment

Stakeholders involved: Project Stakeholders, Project Developer, Design Organisation, State authorities.

Description: Since the model project will have significant effects on the environment, it is necessary to conduct an Environmental Impact Assessment procedure in accordance with Ukrainian legislation. The development process can continue in parallel with the project documentation development stage.

Expected expenses: 200 000 – 800 000 UAH.

Duration: 6-8 months.

Output: Obtaining of a positive conclusion on the admissibility of the planned activity.

Step 9: Facilities construction

Stakeholders involved: Construction Companies, Project Developer, State Authorities.

Description: After receiving of a positive opinion on the Environmental Impact Assessment and receiving the approval of the project documentation, the construction stage can begin. It is important to ensure that there are no significant changes in the project execution process with the designed solutions and the agreed project design, because in the case of such changes, it is necessary to undergo changes approvals with Gold Standard.

Expected expenses: The construction of a plant with a capacity of 10 million cubic meters of biomethane per year will cost at least USD 15 million (62).

Duration: 1-2 years from beginning to commissioning.

Output: Operating biomethane production facility.

Step 10: Natural gas distribution network connection

Stakeholders involved: State Authorities, Natural gas transportation system operator (TSO), Project Developer, Customers (natural gas/biomethane), local gas distribution companies (Oblgases).

Description: The produced biomethane must be brought up to natural gas standards, and the plant itself must have access to the gas distribution network and all the necessary equipment for supplying biomethane and selling it to customers. Connection may be done through non-standard connection procedure for large scale project, in accordance with Code of gas distribution systems. Project developer shall receive technical conditions of connection and conclude connection agreement before connection of facility to the gas distribution system. Upon connection, Project Developer may become natural gas market participant and may sell produced methane for customers, both inside and outside of the country.

Expected expenses: Depend on location and productivity of the project facilities. Costs of establishing the grid connection vary in a very broad range. For instance, pipe construction and connection it to gas network may cost EUR 10,000 for project when natural gas network will be at distance 1 km and pipe can be laid without infrastructure barriers.

Duration: Unknown.

Output: Connection to natural gas distribution system.

Step 11: Project monitoring

Stakeholders involved: Project Developer (Consultant/Personnel), Project stakeholders, SustainCERT.

Description: After project commissioning, Project Developer shall monitor project and provide respectful report according to the monitoring plan approved on previous stages.

Also, Project Developer must:

- Engage continuously with stakeholders upon their concerns and reporting on such interactions.
- Submit Annual Reports in years when verification does not occur. Verification must occur at least once during a five-year Certification cycle with the first Verification completed within two years of project Implementation Date or Design Certification, whichever is later.

- Prepare a Monitoring Report when requesting verification of emission reductions. There are Monitoring Report template and Guide. Project Design Document identifies relevant monitoring indicators and/or parameters, defines monitoring approach for the aims of future Monitoring Reports.

Expected expenses: Cost of Monitoring Report preparation by Project Developer (Consultant/Personnel).

Duration: 1-2 weeks.

Output: Monitoring Report, Annual Report.

Step 12: Third-party verification

Stakeholders involved: Validation and verification body (VVB), Project Developer (Consultant/Personnel).

Description: After the Project Design receiving of "Certified" status project performance validation should be undertaken by accredited validation and verification body.

Projects must:

- Identify, contract and pay VVB to carry out verification.
- Provide completed Monitoring Report (MR) and supporting documentation for verification to VVB.
- Expected expenses: Cost of the validation process is negotiable with VVB due to specifics of the Project - country of location, type and scale of the Project, type of validation, etc. There is limited publicly available information on GS validation costs and should be additionally requested and negotiated with accredited VVB due to specifics of the Project.

Duration: Approximately 1-3 months.

Output: Positive verification opinion issued by VVB, Final Verification Report, and Monitoring Report.

Step 13: Performance review by SustainCERT

Stakeholders involved: Project Developer (Consultant/Personnel), SustainCERT.

Description: Project performance document is reviewed by the SustainCERT with clarification and corrective actions, if needed. Information upon review undertaken by the SustainCERT is publicly available on its website.

Project Developer must ensure:

- Positive verification opinion from VVB.
- Submission of VVB approved Monitoring Report and all relevant supporting documentation to SustainCERT.
- Submission of VVB Final Verification Report to SustainCERT.
- Performance Review Fee pay.

Expected expenses: At least USD1000 for Performance Review.

Duration: 3 weeks.

Output: Upon successful Performance Review the Project receives "Certified Gold Standard Project" in Gold Standard Impact Registry. Verified Emission Reductions, eligible as emission units for cancelation under CORSIA scheme can be issued.

Step 14: Credits sale

Stakeholders involved: Project Developer, Carbon credit traders, Customers.

Description: After Verification Report issuance by VVB and its review by the SustainCERT Verified Emission Reductions can be issued and listed in Impact Registry.

Sale-purchase of Credits

There are three key options for credits sale (Verified Emissions Reductions (VERs), including for the aim of CORSIA offsetting requirements fulfilment:

- **Sale through Gold Standard Project Marketplace**

Project Developer may sell its Verified Emissions Reductions (VERs) credits through Gold Standard website. Project Developer shall feature its Project listing page via application form and after Gold Standard approval. Marketplace sales are mainly focused on personal carbon footprint offsetting, while may also be purchased by Aeroplane Operators representatives for cancelation under CORSIA.

- **Direct sale for the Customer from Project Developer**

Airline Operators or intermediaries on their authorisation can find CORSIA eligible projects on Gold Standard Impact Registry. Upon selection of the project that meets requirement of the Customer it can directly contact the Project Developers to negotiate and make a purchase. After purchase, the Customer receives certificates that document purchase of the carbon credits. Such certificates are generated automatically in Impact Registry and certify retirement of credits.

- **Purchase with carbon consultant or retailer engagement**

Project developers may also conclude an agreement with intermediaries that can help in selling of credits. They form carbon credits projects portfolio and propose them for potential buyers. Gold Standard reference International Carbon Reduction and Offset Alliance (ICROA) Accredited organisations as carbon offset providers under this sale-purchase model.

Carbon Credit Prices:

There is considerable spread in carbon credit prices due to carbon credits sale-purchase publicly available data, taking to account nature of the model project considered.

Table 14. Gold Standard Marketplace minimum price for Verified Emission Reductions

Project Type	Minimum price (USD) per Gold Standard VER (tCO2e)
Household biogas	19
Biomass/Biochar	11
Cookstove	15
Energy efficiency - community focused	13
Forestry	18
Geothermal	12
Run-of-river hydro	10
Solar	12
Safe water supply	12
Waste Management	10
Wind	10

Source: The Gold Standard Marketplace

For instance, there is a minimal price for carbon credits for various types of projects, defined by the Gold Standard that are sold via Gold Standard Project Marketplace. Should be noted that 85% of proceeds from purchase through Marketplace go directly to Project Developer, while 15% are withdrawn to cover foreign exchange rates, service charges and the administrative costs. Payments may be carried out via PayPal and direct bank account transaction (for purchase above 5000 USD such option is mandatory). Project Developers may increase prices above this minimum.

As project dealing with organic waste biogas production with further upgrade to natural gas quality, it is most likely that project will be classified as Waste Management project. Thus, the price for carbon credits generated from model project may potentially start at least 10 USD per credit.

Also, there is information regarding CORSIA eligible credits prices to be significantly higher than average market price. For instance, for Waste Disposal projects weighted average price in 2021 constituted USD 20.67 per credit with considerable price spread of USD 45.40 per credit.

Table 15. Carbon Market Prices of CORSIA-eligible Carbon Credit Transactions by Project Category.

	2020		2021 (through Nov 30th, 2021)	
Project Category	Weighted Average Price (USD/tCO_2e)	Price Spread Between Min & Max (USD/tCO_2e)	Weighted Average Price (USD/tCO_2e)	Price Spread Between Min & Max (USD/tCO_2e)
Energy Efficiency / Fuel Switching	See Other	See Other	USD 2.52	USD 14.01
Forestry and Land Use	USD 9.35	USD 17.70	USD 11.76	USD 16.00
Renewable Energy	USD 1.28	USD 18.94	USD 1.19	USD 18.06
Waste Disposal	**See Other**	**See Other**	**USD 20.67**	**USD 45.40**
Other	USD 4.25	USD 44.79	USD 18.92	USD 15.32
All Categories	USD 4.89	USD 46.94	USD 3.08	USD 46.94

Source: Ecosystem Marketplace (63)

On the other hand, prices for Gold Standard certified carbon credits on voluntary carbon market credits are significantly lower. For instance, average carbon credit prices constituted on average 3.94 USD per credit in 2021 (through August), while in 2020 it costed 4.57 USD and 5.27 USD in 2019, due to voluntary carbon market participants survey (64). Such prices are general and does not include specifics of CORSIA eligible carbon credits sales practice.

