



Ukraine

TECHNOLOGY NEEDS ASSESSMENT REPORT TECHNOLOGY ACTION PLAN MITIGATION

August 2021



TECHNOLOGY NEEDS ASSESSMENT REPORT

TECHNOLOGY ACTION PLAN MITIGATION

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This publication is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UN Environment) and the UNEP DTU Partnership (UDP) in collaboration with the University of Cape Town. Views expressed in this publication are those of the authors and do not necessarily reflect the views of UNEP DTU Partnership, UN Environment or University of Cape Town. We regret any errors or omissions that may have been unwittingly made. This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, the provided acknowledgement of the source is given. This publication may not be used for resale or any other commercial purpose whatsoever without prior permission in writing from the UNEP DTU Partnership.

Foreword

Ukraine plays an active role in international climate change cooperation processes. Being a Party of United Nations Framework Convention on Climate Change and Paris Agreement our country puts significant efforts through its policies and measures to contribute to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.



In July 2020, Ukraine at a high political level has supported the European Green Deal, which aims to achieve climate neutrality on the European continent by 2050. Ukraine has stated that it is an integral part of achieving the goals of this course and that is among other things, a logical continuation of international efforts to green the country's economy. In March 2021, the Cabinet of Ministers of Ukraine approved the National Economic Strategy for the period up to 2030, which provides for the achievement of climate neutrality no later than 2060.

Remaining an active participant in the global fight against climate change, recognizing its responsibility to achieve the goals of the Paris Agreement and guided by national interests and priorities, the Government of Ukraine needs a list of sectorial transformations, policies and measures to facilitate the transition to a climate-neutral economy in the second half of this century in the most economically and socially optimal way, on the basis of justice and in the context of sustainable development and efforts to eradicate poverty, as required by Article 4 of the Paris Agreement.

Low carbon development of Ukraine's economy will be possible only due to wide dissemination of modern highly efficient technologies, in particular, for Agriculture, Waste and Water sectors. For us, the ongoing Technology Needs Assessment project in Ukraine is an excellent opportunity to accelerate environmentally friendly technology transfer that should become the basis for Ukraine to reach the ambitious GHG emission reduction targets and promote low carbon and climate-resilient development of the country.

Iryna Stavchuk

A stylized, handwritten signature in black ink.

Deputy Minister for European integration
of Environmental Protection and Natural Resources of Ukraine

Preface

Ukraine has been playing an active role in the cooperation processes of international climate change as an Annex I Party to the United Nations Framework Convention on Climate Change since 1997 and Annex B Party to Kyoto Protocol since 2004.

In 2016, Ukraine was one of the first countries to ratify the Paris Agreement. Being committed to achieve Paris Agreement's goals and being guided by national priorities, Ukraine will ensure in doing its best to achieve by 2050 the target of indicative greenhouse gases emission up to 31-34% of the emission level in 1990. This target is ambitious and fair in the context of Ukraine's participation in the global response to the threat of climate change.

Ukraine has also climate related obligations determined in accordance to EU-Ukraine Association Agreement, which became the part of National Legislation in 2014, envisioned the gradual approximation of Ukraine's legislation to EU Laws and policies in energy efficiency, renewable energy, energy products taxation, waste treatment, and climate change, including the implementation of trading scheme for GHG allowances in accordance to Directive 2003/87/EU.

According to the Decision 3/CP.5 adopted at the 5th session of the United Nations Framework Convention on Climate Change Conference of Parties, Ukraine annually submits its National Greenhouse Gas Inventory, which includes the detailed and complete information for the entire time series in accordance with the guidelines of the UNFCCC. Moreover, in accordance with articles 4 and 12, under UNFCCC, the country periodically develops its National Communication. The latest one has been submitted in 2013.

In accordance with article 4, para. 12 under the Paris Agreement, Ukraine periodically submits its Nationally Determined Contribution. The first one has been submitted in 2016. Its revision will be completed in 2021.

In accordance with article 4, para. 19 under Paris Agreement, Ukraine has already prepared and submitted in 2018 its Low Emission Development Strategy up to 2050, being focused mostly at Energy and Industrial sectors.