Table 16. Transacted Voluntary Carbon Offset Volume and Average Price by Standard

	2019		2020		2021 (through August)	
	Volume ($MtCO_2e$)	Price (USD)	Volume ($MtCO_2e$)	Price (USD)	Volume ($MtCO_2e$)	Price (USD)
Verified Carbon Standard (VCS)	44	1.74	66.1	3.76	125.6	4.17
Gold Standard	**13.2**	**5.27**	**13.9**	**4.57**	**4.9**	**3.94**
American Carbon Registry (ACR)	2.5	5.36	5.4	8.44	2	11.37
Clean Development Mechanism (CDM)	4.9	2.02	7	2.19	8.2	1.13
Climate Action Reserve (CAR)	4	2.34	2.1	4.44	4.9	2.12

Source: Ecosystem Marketplace (64)

Expected expenses: Shall be measured upon type of sale-purchase practice applied.

Duration: Depends on project life cycle and VER issuance. Potentially, project developer may issue VER annually weighed expected amount of reductions generated against the cost of verification.

Outcome: It is hardly likely to estimate potential carbon offsetting for the project with given level of detalisation.

4. Legal aspects of carbon offset model implementation

In order to be able to apply the "carbon offsetting" carbon dioxide emissions compensation mechanism in Ukraine, it is necessary to develop a sufficient and effective legal infrastructure. This includes a logically coordinated, dynamic system of unified legal terms and conditions to ensure effective legal regulation of public relations.

A CO_2 offset mechanism is the cancellation of all or part of the CO_2 emitted by an activity in one sector by preventing/limiting or reducing CO_2 emissions by someone else in another sector. Offsetting does not result in an overall reduction in emissions, but simply balances emissions created in one sector by reducing emissions in another sector.

Offset mechanism under CORSIA is the cancellation of the calculated by the State CO_2 emissions from international flights between participating states by the aeroplane operators to which it is attributed in a quantity equal to its total final offsetting requirements for a given compliance period through purchase and cancellation of the eligible emission units generated by projects that reduce emissions in other sectors. Where “cancellation” means the permanent removal and single use of eligible Emission units withing eligible Emissions Unit Programme designated registry such that the same emissions unit may not be used more than once.

Main components of CORSIA offset infrastructure include the following:

1. **Offset obligation.** According to Chapter 3 SARPs Annex 16, Volume IV, the obligation to offset aeroplane operator’s emissions arise only, when aeroplane operator’s international flights between participating states lead to growth of CO_2 emissions above the baseline. The State shall calculate the annual operator’s final CO_2 offsetting requirements based on the data reported under operator’s MRV obligations and taking into account emissions reductions from the use of CORSIA eligible fuels.

2. **Eligible Emission units.** CO_2 compensation takes place by purchasing so-called “carbon credits” or “emission units” or “’certificates” from companies that invest in projects to reduce CO_2 emissions. Such companies are sometimes called CO_2 offset providers.

   In order to count as compensation under the CORSIA, the purchase of credits from this particular project must meet certain criteria and requirements.

   According to Chapter 4 SARPs Annex 16, Volume IV an emission unit represents one metric tonne of carbon dioxide equivalent. Eligible Emission units, that aeroplane operator can use to meet its offsetting obligation, should also be identified as such by each Emissions Unit Programme. Such identification is carried out according to each programme’s respective Scope of Eligibility, reflection of Eligible Unit Dates and any specifications regarding activity and/or unit types, methodologies, programme elements, and/or procedural classes.

   In addition, under CORSIA Emissions Unit Eligibility Criteria, the program should define and ensure the underlying attributes and property aspects of an emission unit, and publicly disclose the process by which it does so. Therefore, Emission Unit Programmes are entities where emission units are issued through registries. Ownership transfer can be only between Emission Unit Programmes accounts. Usually, emission units issued by one program cannot be transferred to other databases or trade as paper certificate.

3. **Emissions Unit Programmes.** Programmes, that are approved by the ICAO Council to supply CORSIA Eligible Emissions Units. In order to be approved by the ICAO Counsil such programmes should have specific design elements and meet eligibility criteria. Detailed information on Emission Unit Programmes please see page 33.

   One of the most important elements of programmes is register. The programme must provide for and implement its registry system to identify its CORSIA eligible emissions units and to enable the public identification of cancelled units that are used toward CORSIA offsetting requirements if the registry does not already feature this capability. This should be done consistent with the capabilities described by the programme in its communications with ICAO, and any further requirements decided by the ICAO Council for CORSIA Eligible Emissions Unit Programme-designated Registries.

4. **Eligible Emission Units identification and tracking.** To fulfill the aeroplanes operator's offsetting requirements, the operator shall buy and:
   - cancel such CORSIA Eligible Emissions Units within a registry designated by a CORSIA Eligible Emissions Unit Programme, and
   - request each CORSIA Eligible Emissions Unit Programme registry to make visible on the registry's public website, information on each aeroplanes operator's cancelled emission units.

   Emissions Unit Programme is responsible for tracking and individual identification of emission units through it's registry. Each unit should have it's individual serial number.

5. **Validation and verification of emission reduction.** It is mechanism for confirming that this project will really lead to limiting or reducing a certain volume of CO_2 emissions. Firstly, emissions reductions should be calculated. After that emissions reductions should be measured and verified by an accredited and independent third-party verification entity. Ex-post verification of the project's emissions must be required in advance of issuance of offset credits.

6. **Reporting and verification of emission unit cancellation.** The aeroplane operator shall report to the State on the cancellation of Eligible Emissions Units by submitting to the State a copy of the verified Emissions Unit Cancellation Report for approval and a copy of the associated Verification Report. The State in its turn reported this information to the ICAO. A verification body shall conduct the verification according to ISO 14064-3:20064. The aeroplane operator and verification body shall submit their reports to the State independently.
   A verification body shall be accredited to ISO 14065:20135 and the relevant requirements in Appendix 6, Section 2 SARPs Annex 16, Volume IV by a national accreditation body, to be eligible to verify the operator's Emissions Unit Cancellation Report. While national accreditation body shall be working in accordance with ISO/IEC 17011:2004.

Therefore, in order to implement carbon offset model in Ukraine the components mentioned above must be reflected. As of today, none of these elements are implemented in Ukraine.

To sum up all mentioned about, there are three possible ways for implementation of carbon offset model in Ukraine.

The first one is to adopt a carbon offsetting framework law, which will include voluntary and mandatory schemes not only in aviation sector. Such legal act will include all similar for both mechanisms core components, institutional, administrative, financial and liability aspects, foresee a local Emissions Unit Programme. It could include provisions on state support for projects that can generate carbon units. Tax and currency aspects should be also foreseen. After that, the necessary secondary legislation covering CORSIA will be adopted.

The second one is to adopt an aviation carbon offsetting law, which will include voluntary and mandatory schemes and be designated purely for the introduction of the offset mechanism in the aviation industry. In such scenario local Emissions Unit Programme should be foreseen too in order to contribute to the creation of a voluntary offsetting market, as well as provisions on state support for projects that can generate carbon units and tax, currency and liability aspects could be covered.

The third one is to implement relevant Chapters 3 and 4 SARPs Annex 16, Volume IV related to offset mechanism in aviation to the Ukrainian legislation as well as the penalties and enforcement that aeroplane operators and others will be subject to if they do not comply. Considering current martial law and institutional capacity this one seems to be faster.

Action Plan

Gap analysis table for implementation of the Chapters 3 and 4 SARPs Annex 16, Volume IV related to offset mechanism in aviation under the recommendations for Stream 1.

No.	Title of the gap	Description of the gap	Recommendations
1	Current aviation legislation does not provide obligation for aeroplane operators to offset their emissions as well as does not grant the authority of SAAU to establish the rules for implementing such offsetting	According to Article 4 of the Air Code of Ukraine № 3393-VI dated May 19, 2011 (hereinafter – Air Code of Ukraine) Ukraine, as a state that has joined the Convention on International Civil Aviation (hereinafter – Convention), is responsible for the fulfillment of international obligations arising from this Convention. CORSIA is global market-based measure scheme that contained in the document entitled International Standards and Recommended Practices, Environmental Protection Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), Annex 16, Volume IV to the Convention. It is the part of the International Standards and Recommended Practices of the International Civil Aviation Organisation. Clause 6 Article 84 of the Air Code of Ukraine mentioned that market measures to limit or reduce emissions affecting global climate change are implemented taking into account the recommendations of the International Civil Aviation Organisation and in accordance with the legislation of Ukraine. Aviation regulations of Ukraine are developed in accordance with the standards and recommended practices of the International Civil Aviation Organisation, regulations of the International Air Transport Association, the European Association for the Safety of Air Navigation (Eurocontrol), the European Aviation Safety Agency, other international aviation organisations and taking into account the legislation of the European Union in the field of civil aviation, clause 3 Article 11 of the Air Code of Ukraine.	As Air Code of Ukraine establishes the legal basis for activities in the field of aviation, the terms and conditions of offset mechanism should be incorporated to it. To consider: (i) supplementing the Air Code of Ukraine with basic terms and conditions of offset obligation, including elaborating the Article 84 of Air Code of Ukraine with more details; (ii) expanding the list of issues for which aviation regulations can be developed in clause 5 Article 11.

		In Ukraine, the powers of state authorities are determined by the laws of Ukraine. Clause 5 Article 11 of the Air Code of Ukraine defines an exclusive list of issues that may be established in aviation regulations. Such list does not contain provisions on the carbon offsetting and reduction scheme.	
2	Current aviation legislation does not contain regulation on the applicability of CO_2 offsetting requirements	Chapter 3 of the Volume IV Annex 16 on the CO_2 offsetting requirements from international flights and emissions reductions from the use of CORSIA eligible fuels (hereinafter - Chapter 3 Volume IV Annex 16) establishes basis of the offsetting mechanism. Chapter contains provisions on applicability of CO_2 offsetting requirements. This section defines to which aeroplane operator offsetting requirements shall be applicable, the state's obligation to notify about its voluntary participation in CORSIA and the obligation to calculate the operators' offsetting requirements.	To consider introducing the respective offsetting requirement in the Air Code of Ukraine.
3	Current aviation legislation does not contain methodology for calculation of CO_2 offsetting requirements.	Chapter 3 of the Volume IV Annex 16 describes detailed methodology of calculation of CO_2 offsetting requirements prior to consideration of the CORSIA eligible fuels and total final CO_2 offsetting requirements with emissions reductions from the use of CORSIA eligible fuels	To consider introducing the respective methodology in the Aviation regulations of Ukraine.
4	Current aviation legislation does not contain regulation on the reduction of aeroplane operator's offsetting requirements from CORSIA eligible fuels	An aeroplane operator can reduce its offsetting requirements by claiming emission reductions from CORSIA eligible fuels. Eligible fuels are those that meet the sustainability criteria specified by ICAO and are produced by organisations that are certified under an ICAO approved sustainability certification scheme. Chapter 3 of the Volume IV Annex 16 section describes methodology of calculation of emissions reductions for aeroplane operators, if they intend to claim for emissions reductions from the use of CORSIA eligible fuels.	To consider supplementing Aviation rules of Ukraine with provisions on: (i) emissions reductions from the use of CORSIA eligible fuels; (ii) verification of CORSIA eligible fuels.

		Also, subsection 2.4.3 section 2.4 Charter 2 of the Volume IV Annex 16 establish rules for aeroplane operators on ways of the proof of use of CORSIA eligible fuels for the purpose of verification and approval of emissions reductions. As Aviation regulations of Ukraine stand in present, there are no regulation on verification of CORSIA eligible fuels.	
5	Current aviation legislation does not contain rules on eligibility of emission units, procedure of its cancellation, reporting and verification	Chapter 4 of the Volume IV Annex 16 on the emission units establishes the rules on: • cancellation. Section describes the cancellation procedure itself and defines which emission units is eligible to be used in order for the offsetting obligation to be considered fulfilled. Also, specifically subsection 4.2.1 of the section 4.2, Chapter 4 Volume IV Annex 16 contained aeroplane operator's obligation to meet its offsetting requirements as calculated by the state to which it is attributed, by cancelling CORSIA Eligible Emissions Units in a quantity equal to its total final offsetting requirements for a given compliance period; • reporting. This section together with Appendix thereto describes types of reports on the emissions unit cancellation, that should be submitted from aeroplane operator to state and from state to ICAO; • verification. The section establishes both the requirements for the verification of reports on cancellation of the emissions units and to the verifiers themselves and the procedure for their accreditation.	To consider introducing the respective obligation to Air Code of Ukraine and rules on cancellation, reporting and verification in the Aviation regulations of Ukraine.
6	Current aviation legislation does not contain rules on engagement of the verification body, requirements to such the verification body and procedure of it's accreditation	According to Annex 16 the aeroplane operator shall engage a verification body for the verification of its annual emissions report (paragraph 2.4.1.1. subsection 2.4.2 section 2.4. Chapter 2) and its emissions unit cancellation report (paragraph 4.4.1.1. subsection 4.4.1 section 4.4. Chapter 4). Such verification body shall be accredited under ISO 14065:2013 and the relevant requirements in Appendix 6 Section 2 by a	To consider introducing the respective provisions on the accreditation of a verification body in Ukraine in line with CORSIA requirements. Under this scenario the Law of Ukraine "On accreditation of conformity assessment

		national accreditation body, in order to be eligible to verify aeroplane operator's reports. A national accreditation body shall be working in accordance with ISO/IEC 170113, according to the paragraphs 2.4.2.1 and 2.4.2.2 of subsection 2.4.2 section 2.4 Charter 2 of the Volume IV Annex 16, note thereto and paraphs 4.4.2.1 and 4.4.2.2 of subsection 4.4.2 section 4.4 Charter 4. Aeroplane operator may engage a verification body accredited in another state, subject to rules and regulations affecting the provision of verification services in the state to which the aeroplane operator is attributed, according to the paraphs 2.4.2.1 and 2.4.2.2 of subsection 2.4.2 section 2.4 Charter 2 of the Volume IV Annex 16 and note thereto. As Aviation regulations of Ukraine stand in present, there are no detailed rules regarding the engagement of the verification body, requirements to such the verification body and procedure of it's accreditation.	bodies" No. 2407-III dated May 17, 2001 should be taken into account.
7	SAAU has partial powers to enforce financial sanctions	Under the Ukrainian legislation measures of legal responsibility, in particular powers to enforce financial sanctions, must be regulated in law. Under the Ukrainian legislation measures of legal responsibility, in particular powers to enforce financial sanctions, must be regulated in law. Therefore, if an aeroplane operator does not cancel sufficient emissions units to meet its offsetting requirements, it should be able to use sanctions SAAU. There are two more issues, which should be regulated. Firstly, in order to provide SAAU more instruments for control under the information from aeroplane operators liability for incomplete information disclosure should be included.	To consider amend Article 127 of the Air Code of Ukraine and reflect relevant provisions about liability in Aviation rules of Ukraine.

		Paragraph 7 section 1 part 1 Article 127 of Air Code of Ukraine on financial sanctions applied to legal entities - subjects of aviation activity does not contain liability for incomplete information disclosure. Secondly, liability for engagement of the verifier who does not comply with requirements for verifiers could also be foreseen. The engagement of the independent third party for the verification of the information provided by the aeroplane operator is one of the most important for the ensuring transparency of the whole system.	
8	Code of Ukraine on Administrative Offenses does not cover liability of verifiers under CORSIA	As it was mentioned above issues related to verification is important for the ensuring transparency of the whole system. Each participant must be responsible for its part of the obligations. Therefore, liability for violation of verification procedures by the verifier is also should be reflected.	To consider reflect relevant provisions on verifier's liability in Code of Ukraine on Administrative Offenses
9	SAAU's power to conduct state control is not cover check of offsetting compliance	In order to be able to promptly detect inaccurate information, the SAAU must have the authority to conduct inspections of operators. According to the section 2 Article 15 of Air Code of Ukraine the authorised civil aviation authority conducts scheduled and unscheduled inspections in order to determine the compliance of the certificate holder with the requirements established by the aviation rules of Ukraine or other normative legal acts. Therefore, the option to conduct inspections should be foreseen in the Aviation rules of Ukraine, which regulates offsetting relations.	To consider adding relevant provisions on the inspections to the Aviation rules of Ukraine.