The Paris Agreement, in enhancing the implementation of the United Nations Framework Convention on Climate Change, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

- «Controlling the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the increase in temperature to 1.5°C above preindustrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
- Increasing the ability to adapt to the adverse impacts of climate change and to foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;
- Making finance flows consistent with a pathway towards the low greenhouse gas emissions and the climate-resilient development».

In Ukraine, the achievement of optimum interrelationship (synergy) of Paris Agreement's goals with the Ukraine's national priorities will make it possible to:

- Enhance the role of the technological modernization of economy on the basis of sustainable development;
- Implement the renewable energy and material sources on a broader and sounder basis;
- Ensure the interlink of the State policy in climate change with the strategies, policies, plans and programs of economic and social development;

- Implement new economic instruments to ensure the optimum way for Ukraine in order to make its nationally determined contribution into Paris Agreement;
- Establish grounds to attract the climate investments into the Ukraine's economy;
- Strengthen the Ukraine's role in the international climate change with combatting efforts.

Ukraine is actively involved in Global Technology Need Assessment (TNA) process that should ensure adequate technological support and create a favourable environment for technology development and its transfer. The process of TNA serves as the continuation of systematic research on climate change in Ukraine. The TNA Project provided a great opportunity for Ukraine to perform the country-driven technology assessment to identify environmentally sound technologies that might be implemented with substantial contribution in addressing climate change mitigation needs of the country.

The first TNA Report for climate mitigation includes technology prioritization, which includes technological information, enabling environment, capacity building and understanding the mechanisms for technology transfer. The first report provides existing national policies on climate change mitigation and development priorities of the country, the inventory of GHG emissions, stakeholder engagement and institutional arrangements, sector prioritization process, the identification of criteria, the assessment of the technologies on the selected sectors by using the multi-criteria approach and technology prioritization. The first report contains the detailed description of prioritized technologies and technological fact sheets (TFS).

The second TNA Report for climate mitigation aims to outline the analysis of existing barriers and enable an environment for prioritized technologies in Ukraine. It has two objectives: to identify barriers to the transfer and diffusion of each selected technology and to establish enabling environment for technologies of the same sector on the basis of these findings.

The present third Report for climate mitigation includes Technology Action Plans (TAP) and Project Ideas for prioritized technologies in Waste and Agriculture sectors of Ukraine.

The results of Technology Needs Assessment process in Ukraine have already become an integral part of 2nd NDC preparation in Ukraine, in particular for Waste and Agriculture sectors.

The Executive Summary

The Technology Needs Assessment (TNA) project provides a great opportunity for Ukraine to perform the country-driven technology assessment to identify environmentally sound technologies that might be implemented with a substantial contribution in addressing climate change mitigation needs of the country.

The TNA for climate change mitigation in Ukraine is focused on Agriculture and Waste sectors. These two sectors are responsible for 17 % of total greenhouse gases emissions in 2018¹ and do not demonstrate downward trends during the last decade like Energy and Industry Sectors.

Agriculture sector demonstrates the upward trend with agriculture-related GHG emissions having increased by more than half during the last reporting decade. The intensification of agricultural production could lead to further significant growth of GHG emissions both in Agriculture sector and Land Use, Change in Land Use and Forestry sector due to the intensive application of fertilizers and soil mineralization.

The waste sector is only one where GHG emissions increased since 1990 and has remained at a constant level during the last decade. The growing waste generation and the lack of developed practices for waste management pose a risk for further growth of GHG emissions in the sector.

The technology action plan (TAP) is the third and final step (after technology's prioritization and technology barrier analysis and enabling framework phases) in the framework of technological transfer, which also includes technological information, enabling environment, capacity building and understanding the mechanisms for technological transfer in Ukraine. The TAP report aims to outline actions and responsible bodies for application and diffusion of technology in the Waste and Agriculture sectors of Ukraine. Its purpose is to present the action plan for prioritized technologies in the country, which is the outcome of the TNA process in general, and TAP preparation process in particular.

TAP is a summarized plan for the acceptance, diffusion and transfer of prioritized technologies that will contribute to the country's social, environmental and economic development and to climate change mitigation. TAP is composed of numerous specific actions. Those are the central components of TAP to implement the measures identified in the analysis of barriers and enabling frameworks.