Summary of consultations with stakeholders

A number of meetings were held with the main stakeholders, namely:

- ICAO.
- State Aviation Administration of Ukraine (SAAU).
- State Energy Efficiency Agency of Ukraine (SAEE).
- State Forestry Agency of Ukraine.
- Ministry of Environment and Protection of Natural Resources of Ukraine.
- Ministry of Agrarian Policy and Food of Ukraine.
- SkyUp Airlines LLC.
- Antonov Company SC.
- EBRD.
- Astarta-Kyiv.
- Arnika.
- NGO "Ukrainian Climatic Cadastre".
- National joint-stock company "Naftogaz of Ukraine".

Status and problems of CORSIA implementation, the prospects of offsetting and trading of carbon credits in Ukraine were discussed. The main topics of discission:

- successful providing of MRV according CORSIA in Ukrainian aeroplane operators;
- CORSIA implementation in Ukraine in part of offsetting (including making changes to the legislation);
- mandatory and voluntary scheme of offsetting;
- programmes or project for generating carbon offset which airlines can buy for reducing obligations under CORSIA;
- co-operation of Ukrainian airline operators with EU ETS;
- using by airlines SAF and its prospective;
- development of the Law of Ukraine on the system of trading quotas for greenhouse gas emissions;
- monetize carbon credits from producers, trading of carbon credits, prices;
- creating a Unified Energy Origin Guarantee System for confirming of renewable energy by guarantees of origin for the possibility of buying/selling "green" energy according to EU Council Directive 2001/2018/EC (RED II);
- creating and implementation of the National Trade System, which will include offsets;
- production of biofuel, biogas (biomethane), and calculations to reduce emissions due to it;
- the State Strategy for the Development of the Forest Industry of Ukraine until 2035;
- prospective industry (such as agricultural, forestry, energy, other) for generation of credit offsets;
- calculation of CO_2 emissions and absorption in different industries;
- issue of establishing a baseline, organising reporting and verification process for agricultural producers;
- development of relations with other countries regarding co-operation in accordance with Article 6 of the Paris Agreement, other.

All stakeholders agree that the topic of decarbonisation and climate change in general is important and needs attention. The issue of offsetting is relevant and promising, especially for potential producers of carbon credits. It should be noted that the risk of deterioration of the situation in connection with a Russian invasion and the risk of the lack of interviews of main stakeholders were partially realised. Constant airstrikes on critical and energy infrastructure have led to problems with electricity and periodic lack of communication and internet. Therefore, the number of interviews was less than planned, but this did not affect the quality of the collected information and, accordingly, the Report. This was achieved due to a deeper and additional research.

Conclusions, Findings and Recommendations

General conclusions and findings

The study of the implementation of CORSIA in Ukraine was carried out in comparison with world practices, including the implementation of the MRV, the CORSIA carbon offset model and credit sales practices, key market players and drivers, market size and prices, global experience in trading carbon credits, mandatory and voluntary offsetting schemes, global experience in aviation, as well as prospects for carbon credit sales models and market in Ukraine. Eligible programmes, promising sectors, technologies and projects for decarbonisation and generation of carbon credits in the world and in Ukraine were considered, as well as a pilot carbon offsetting project was modelled for better process understanding. In addition, the legal aspects of the implementation of carbon offset model projects are analysed.

The following main summary and conclusions can be drawn from the research and analysis:

- **Ukraine is a participant of CORSIA at the voluntary stage.** Ukraine is one of the 118 countries participating in CORSIA on a voluntary basis. All 8 Ukrainian airlines that meet CORSIA requirements are CORSIA participants. From 2027, participation in CORSIA is mandatory.
- **MRV according to CORSIA has been successfully implemented in Ukraine.** SAAU approved and implemented the Aviation Regulations of Ukraine "Technical requirements and administrative procedures for monitoring emissions by civil aircraft operators". 8 Ukrainian aeroplane operators report their emissions to SAAU.
- **Only foreign verifiers of GHG emission under CORSIA are available for aeroplane operators now.** Currently, Ukrainian airlines co-operate with foreign verifiers due to the fact that there are no local certified verifiers in Ukraine. It is necessary to ensure the appearance of a Ukrainian certified verifier**.**
- **Absence of carbon trading market in Ukraine.** Currently, business companies, investors and government are increasingly interested and raise this issue for discussion and are starting to work in this direction.
- **Prospects for Ukrainian producers that can generate carbon credits.** After the implementation of offsetting according to CORSIA, Ukrainian producers have prospects to generate and sell carbon credits to airlines. Due to the prices of carbon credits under CORSIA expected to be higher comparing to voluntary schemes, this market is more attractive. In addition, after the implementation of carbon absorption calculation, verification and certification according to international standards, producers will be able to enter the international market.
- **The most promising sectors for the generation of carbon credits in Ukraine are agriculture, forestry, renewable energy and energy efficiency projects.** Considering the Ukrainian specifics - the presence of a sufficient area of forests, agricultural land, big vertically integrated agricultural holdings and development organic agriculture, the possibility of introduction of new production technologies related to decarbonisation in agriculture, natural resources for renewable energy, high energy consumption in economy, these sectors are promising. Companies are already working in this area.

- **Carbon offsetting market worldwide still underdeveloped and not fully standardised, but developing with a high pace, fueled by increasing regulatory pressure.**
  Offsetting project certification systems are quite diverse and require harmonisation. Offsetting projects differ greatly in terms of the price of carbon credits, the needs and motivations of credit buyers, the geographic coverage of projects, the types of projects, the methodologies used, etc. The prospects of offset projects are not clear enough for projects from Ukraine, considering the variety of options for their implementation. It requires testing and piloting in different industries to fully clarify the process and economic feasibility of the certification.
- **Prospects for the growth of biofuel and SAF production.** Ukraine has potential for the production of biofuels and SAF in accordance with the requirements of CORSIA
- **Ukrainian aeroplane operators have experience in European mandatory schemes (EU ETS).** For all their EEA flights, aeroplane operators report and later purchase quotas in accordance with the requirements of the EU ETS (if meet the requirement). For these purposes, each airline is registered in one of the European countries.
- **Ukrainian aeroplane operators do not use voluntary offsetting schemes.** Most of major international airlines use a voluntary offsetting scheme when they offer passengers to offset their carbon footprint. Ukrainian airlines are considering the possibility of implementing this.
- **Insufficient legal basis for the implementation and regulation of the carbon offset model.** In order to be able to apply the offsetting (carbon dioxide emissions compensation mechanism) in Ukraine, it is necessary to develop a sufficient legal infrastructure. This includes a logically coordinated, dynamic system of unified legal terms and conditions to ensure effective legal regulation of public relations.
- **All stakeholders agree that the topic of decarbonisation and climate change in general is important and needs attention.** The issue of offsetting is relevant and promising, especially for potential producers of carbon credits. All major stakeholders are already taking the necessary steps to decarbonise and implement the necessary programmes.
- **Need for raising awareness for the carbon credit market among key stakeholders.** Although the main stakeholders are aware of the main issues of decarbonisation, but given the specificity of the topic and the lack of such a market in Ukraine, it is necessary to raise awareness for its implementation and development.

The offset market development streams should be the following:

- Stream 1: Aeroplane operators' integration to existing international carbon offset market.
- Stream 2: Ukrainian-based offset projects entering international offset market.
- Stream 3: National carbon offset market creation and integration to international markets.