The document is elaborated on the basis of "Enhancing the Implementation of Technology Needs Assessment's Guidance for Preparing a Technology Action Plan" developed by UNEP DTU Partnership² and it is based on the experience gained in the first and second phases of the TNA project in Ukraine.

During the first phase, following technologies (comprising consumer and capital goods, public provided and other market goods) were prioritized on the basis of TNA methodology and Multi-criteria analysis (MCA) approach³ and these were selected for further examination of barriers and enabling framework in Ukraine:

Agriculture sector:

- The use of information and telecommunication technologies for GHG emission reductions in agriculture;
- Conservation tillage technologies (low-till, no-till, strip-till, etc.);
- Biogas production from animal waste;
- Organic agriculture;
- The production and use of solid biofuels from agricultural residues

Waste sector:

- Methane capture at landfills and waste dumps for energy production;

[Ukraine, 2020 National Inventory Report \(NIR\) | UNFCCC](#)¹

² Enhancing Implementation of Technology Needs Assessments. Guidance for Preparing a Technology Action Plan. – UNEP DTU. –2017. [Enhancing Implementation Of Technology Needs Assessments – Technology Needs Assessment \(unepdtu.org\)](#)

³ MCA (2009). Multi-criteria analysis: a manual January 2009 Department for Communities and Local Government: London, available at: http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf

- Waste sorting (sorting of valuable components of municipal solid waste with subsequent treatment of waste residual by other technologies);
- The closure of old waste dumps with methane destruction (flaring, bio-covers, passive vent etc.)
- The aerobic biological treatment (composting) of food and green residuals;
- The mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of municipal solid waste);
- The mechanical-biological treatment of waste with the alternative fuel production for cement industry.

During the second phase, Barrier Analysis and Enabling Framework (BAEF, Report II) the list of important barriers for successful dissemination of prioritized technologies was identified taking the country-specific circumstances in Ukraine, as well as the corresponding measures to overcome these barriers was proposed. It was done following the Second Edition of Overcoming Barriers to the Transfer and Diffusion of Climate Technologies Guidebook⁴ developed by UNEP DTU. The following groups of barriers and corresponding measures to overcome them were identified: the economic, financial, legal and regulatory, network, institutional and organizational capacity, human resources; social, cultural and behavioural; information and awareness; and technical. The corresponding barriers and measures to overcome them are presented in detail in the BAEF report.

It has to be noted that in the BAEF phase, benefits from the implementation of mitigation actions to contribute to gender equality in the waste and agriculture economy sectors of Ukraine were investigated. The results of the gender analyses and corresponding clarifications on how the concrete measures would contribute to gender equality are presented in BAEF report.

TAP phase was implemented in close cooperation with the stakeholders. Due to the global pandemic caused by COVID-19, all consultations with the stakeholders as well as the meetings of sectoral working groups were carried out virtually. At that stage, the project experts have prepared the zero-draft version of the specific TAPs for each prioritized technology in accordance with the guidance provided by UNEP DTU. Thereafter, the personal consultations were organized with interested parties including key national experts and stakeholders' representatives.

These two stages approach have created preconditions for dialogue with stakeholders regarding further TAP preparation activity. This dialogue was organized by the Ministry of Ecology and Natural Resources of Ukraine through online conference. The event was headed by Iryna Stavchuk, the Deputy Minister of Ecology and Natural Resources of Ukraine. During the conference, the main results of the Technology Prioritizations and Barrier Analysis and Enabling Framework phases were presented. The vision of final phase of the project execution was discussed.

Then sectoral experts of the project have prepared and sent the questionnaires to the stakeholders aimed at revealing the most important actions which implementation would be crucial for further diffusion of the prioritized technologies. At the last stage, final versions of technology TAPs were finalized paying attention to stakeholders' responds provided in the questionnaires. The project ideas for the most popular technologies among the stakeholders were prepared and included in the report. The questionnaires have played the two important roles - to perform QA for the draft TAP version and to ensure the active participation of stakeholders in TAP preparation process.

For each prioritized technology, the TAP was prepared including:

- the level of ambition;
- actions and activities to be implemented;
- information on stakeholders to be involved and the timeframe of activity implementation;
- the estimation of resources needed for actions and activities;

⁴ Nygaard, I., & Hansen, U. E. (2015) Overcoming Barriers to the Transfer and Diffusion of Climate Technologies. (2nd ed.) UNEP DTU Partnership. TNA Guidebook Series. Available at: https://backend.orbit.dtu.dk/ws/files/121688225/Overcoming_Barriers_2nd_ed.pdf.

- management planning;
- generalized table, specifying the key milestones for technology TAP implementation.

The following main results were obtained in the TAP phase of TNA project in Ukraine.

Agriculture sector:

Activities included in the TAPs have the potential to support climate technologies dissemination and trigger significant GHGs emission reduction in Agriculture sector (see Table ES.1).

Table ES.1 – The level of ambition for agriculture sector in Ukraine

Technology	Level of ambition for 2030		
	GHGs emission reduction, Mt of CO ₂ -eq. per year	Land area coverage, million ha	Other parameters
The use of information and telecommunication technologies for GHG emission reductions in agriculture	2	10	-
Conservative tillage technologies	7	10	-
Biogas production from animal waste	2	-	0.34 billion m ³ of natural gas 250 MW of electric capacity
Organic agriculture	3.5	3.5	-
The production and use of solid biofuels from agricultural residues	3.8	-	3.6 Mtoe of solid agricultural residues

The dissemination of proposed climate technologies will also result in additional benefits due to the increased operational efficiency and material efficiency of agricultural production, the development of rural areas, the reduced soil erosion and runoff pollution of water resources, improved soil quality and fertility, as well as adaptation co-benefits.

The proposed project idea “Enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine” was developed to support the implementation of the following three technologies:

- The use of information and telecommunication technologies for GHG emission reductions in agriculture,
- Conservative tillage,
- Organic agriculture.

All three technologies relate to crop production and have the potential to both reduce greenhouse gases emissions from agricultural operations and increase carbon sequestration. ICT increases the operational efficiency of farm operation and could serve as an enabler for the introduction of conservative tillage and organic agriculture.

Waste sector:

Detailed intermediate and target indicators for waste management system development were formulated and presented⁵ in Ukraine by 2050. The set of indicators is quite ambitious, however it is realistic and could be fully achieved by local opinions. The proposed set of target indicators is presented in the table ES.2. This trend corresponds to the target scenario of Waste sector development for 2030 and 2050 in 2nd NDC, and the

⁵ Processing is disaggregated by recycling and biological treatment

full implementation of acting National Waste Management Strategy by 2040, that means it's postponement by 10 years⁶.

Table ES.2 – The level of ambition for waste management sector development in Ukraine up to 2050

Indicator for MSW	Base value, 2020	Target		Long-term vision
		2030	2040	2050
Reuse	4.6	8	10	10
Recycling		10	34	40
Biological treatment		5	16	20
Incineration	1.7	7	10	25
Disposal/landfilling	93.7	70	30	5
Total (estimated)	100	100	100	100

Project ideas were prepared for the most popular technologies among the stakeholders:

- The creation of Ukraine Circular Economy Platform (Waste sorting).
- The aerobic composting of food and green residuals by windrow method.
- The mechanical-biological treatment of municipal solid waste with biogas production.

Important gender equality issues are addressed in the light of implementation of mitigation actions in the waste and agriculture economy sectors of Ukraine:

- each project idea includes benefits for gender equality from its implementation;
- cross-cutting sections include information on gender equality opportunities from waste management sector development.

The diffusion of modern MSW treatment technologies will benefit not only to the GHG emission reduction in the corresponding type of economy activity, as well as to the implementation of economy sound solutions. It will also lead to GHG emission reduction and economic benefits in all other IPCC sectors: industry – by reducing the need in primary raw material for manufacturing; energy – by combusting alternative fuels; agriculture and forestry – by the prevention of crucial industrial impact on lands, as well as the use of organic fertilizers manufactured from organic waste fraction as an alternative to mineral fertilizers. Moreover, different MSW treatment technologies shouldn't be considered as simple alternatives. On the contrary, they are complimentary to each other, wherein the scale of each technology diffusion depends on country and regional circumstances, such as MSW composition, the density of inhabitants and their welfare and culture etc. At the project level, it means that all the above-mentioned circumstances should be taken into account, when implementing specific design solutions.