Recommendations

Based on the general concept of the further development of the offsetting market, a number of recommendations were developed. Recommendations are grouped by development streams and addresses corresponding stakeholder groups:

Stream 1: Aeroplane operators' integration to existing carbon offset market

SAAU:

1. *Implementation into Ukrainian legislation Chapters 3 and 4 SARPs Annex 16, Volume IV together with relevant Appendix and development of the relevant secondary legislation to enable and explain the procedure of purchase of carbon credits from CORSIA-accredited Programmes.*

Chapter 3 of the Volume IV Annex 16 On the CO2 offsetting requirements from international flights and emissions reductions from the use of CORSIA eligible fuels and Chapter 4 of the Volume IV Annex 16 on the emission units contains key provisions that are together with the general Chapter 1 of the Volume IV Annex 16 On Administration and Chapter 2 of the Volume IV Annex 16 On monitoring, reporting and verification (MRV) of aeroplane operator annual CO2 emissions are necessary for successful implementation of the carbon offset mechanism under the CORSIA in Ukraine. It is important not only for fulfillment of Ukraine's obligations, but also as an example for the development of the internal carbon offset market model.

2. *Development of the Guidelines for aeroplane operators how to buy and cancel emission units.*

Despite the reduced number of flights and the unlikely need for offsetting emissions on recent CORSIA implementation stage, it is important for aeroplane operators to be prepared for the purchase and cancelation of emission units (carbon credits). It is important to study and explain to aeroplane operators the key requirements for credits: CORSIA eligible programmes under which credits can be purchased, approaches to the selection of credits, purchasing of such credits, credits cancellation, reporting and verification requirements, etc.

3. *Improve connections between airlines and potential developers of offset projects to ensure the supply of emission units within Ukrainian companies, where possible.*

Airlines are interested in using Ukrainian projects for offsetting (as well as interested Ukrainian producers of carbon credits), and even in investing in Ukrainian projects, but this requires additional resources. This also applies to international obligations, if Ukrainian projects were certified there. Accordingly, the projects of Ukrainian producers of carbon credits must be certified by CORSIA. Facilitate communication between offset market participants for CORSIA - project developers as potential sellers and aircraft operators as potential buyers to identify prospects for buying and selling carbon credits, including through awareness raising activities.

4. *Motivating airlines to create and promote voluntary offsetting by passengers and clients.*

Most of major international airlines use a voluntary offsetting scheme. In this way, they contribute to decarbonisation, offset the carbon footprint and the achievement of Net Zero 2050 goals. Companies also use it for their marketing purposes, proclaiming themselves as environmentally oriented. This should also motivate Ukrainian airlines to implement voluntary offsetting schemes.

5. *Promotion of development of SAF production in Ukraine*

Ukraine has the potential to become one of the sizeable producers of SAF, having enough raw materials from agriculture and forestry. It is profitable for producers because of the price of SAF, which is twice as high as the price of traditional fuel. Also, producers can generate carbon credits and sell them.

6. *Provide explanatory work on future of SAF in aviation and its impact on CORSIA among aeroplane companies*

The state and SAAU should motivate airlines to use SAF and set quantitative targets for its use to achieve the goals of Net Zero 2050. And, accordingly, for this promotion of SAF production in Ukraine and provision of supply at Ukrainian airports.

7. *Preparation of the regulatory framework for the implementation of accreditation of verifiers by NAAU.*

In Ukraine accreditation is carried out in accordance with the requirements established by legislation in the field of accreditation, national accreditation standards harmonised with relevant international and European standards, as well as other accreditation documents adopted by the national accreditation body of Ukraine, which is NAAU, international and European accreditation organisations. Therefore, the detailed rules regarding the engagement of the verification body, requirements to such verification body and procedure of it's accreditation under CORSIA should be developed in tie co-operation with NAAU.

Stream 2: Ukrainian-based offset projects entering international offset market

UNDP, Project Developers, SAAU:

8. *Comprehensive analysis of offsetting potential by key sectors.*

Prospects for implementation of offsetting projects are poorly researched in Ukraine. Limited range of projects from Ukraine can be certified under CORSIA eligible programmes. In addition, the specifics of the Ukrainian economy and offset experience (corruption risks, cost of finance, currency rates fluctuations, lack of offsetting expertise, absence of offset projects on market, etc) have a significant impact on the prospects for the implementation of offsetting projects in traditional types of projects. Execution of such an analysis is important in order to focus the activities of potential project developers for the effective issuance of high-quality carbon credits in various economy sectors, at least renewable energy, forestry, agriculture, energy efficiency, et alia. Due to the variety of carbon credit certification schemes, diverse carbon markets, fluctuations in credit prices from market to market, different approaches to determining and assurance of the carbon credits quality, and the associated costs of implementing credit certification, it is necessary to conduct a detailed study of the requirements and costs for each sector of economy. This will contribute to a deeper understanding of the prospects for the development of the offset market in Ukraine.

9. *Develop amendments to legal mechanism, taking into account currency and tax aspects of selling of carbon credits on international offset markets.*

The legal status of carbon credits (emission units), its exchange as a commodity, related issues of purchase and sale, taxation, etc. are not currently determined in Ukraine. Such gaps can hinder the sale of credits on the international markets. Accordingly, it is worth studying in more detail the issue of the legal status of carbon credits, obstacles and shortcomings in the legislation, and steps to eliminate them for the unimpeded entry of carbon credits of Ukrainian companies to the international carbon market.

10. Development of pilot projects on carbon offsetting for aims of CORSIA and other carbon markets.

The global market for CORSIA eligible carbon credits has not yet developed sufficiently during the pilot phase of CORSIA implementation. Projects based in Ukraine are not represented in international offset markets. The issue of economic feasibility is one of the determining factors for the implementation of offset projects in Ukraine. Its definition requires a thorough analysis of possible project implementation options, a detailed study of related costs, correct application of methodological approaches, legal, tax aspects, and provision of a high level of expertise on a number of issues - from emission modeling, verification, to project implementation. It is necessary to carry out such an analysis with the study of the real needs of the implementation of the offsetting project, the determination of possible obstacles and opportunities through the implementation of a pilot project in agriculture, forestry or renewable energy, etc.

11. Raising awareness among stakeholders on carbon offset markets perspectives, expanding expertise and gaining experience in carbon offsetting for Ukraine.

Disseminate information about the offset market among interested parties, because as of now, little is known about the prospects of the market in Ukraine, and the implementation of such projects is not widespread. In particular, the main target group of stakeholders should be potential project developers, the expert community involved in the development and support of projects and their verification, state bodies whose areas of responsibilities relate to the prospects of offsetting, banks and financial institutions that can finance offset projects, etc. Raising awareness is necessary to disseminate knowledge, solutions, and perspectives on offsetting, both for CORSIA purposes and for other markets. This is possible by conducting research and publishing their results, information events, round tables with the participation of stakeholders, etc. Such steps will raise awareness and as a result create a favorable basis for the launch of an internal market.

Stream 3: National carbon offset market creation and integration to international markets

12. Development of the concept of legal and institutional infrastructure of the future Ukrainian offset market (voluntary and obligatory) in co-operation with stakeholders and taking into account obligations under the carbon reducing mechanism like EU ETS, Paris agreement etc.

On this stage a carbon offsetting framework law should be developed. Such law should include voluntary and obligatory schemes not only in aviation sector. Such legal act should include all similar for both mechanisms core components: legal status of carbon credits (emission units), its exchange as a commodity, related issues of purchase and sale (primary and secondary markets), institutional, administrative, financial and liability aspects. Creation of the local emissions unit programmes should be also foreseen. Tax and currency aspects should be also satteled in order to enable international players to buy emission units in Ukrainian emission unit programme.

The work on creation of the internal ETS system and obligation under Paris agreement should be also taken into account in order to avoid any double counting of emission units and f Ukraine's non-fulfillment of its obligations. Framework law could include provisions on state support for local projects that can generate carbon units.

13. *Coordination of state policy in regard of offset market between different government stakeholders (MinEcology, MinAgro, MinInfrastructure, MEPNR, MinRegion, MinEconomy, NSSMC etc).*

Realisation of the offset market model in Ukraine will have positive effect not only on the achieving environmental goals, but also will contribute to the development of the economy through opening a new way for attracting funds to more energy efficient or environmentally friendly business. Therefore, coordination with different government stakeholders, which are responsible for policy development and realisation will allow to coordinate funds more effective.

14. *NAAU+SAAU – to promote new opportunity for verifiers on carbon offset market (CORSIA and not only).*

Help and support is needed in the emergence of Ukrainian local certified verifiers who could replace the international verifiers with whom Ukrainian airlines currently work, and in the perspective of providing services at the international level.