The diffusion of modern MSW treatment technologies and climate technologies in agriculture will also benefit to gender equality in Ukraine, in particular, contributing to the decrease in difference between the average salary for men and women, as well as to increasing the share of women in the management staff in the waste treatment and agriculture companies in Ukraine.

The map of main outcomes of the TAP process, which are prepared with technology specific TAPs and project ideas both in the waste and agriculture sectors, are presented in Tables ES.3 and ES4 respectively.

⁶ Unfortunately, the National Waste Management Strategy up to 2030 can't be implemented in time.

Table ES.3 – The map of technology specific TAPs and project ideas, agriculture sector

Type of outcome	Technology	Location
TAP	The use of information and telecommunication technologies for GHG emission reductions in agriculture	Section 1.1.2.7
TAP	Conservation tillage technologies (low-till, no-till, strip-till, etc.)	Section 1.1.3.7
TAP	Biogas production from animal waste	Section 1.1.4.7
TAP	Organic agriculture	Section 1.1.5.7
TAP	The production and use of solid biofuels from agricultural residues	Section 1.1.6.7
Project idea	Enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine	Section 1.2.2

Table ES.4 – The map of technology specific TAPs and project ideas, waste sector

Type of outcome	Technology	Location
TAP	Methane capture at landfills and waste dumps for energy production	Section 2.1.2.7
TAP	Sorting of valuable components of MSW with subsequent treatment of waste residual by other technologies	Section 2.1.3.7
TAP	The closure of old waste dumps with methane destruction	Section 2.1.4.7
TAP	The aerobic biological treatment (composting) of food and green residuals	Section 2.1.5.7
TAP	The mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of MSW)	Section 2.1.6.7
TAP	The mechanical-biological treatment of waste with alternative fuel (SRF) production for cement industry	Section 2.1.7.7
Project idea	The creation of Ukrainian Circular Economy Platform	Section 2.2.2.A
Project idea	The aerobic composting of food and green residuals by windrow method	Section 2.2.2.B
Project idea	The mechanical-biological treatment of municipal solid waste with biogas production	Section 2.2.2.C

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Acronyms

AD	Anaerobic Digestion
BAEF	Barrier Analysis and Enabling Framework
CAPEX	Capital Expenditures
CHP	Combined Heat and Power
CLO	Compost-Like-Output
CMU	Cabinet of Ministers of Ukraine
COP	Conference of the Parties
DH(S)	District Heating (Systems)
DTU	Technical University of Denmark
EBRD	European Bank Reconstruction and Development
EPR	Extended Producer Responsibility
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
ICT	Information and Telecommunication Technologies
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
LEDS	Low Emission Development Strategy
LFG	Landfill Gas
LULUCF	Land Use, Land-Use Change and Forestry
MBT	The Mechanical Biological Treatment of waste
MCA	Multi Criteria Analysis
MCTDU	The Ministry of Communities and Territories Development of Ukraine
MENRU	The Ministry of Ecology and Natural Resources of Ukraine
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
NC	National Communication
NDC	Nationally Determined Contribution
NEURCU	National Energy and Utilities Regulatory Commission of Ukraine
NGO	Non-Governmental Organization
NPV	Net Present Value
OPEX	Operational Expenditures
RES	Renewable Energy Sources
RDF	Refused Derived Fuel
SAEE	The State Agency on Energy Efficiency and Energy Saving
SCU	The Supreme Council of Ukraine (Verkhovna Rada of Ukraine)
SRF	Solid Recovered Fuel
TAP	Technology Action Plan
TNA	Technology Needs Assessment
TPEC	Total Primary Energy Consumption
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WSL	Waste Sorting Line
WWTP	Waste Water Treatment Plant

Units of measurement

°C	Degrees Celsius
CO ₂ -eq.	Carbon Dioxide equivalent
GWh	Gigawatt-hour
ha	hectare
EUR	Euro (€)
kt	thousand tons
ktoe	thousand tons of oil equivalent
kWh	kilowatt-hour
Mt	Millions of tons
Mtoe	Millions tons of oil equivalent
MW	Megawatt
MWh	Megawatt-hour
toe	tons of oil equivalent
USD	United States Dollar

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Chapter 1 Technology Action Plan and Project Ideas for Agriculture Sector

1.1 TAP for Agriculture Sector

1.1.1 Sector overview

Agriculture sector is an important driver of national economic growth, expansion of export volumes, as well as food security.

Historical GHG's emissions. Agriculture sector has significant contribution to total greenhouse gases emission volumes in Ukraine. Emissions related to agricultural activities are reported in several categories of the national GHGs inventory (i.e. Agriculture, Fuel Combustion Activities, and Cropland sub-sector in Land Use, Land Use Change, and Forestry sector) and their total volume is estimated at the level of 98.8 Mt CO₂-eq. for 2019. The main sources of emissions include soil organic carbon loss at cropland (51%), agricultural soils (33%), enteric fermentation (8%), fuel use by agricultural machinery (6%), and manure management (2%). Other sources (e.g. fuel and energy use by stationary sources at agricultural enterprises, urea application, rice cultivation, etc.) contribute to less than 1% of the total volume of agriculture-related GHGs emissions in Ukraine (GHGI, 2021).

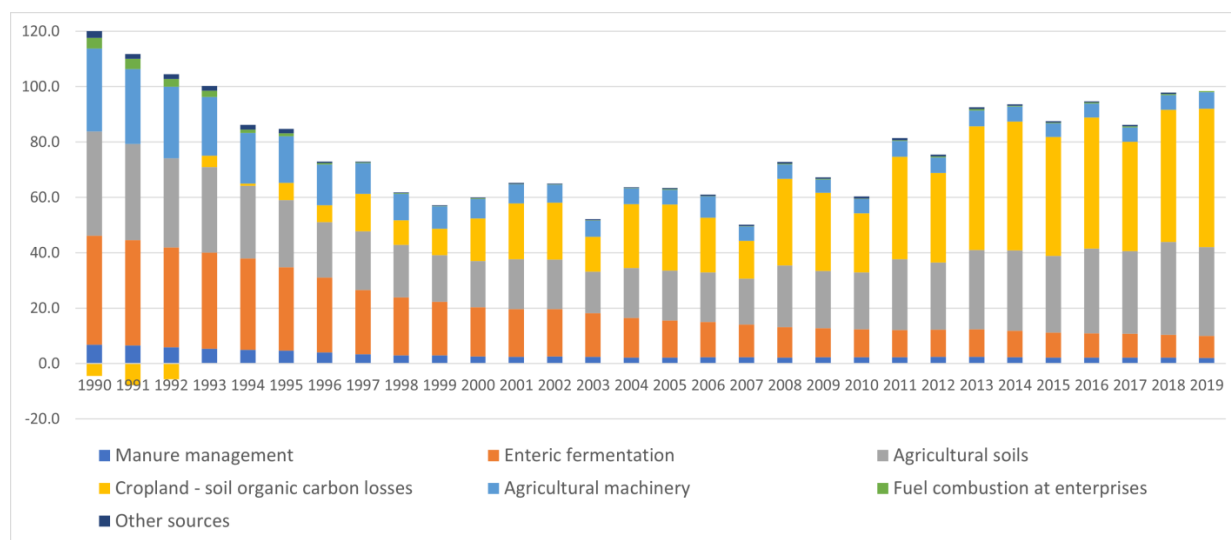


Fig. 1.1. GHGs emission volumes from agricultural activities in 1990-2019

Emissions in the cropland sub-sector stem from soil organic carbon losses due to more intense agricultural practices and decline in the use of organic fertilizers and demonstrate a tendency to grow. The loss of soil organic carbon is caused by a negative balance between the inflow of nitrogen and carbon in the form of humification of dead organic matter and organic fertilizers on one side and the removal of nitrogen and carbon with main products (harvest), by-products and crop residues as a result of soil humus mineralization process on the other side (GHGI, 2019).

Emissions from agricultural soils are driven by more intense application of mineral nitrogen fertilizers. Both the average application rate for mineral N fertilizers and the area treated with mineral fertilizers are growing in Ukraine. There is further potential for growth, especially in terms of land area treated by mineral fertilizers, and the implementation of climate technologies is important to balance potential increase in emission volumes.