15. *Methodological support of development and implementation of offsetting projects.*

Agricultural companies have great interest and opportunities to generate and sell carbon credits. But they also have many questions – How to establish a baseline? How to organise reporting? How to calculate emission? How to verify report? Who is certified verifier? Etc. Therefore, they need support from the state in the clarification, regulation and organisation of the end-to-end process.

16. *Support of the development of national carbon offsetting programmes with the perspective of entering the list of CORSIA-eligible programmes.*

It is very important within this initiative to develop national carbon offsetting programmes with the possibility of integration with the list of CORSIA-eligible programmes so that they are available to both Ukrainian and international airlines.

17. *Promotion of voluntary offsetting among aeroplane operators, possibly at the regulatory level.*

Along with voluntary offsetting schemes by passengers, airlines must also join voluntary carbon offsetting schemes for compensation its footprint. These can be emissions related to flights for own purposes or those of employees, emissions from equipment and transport at airports, etc.

18. *Investigate the possibility of application of CORSIA MRV system for other transportation industries (maritime, railway etc).*

Due to the fact that other transport is similar to air transport in its MRV capabilities and, given that it also has significant carbon emissions, it would be appropriate to apply MRV according to CORSIA to other types of transport.

19. *Promotion of voluntary offsetting by all transport sector (railway, buses, taxi, communal transport, maritime)*

There is international experience in the application of voluntary offsetting schemes by passengers and clients in aviation and land transport. It is necessary to adopt this experience and motivate transport companies and passengers to be environmentally conscious and offset their carbon footprint.

Annexes

Annex 1: Gold Standard Methodologies for biogas projects.

Reference	Title of methodology	Typical Project activity
AMS-I.A.	Electricity generation by the user	Project activities that involve installation and operation of renewable electricity generation units that supply electricity to individual households/users or groups of households/users included in the project boundary. The renewable energy generation units include technologies such as solar, hydro, wind, biomass gasification and other technologies that produce electricity all of which is used on-site/locally by the user, e.g., solar home systems, wind battery chargers.
AMS-I.E.	Switch from Non-Renewable Biomass for Thermal Applications by the User	Project activities that displace the use of non-renewable biomass by introducing renewable energy technologies. Examples of these technologies include but are not limited to biogas stoves, solar cookers, passive solar homes, renewable energy based drinking water treatment technologies (e.g. sand filters followed by solar water disinfection; water boiling using renewable biomass).
AMS-I.I.	Biogas/biomass thermal applications for households/small users	Project activities that involve activities for generation of renewable thermal energy using renewable biomass or biogas for use in residential, commercial, institutional applications (e.g. for supply to households, small farms or for use in built environment of institutions such as schools). Examples of these technologies that displace or avoid fossil fuel use include but are not limited to biogas cook stoves, biomass briquette cook stoves, small scale baking and drying systems, water heating, or space heating systems.
AMS-III.D.	Methane recovery in animal manure management systems	Project activities that involve replacement or modification of existing anaerobic manure management systems in livestock farms to achieve methane recovery and destruction by flaring/ combustion or by use of the recovered methane for energy generation.
AMS-III.F.	Avoidance of methane emissions through controlled biological treatment of biomass	Project activities that involve controlled biological treatment of biomass or other organic matter is introduced through one, or a combination, of the following measures: aerobic treatment by composting and proper soil application of compost; or anaerobic digestion in closed reactor equipped with biogas recovery and combustion/flaring system.
AMS-III.G.	Landfill methane recovery	Project activities that involve capture and combustion of methane from landfills used for disposal of residues from human activities including municipal, industrial and other solid wastes containing biodegradable organic matter.

AMS-III.H.	Methane recovery in wastewater treatment	Recovery of biogas resulting from anaerobic decay of organic matter in wastewaters through introduction of anaerobic treatment system for wastewater and/or sludge treatment.
AMS-III.O.	Hydrogen production using methane extracted from biogas	Project activities that involve installation of biogas purification system to isolate methane from biogas for the production of hydrogen displacing LPG as displacing both feedstock and fuel in hydrogen production unit.
AMS-III.R.	Methane recovery in agricultural activities at household/small farm level	Project activities that involve recovery and destruction of methane from manure and waste from agricultural activities through installing methane recovery and combustion system of methane emission and or changing the management practice of a organic waste or raw material in order to achieve controlled anaerobic digestion equipped with recovery and combustion system.
AMS-III.AO.	Methane recovery through controlled anaerobic digestion	Project activities that avoid methane emissions from biomass or other organic matter (e.g. MSW, organic waste, animal manure, wastewater) that would have otherwise been left to decay anaerobically in a solid waste disposal site (SWDS), or in an animal waste management system (AWMS), or in a wastewater treatment system (WWTS). In the project situation, controlled biological treatment of biomass or other organic matters is introduced through anaerobic digestion in closed reactors equipped with biogas recovery and combustion/flaring system.
AMS-III.AQ.	Introduction of Bio-CNG in transportation applications	Project activities that involve production of Biogenic Compressed Natural Gas (Bio-CNG) from renewable biomass including waste organic matters to be used in transportation applications. The crops from renewable biomass origin used for production of the Bio-CNG should be sourced from dedicated plantations.
ACM0001	Flaring or use of landfill gas	Project activities that capture landfill gas (LFG) and flare and/or use it to produce energy and/or use to supply consumers through natural gas distribution network.
ACM0010	GHG emission reductions from manure management systems	Project activities that involve manure management on livestock farms, where the existing anaerobic manure treatment system is replaced by one or a combination of more than one animal waste management systems that result in less GHG emissions.
ACM0014	Treatment of wastewater	Project activities that involve treatment of industrial wastewater in anaerobic digester capture or flaring utilization of the generated biogas for electricity and heat generation; or treatment of wastewater in the same treatment plant as in the baseline situation but treatment of the sludge from primary and/or secondary settler either in a new anaerobic digester or treatment of sludge under clearly aerobic conditions.

ACM0022	Alternative waste treatment processes	Project actvities that involve of one or more combination of following waste treatment options: composting process in aerobic conditions; Gasification to produce syngas and its use; Anaerobic digestion with biogas collection and flaring and/or its use; Mechanical/thermal treatment process to produce refuse-derived fuel (RDF)/stabilised biomass (SB) and its use; incineration of fresh waste for energy generation, electricity and/or heat.
ACM0024	Natural gas substitution by biogenic methane produced from the anaerobic digestion of organic waste	This methodology applies to project activities where organic waste is treated by anaerobic digestion and biogas is upgraded and used to replace natural gas. The project activity may claim emission reductions for displacing natural gas in a natural gas distribution system, which includes transportation by trucks and/or pipelines, with upgraded biogas.
AM0053	Biogenic methane injection to a natural gas distribution grid	Project activities that process and upgrade biogas to the quality of natural gas and distributes it as energy via natural gas distribution grid. The source of biogas, which is generated by an anaerobic decomposition of organic matter, could be landfills, liquid waste treatment, animal waste management systems, etc.
AM0069	Biogenic methane use as feedstock and fuel for town gas production	Project activities where biogas captured at a wastewater treatment facility or a landfill is used to fully or partially substitute natural gas or other fossil fuels of higher carbon content as feedstock and fuel for the production of town gas.
AM0073	GHG emission reductions through multi-site manure collection and treatment in a central plant	Project activities where manure is collected and treated in a single central treatment plant. The existing anaerobic manure treatment systems, in the multiple livestock farms within the project boundary, are replaced by a central treatment plant with one or a combination of more than one animal waste management systems (AWMSs) that result in less GHG emissions. CERs may also be claimed from biogas sourced heat/electricity exportations.
AM0075	Methodology for collection, processing and supply of biogas to end-users for production of heat	Project activities that involve collecttion of biogas from one or several biogas producing site(s), processing and upgradation the biogas in a new biogas processing facility which is constructed and operated as part of the project activity, and supply the processed biogas to end- user(s). The end-user(s) will use the processed biogas to produce heat in heat generation equipment.
AM0094	Distribution of biomass based stove and/or heater for household or institutional use	Project activities that directly invest (partially or fully) in and/or provide a subsidy for: (i) the distribution of biomass based stoves and/or heaters and (ii) the supply of biomass briquettes (e.g. transportation infrastructure, biomass briquetting factories etc.) in a targeted project geographical area (TPA). The project activity shall include both components i.e., distribution of improved stoves and distribution of fuel.