On the contrary, emission related to husbandry activities (i.e. enteric fermentation and manure management) decline over time due to lower number of animals grown in Ukraine.

Emissions from the use of liquid fuel by agricultural machinery are not reported directly in the national GHGs inventory and were estimated on the assumption that they constitute 90% of emissions from fuel consumption by off-road transport. Agricultural machinery consumes approximately 1.5-1.6 Mt of diesel fuel per year with two opposite trends being observed. On the one hand, intensification of

agricultural practices and investment in new machinery lead to the increase in fuel consumption. On the other hand, fuel efficiency increases due to the use of more powerful equipment and ICT.

The agriculture sector is reflected in the existing strategic documents related to national climate policy but there is insufficient coverage of climate change mitigation activities in sector-specific policy documents and the lack of policy tools which promote climate technologies in the agriculture sector.

Low Emissions Development Strategy (LEDS, 2017) includes several policy options for climate mitigation in the agriculture sector: drafting nationally acceptable recommendations on the improvement of animal feeding practice (increase in the feed energy content, the use of specific natural or synthetic additives to improve digestibility, etc.); promoting the implementation of improved manure management technologies; enhancing the efficiency in the use of fertilizers; and incentivizing more efficient use of water.

GHG emissions projections. Ukraine has updated its NDC on the basis of the modeling of GHGs emissions prepared within EBRD's project "Support to the Government of Ukraine for updating its Nationally Determined Contribution (NDC)" and broad stakeholder consultation activities conducted during December, 2020 – April, 2021. Reports prepared under the TNA project were used in defining future GHGs emission targets during NDC development, as well as for the selection of policy and measures to support NDC implementation.

According to the updated NDC, Ukraine's new more ambitious target is to reduce GHGs emissions by 65% compared to 1990 levels in 2030. The NDC does not contain sectoral targets, however, accompanying presentation materials indicated the planned reduction of GHGs emissions in the Agriculture category of the national GHGs emission inventory to 38 Mt CO₂-eq. in 2030 or by 14% comparing to 2018 levels and 56% comparing to 1990 levels (NDC, 2021).

Technology Needs Assessment in Ukraine. Technology's prioritization for the Agriculture sector was carried out in the first phase of Technology Needs Assessment for climate change mitigation in Ukraine (TNA, 2019). Within the first stage of the TNA project, the following mitigation technologies have been selected taking into account consultation with a wide group of stakeholders, agriculture sector's development priorities, climate, energy and environmental policy goals:

- 1) Organic agriculture;
- 2) Biogas production from animal waste;
- 3) Conservation tillage technologies (low-till, no-till, strip-till, etc.);
- 4) The production and use of solid biofuels from agricultural residues;
- 5) The use of information and telecommunication technologies in agriculture for the reduction of GHGs emission in agriculture.

The second phase of Technology Needs Assessment included the analysis of technology barriers and developing recommendations for creating enabling framework in order to ensure further dissemination of climate technologies in agriculture in Ukraine (TNA, 2020).

All technologies listed above are already available in Ukraine, however the level of penetration is far beyond their technological and economic potential. The key barriers identified under the TNA project and recommendations on the measures to overcome barriers are summarized in the following sections.

Actions included in the technology action plans aim at supporting further dissemination of prioritized technologies.

The diffusion of climate mitigation technologies in the agricultural sector would create new job opportunities, as, for instance, organic agriculture is more labor intensive than traditional farming practices. It is important that the state's support measures that introduced to promote the diffusion of climate technologies, take into account gender aspects (support of women owned farms, women access to capacity building programs, etc.) to close the existing gender gap in employment and salary levels.

Stakeholder consultations. Key stakeholders for the implementation of the TAPs for climate technologies in agriculture include:

- central state authorities, including the Ministry of Agricultural Policy, the Ministry of Environmental Protection and Natural Resources, the Ministry of Economy, the State Energy Savings and Energy Efficiency Agency of Ukraine;
- regional and local state authorities, including regional state administrations and local communities;
- business associations and private companies;
- scientific institutions; and
- non-governmental organizations.