References

1. **Verco.** *ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and MRV provisions.*

2. **Carbon Credits.com.** *What Drives the Growth of The Carbon Offset Market?* [Online] https://carboncredits.com/what-drives-the-growth-of-the-carbon-offset-market-3-key-factors/.

3. **State Aviation Administration of Ukraine.** *Action plan of Ukraine for reducing aviation CO2 emissions.* 2021.

4. **International Energy Agency.** *China's Emissions Trading Scheme - Designing efficient allowance allocation.*

5. **Center for Climate and Energy Solutions.** California Cap and Trade. [Online] https://www.c2es.org/content/california-cap-and-trade/.

6. **Motu Research.** *A Guide to the New Zealand Emissions Trading Scheme: 2022 Update.*

7. **Borders, Air Transport Action Group (ATAG) - Aviation: Benefits Beyond.** *VOLUNTARY CARBON OFFSETTING.* November 2020.

8. **EEX.** *Voluntary Carbon Markets - https://www.eex.com/en/markets/environmental-markets/voluntary-carbon-markets.*

9. **GLobal, S&P.** *Voluntary carbon markets: how they work, how they're priced and who's involved.*

10. **IATA.** Aviation Carbon Offsetting - Guidelines for Voluntary Programs. [Online] https://www.iata.org/contentassets/922ebc4cbcd24c4d9fd55933e7070947/aviation_carbon_offsetting_guidelines.pdf.

11. **Business Traveller.** Guide to airline carbon offset programmes. [Online] 2022. https://www.businesstraveller.com/features/guide-to-airline-carbon-offset-programmes.

12. **Carbon Credits.com.** Delta Air Lines Buys $137 Million Carbon Credits, Focuses on Carbon Removal. [Online] https://carboncredits.com/delta-air-lines-carbon-credits/.

13. *Global carbon markets value surged to record $851 bln last year.* **Reuters.**

14. **Coherent Market Insights.** *Carbon Credit Market to Experience Huge Growth Through 2027.* 2021.

15. **MIT.** MIT - Climate Protal. *https://climate.mit.edu/.* [Online] https://climate.mit.edu/explainers/carbon-pricing.

16. **ICAO.** ICAO. [Online] https://www.icao.int/Pages/default.aspx.

17. **Climate Trade.** Climate Trade. *How to buy carbon credits to offset your footprint.* [Online] https://climatetrade.com/how-to-buy-carbon-credits-to-offset-your-footprint/.

18. **Carbon Credits.com.** Carbon Crypto Guide: KlimaDAO, Carbon NFTs, and Carbon Tokens. [Online] https://carboncredits.com/carbon-crypto-guide-klimadao-carbon-nfts-and-carbon-tokens/#4-1.

19. **NBC.** www.nbcnews.com. *How big is Bitcoin's carbon footprint?* [Online] https://www.nbcnews.com/tech/tech-news/big-bitcoins-carbon-footprint-rcna920.

20. **Ministry of Environmental Protection and Natural Resources of Ukraine.** Annual National Inventory Report for Submission under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. [Online] https://mepr.gov.ua/files/docs/Zmina_klimaty/Kadastr_2021/Ukraine_NIR_2021_draft.pdf.

21. **Про схвалення Оновленого національно визначеного внеску України до Паризької угоди.** ***https://zakon.rada.gov.ua/.*** **[Online] 2021. https://zakon.rada.gov.ua/laws/show/868-2021-%D1%80#Text.**

22. Ministry of Environmental Protection and Natural Protection. ANALYTICAL REVIEW OF THE UPDATED NATIONALLY DETERMINED CONTRIBUTION OF UKRAINE TO THE PARIS AGREEMENT. ***https://mepr.gov.ua.*** **[Online] https://mepr.gov.ua/files/docs/klimatychna_polityka/Analytical%20Review%20Updated%20Nationally%20Determined%20Contribution%20of%20Ukraine%20to%20the%20Paris%20Agreement%20July%202021%20(2).pdf.**

23. UNFCCC. Project Overview. ***https://ji.unfccc.int.*** **[Online] UNFCCC. [Cited: November 4, 2022.] https://ji.unfccc.int/JI_Projects/ProjectInfo.html .**

24. ***Has Joint Implementation reduced GHG emissions? Lessons learned for the design of carbon market mechanisms .*** **Anja Kollmuss, Lambert Schneider and Vladyslav Zhezherin.**

25. Zhenchuk, Marharyta. ***CRITICAL REFLECTIONS ON JOINT IMPLEMENTATION PROJECTS IN UKRAINE.*** **2012. https://carbonmarketwatch.org/wp-content/uploads/2012/11/JI-in-Ukraine-by-NECU.pdf.**

26. Ukraine returns €5 mln in unspent AAU funds to Japan, deal sought for remaining cash. ***carbon-pulse.com.*** **[Online] https://carbon-pulse.com/15064/.**

27. NABU. Kyoto protocol. ***nabu.gov.ua.*** **[Online] https://nabu.gov.ua/en/tags/kyoto-protocol.**

28. European Council. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. ***https://eur-lex.europa.eu.*** **[Online] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0233&from=EN .**

29. Ministry of Environmental Protection and Natural Resources of Ukraine. Загальна інформація про СТВ. ***https://mepr.gov.ua.*** **[Онлайновий] https://mepr.gov.ua/news/32026.html.**

30. ICAO. ***CORSIA Emissions Unit Eligibility Criteria.*** **2019.**

31. —. ***CORSIA Eligible Emissions Units.*** **2021.**

32. UNFCCC. Percentage of projects belonging to a CDM scope of all registered projects. ***https://cdm.unfccc.int.*** **[Online] UNFCCC. [Cited: October 25, 2022.] https://cdm.unfccc.int/Statistics/Public/files/202209/multiple_response_Scope.xls.**

33. VERRA. Who We Are. ***verra.org.*** **[Online] https://verra.org/about-verra/who-we-are/.**

34. —. Verified Carbon Standard. [Online] Verra. [Cited: October 25, 2022.] https://registry.verra.org/app/search/VCS/All%20Projects.

35. Gold Standard. Vision+Impacts. *www.goldstandard.org.* [Online] https://www.goldstandard.org/about-us/vision-and-mission.

36. —. *Market report 2020.* 2021.

37. Standards & Methodologies. *American Carbon Registry.* [Online] [Cited: October 27, 2022.] https://americancarbonregistry.org/carbon-accounting/standards-methodologies.

38. American Carbon Registry. Projects Credits Issued. *American Carbon Registry .* [Online] https://acr2.apx.com/myModule/rpt/myrpt.asp?r=112.

39. Environmental Defense Fund Beijing Representative Office, Sino Carbon Innovation & Investment Co, Ltd. *Analytical report on the status of the China GHG voluntary emission reduction program .* 2020.

40. Global Carbon Council. Global Carbon Council. *www.globalcarboncouncil.com.* [Online] [Cited: October 27, 2022.] https://www.globalcarboncouncil.com/about-gcc/global-carbon-council/.

41. Global Carbon Council . SUBMITTED PROJECTS. *projects.globalcarboncouncil.com.* [Online] Global Carbon Council . [Cited: October 27, 2022.] https://projects.globalcarboncouncil.com/pages/submitted_projects.

42. www.artredd.org. [Online] https://www.artredd.org/.

43. Architecture for REDD+ Transactions. Programs. *https://art.apx.com.* [Online] Architecture for REDD+ Transactions. [Cited: November 6, 2022.] https://art.apx.com/myModule/rpt/myrpt.asp?r=111.

44. *Powering the Future with Liquid Sunshine.* FongShih, Choon, et al. 2018.

45. Jia, Gensuo, et al. *Digital Earth for Climate Change Research.* 2019.

46. IATA. What is SAF? *https://www.iata.org/.* [Online] https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/saf-what-is-saf.pdf/.

47. KPMG . Sustainable Aviation Fuel. Ready for lift off? *KPMG.* [Online] https://assets.kpmg/content/dam/kpmg/ie/pdf/2022/11/ie-sustainable-aviation-fuel.pdf.

48. Ministry of Environmental Protection and Natural Resources of Ukraine. UKRAINE 2050 GREEN ENERGY TRANSITION CONCEPT. *https://mepr.gov.ua/.* [Online] https://mepr.gov.ua/files/images/news_2020/14022020/eng_pdf_%D0%B7%D0%B5%D0%BB%D0%B5%D0%BD%D0%B0%20%D0%BA%D0%BE%D0%BD%D1%86%D0%B5%D0%BF%D1%86%D1%96%D1%8F%20(1).pdf.

49. Кабінет Міністрів України . ДЕРЖАВНА СТРАТЕГІЯ управління лісами України до 2035 року. [Online] https://zakon.rada.gov.ua/laws/show/1777-2021-%D1%80#Text.

50. СТРАТЕГІЯ НИЗЬКОВУГЛЕЦЕВОГО РОЗВИТКУ УКРАЇНИ ДО 2050 РОКУ. [Online] 2017. https://mepr.gov.ua/files/docs/%D0%9F%D1%80%D0%BE%D0%B5%D0%BA%D1%82%20%D0%A1%D1%82%D1%80%D0%B0%D1%82%D0%B5%D0%B3%D1%96%D1%97%20%D0%BD%D0%B8%D0%B7%D1%8C%D0%BA%D0%BE%D0%B2%D1%83%D0%B3%D0%BB%D0%B5%D1%86%D0%B5%D0%B2%D0%BE%D0%B3%D0%BE%20%D1%80%D0%BE%D0%B7%D0%B.

51. Кабінет Міністрів України. СТРАТЕГІЯ екологічної безпеки та адаптації до зміни клімату на період до 2030 рок. [Online] 2021. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fmepr.gov.ua%2Ffiles%2Fdocs%2FZmina_klimaty%2F2021%2F%25D0%25A1%25D1%2582%25D1%2580%25D0%25B0%25D1%2582%25D0%25B5%25D0%25B3%25D1%2596%25D1%258F%2520%25D1%2582%25D0%25B0%2520%25D0%25BE%25D0%25B.

52. Institute of Economics and Forecasting of National Academy of Science of Ukraine (IEF). REPORT 3/ MODELING REPORT. *https://mepr.gov.ua.* [Online] https://www.bing.com/ck/a?!&&p=cc52546adb4f78a5JmltdHM9MTY2NzM0NzIwMCZpZ3VpZD0zZGYzM2JiZC0yY2M1LTYxYTMtMzhiNS0yOWVkMmRkNzYwN2QmaW5zaWQ9NTE1OA&ptn=3&hsh=3&fclid=3df33bbd-2cc5-61a3-38b5-29ed2dd7607d&psq=This+Modelling+Report+was+prepared+by+Institute+of+Eco.

53. Institute for Economics and Forecasting, National Academy of Science of Ukraine (IEF). Report 4, Part A Policies and measures. *https://mepr.gov.ua/.* [Online] https://mepr.gov.ua/files/images/2021/29042021/Policies%20and%20Measures%20Report%204.A.pdf.

54. Ecosystem Marketplace. The art of integrity - State of the Voluntary Varbon Markets 22 Q3. *https://www.ecosystemmarketplace.com.* [Online] https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2022/.

55. Ministry of Environmental Protection and Natural Resources of Ukraine. UKRAINE'S GREENHOUSE GAS INVENTORY 1990-2019. [Online] https://mepr.gov.ua/files/docs/Zmina_klimaty/Kadastr_2021/Ukraine_NIR_2021_draft.pdf.

56. Гелетуха Г.Г., Кучерук П.П., Матвєєв Ю.Б. Перспективи виробництва біометану в Україні. *https://uabio.org.* [Online] Вересень 2022. [Cited: October 24, 2022.] https://uabio.org/materials/uabio-analytics/.

57. AgSTAR Data and Trends. *https://www.epa.gov.* [Online] [Cited: 12 16, 2022.] https://www.epa.gov/agstar/agstar-data-and-trends.

58. GHG reduction potentials of biogas and biomethane industries. *https://www.europeanbiogas.eu.* [Online] European Biogas Association. [Cited: 12 16, 2022.] https://www.europeanbiogas.eu/wp-content/uploads/2020/04/20200419-Infographic_final.pdf.

59. EBRD. [Online] https://www.ebrd.com/work-with-us/project-finance/loans.html.

60. EBRD. [Online] https://www.ebrd.com/work-with-us/projects/psd/mhp-biogas.html.

61. [Online] https://www.ifc.org/wps/wcm/connect/9622ee77-f661-4cb8-b77e-0ff5ec0b29c0/IFC-AR22-Regional-Results-Europe.pdf?MOD=AJPERES&CVID=oggqVqE.

62. Орел, Ігор. В Україні з'являються перші біометанові заводи. Чи варто інвестувати в цей бізнес і скільки можна заробити? *https://forbes.ua.* [Online] [Cited: 12 16, 2022.] https://forbes.ua/money/v-ukraini-zyavlyayutsya-pershi-biometanovi-zavodi-chi-varto-investuvati-v-tsey-biznes-i-skilki-mozhna-zarobiti-30092022-8713.

63. Prices and Volumes of Carbon Trading. ***https://data.ecosystemmarketplace.com/.*** **[Online] https://data.ecosystemmarketplace.com/.**

64. Ecosystem Marketplace's State of the Voluntary Carbon Markets 2021. ***https://www.ecosystemmarketplace.com.*** **[Online] https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2021/.**

65. Review: What is the status of Clean Development Mechanism (CDM) projects? [Online] https://factly.in/review-what-is-the-status-of-clean-development-mechanism-cdm-projects/.

66. verra.org. [Online] https://verra.org/about-verra/who-we-are/.

67. DATA AND INSIGHTS VCS Quarterly Update ISSUE #6 - Q1/2021. ***verra.org.*** **[Online] https://verra.org/datainsights/data-and-insights-april-2021/.**

68. UK Emissions Trading Scheme markets. [Online] https://www.gov.uk/government/publications/uk-emissions-trading-scheme-markets/uk-emissions-trading-scheme-markets.

69. UK emissions trading scheme. [Online] https://www.gov.scot/policies/climate-change/emissions-trading-scheme/.

70. HWF Law Firm. CHINA'S NATIONAL EMISSIONS TRADING SCHEME: THE WORLD'S LARGEST CARBON MARKET HAS FINALLY ARRIVED. [Online] https://www.hfw.com/Chinas-National-Emissions-Trading-Scheme-The-worlds-largest-carbon-market-has-finally-arrived-March-2021.

71. cryptonews. ***Bitcoin Mining CO2 Footprint Is Below 0.08% Of Global Total - CoinShares.*** **[Online] https://cryptonews.com/news/bitcoin-mining-co2-footprint-below-008-of-global-total-coinshares.htm.**

72. Carbon Credits.com. ***The Top 4 Carbon Exchanges for 2022.*** **[Online] https://carboncredits.com/the-top-4-carbon-exchanges-for-2022/.**

73. IATA. ***Aviation Carbon Exchange.*** **[Online] https://www.iata.org/en/programs/environment/ace/#tab-1.**

74. INTERNATIONAL CIVIL AVIATION ORGANIZATION. CORSIA Eligible Emissions Units. [Online] 2021.

75. Our Mission. ***americancarbonregistry.org.*** **[Online] https://americancarbonregistry.org/about-us/mission.**

76. Climate Action Reserve. ***Annual Report 2020.*** **2021.**

77. Державна податкова служба України. РОЗДІЛ VIII. ЕКОЛОГІЧНИЙ ПОДАТОК. ***https://tax.gov.ua.*** **[Online] [Cited: November 07, 2022.] https://tax.gov.ua/nk/rozdil-viii--ekologichniy-poda/.**

78. Gold Standard. Gold Standard launches social enterprise SustainCERT to mainstream SDG impact certification. ***https://www.goldstandard.org.*** **[Online] [Cited: 11 17, 2022.] https://www.goldstandard.org/blog-item/gold-standard-launches-sustaincert.**

79. American Carbon Registry. What Do We Do. ***https://americancarbonregistry.org/.*** **[Online] American Carbon Registry. https://americancarbonregistry.org/how-it-works/what-we-do.**