Stakeholder's engagement process within the third stage of the TNA project included the following activities:

- the presentation of actions planned for the inclusion in the TAPs during the webinar for stakeholder organized by the Ministry of Environmental Protection and Natural Resources of Ukraine on 26.03.2021;
- the collection of feedback from stakeholders using an online questionnaire and submission of additional recommendations (see **Annex IV**);
- the additional presentation of the actions planned for inclusion in the TAPs during industry conferences, in particular, Agro Green Deal 2021 (25.02.2021), Organic Ukraine 2021 (16.04.2021), and a series of webinars within "Estimation of carbon stocks in Chornozems" project in (June-July, 2021);
- in person interviews with the experts specialized in prioritized mitigation technologies;
- the review of position papers and other communications presented by institutions, private companies and business associations;
- participation in key agricultural exhibitions and conferences and following the presentations of sector representatives on the developments of prioritized technologies;
- online discussions using social media and email communication.

The webinar dedicated to stakeholder consultations on TAP development for both mitigation and adaptation of climate technologies in agriculture was held on 26.03.2021. It included a presentation by sectoral experts of TNA project covering the general description of the sector, key findings of the previous stages of the TNA process, as well as recommendations on actions and activities that could support further dissemination of the prioritized climate technologies. Stakeholders who were involved had the opportunity to provide their feedback both during the event and via follow up questionnaires.

TAP preparation is built upon the measures identified in TNA for overcoming barriers to technology implementation and specifies how implement these measures, including who is responsible, when, and from where to secure funding. As such, TAP serves as a bridge between the analysis of prioritized technologies and their implementation. TAPs are developed in accordance with the Guidelines provided by UNEP-DTU Partnership (IETNA, 2017).

The action plans for each technology include the descriptions of respective sector and sub-sector, the ambition related to implementation of the technology, the list of actions, as well as the activities to be implemented under each action. For each activity, there are details on the sources of implementation funding, responsible bodies, implementation timeframe, relevant risks, success criteria, indicators for monitoring of implementation and the budgets.

1.1.2 Action Plan for Technology A1 “The use of information and telecommunication technologies for GHG emission reductions in agriculture”

1.1.2.1 Introduction

Information and telecommunication technologies that have emerged in recent years provide various benefits to farmers in terms of cost saving, resource efficiency, labour optimization, and could also support climate mitigation activities in the agricultural sector. Examples of Information and Telecommunication Technologies (ICT) use in agriculture include the use of auto pilots at agricultural machinery for more efficient operation, drones for the aerial monitoring of agricultural lands and development of fertilizers input maps, satellite images to analyse the land productivity and other characteristics, tractor mounted sensors, specialized applications and software, etc. Besides, technologies required to use digital data include guidance systems that can be used on all kinds of equipment (e.g. tractors, sprayers, planters, etc.) and variable rate technology (VRT) that focuses on the automated application of materials (fertilizers, chemicals, seeds and water) to a given landscape (FAO, 2019).

The Agricultural sector is the largest source of nitrous oxide emissions in Ukraine with agricultural soils being responsible for the major share of emissions. The emission of nitrous oxide from soils occurs naturally as a result of the microbial processes of ammonification, nitrification and denitrification, but the application of nitrogenous fertilizers increases significantly the amount of N₂O emitted from the soils. Emissions from inorganic N fertilizers constitutes about one fifth of all nitrous oxide emissions from Agricultural sector. They directly depend on the volumes of synthetic fertilizers (sodium nitrate, calcium nitrate, ammonium nitrate, ammonium chloride and others) applied by the agricultural companies and demonstrate the tendency to grow. Besides, nitrogen input with mineral fertilizers also contributes to the emissions of greenhouse gases reported under atmospheric deposition and nitrogen leaching and run-off categories of the national inventory.

According to the data from the State Statistical Service of Ukraine, the volumes of synthetic fertilizers applied in Ukraine have been continuously growing during recent years due to both increasing application rate and the expanding area of agricultural land, where synthetic fertilizers are applied. The average N input per hectare of land where synthetic fertilizers were applied has increased to 97.7 kg N per ha in 2019 (SSU, 2021). In Europe, fertilizers containing an average of 11.5 million tons of nitrogen were applied to 133.8 million hectares of farmland, leading to an average application rate of 86 kg N per ha (FE, 2019). Therefore, the average application rate in Ukraine during recent years has already exceeded the average European levels. There is a potential for further growth of N fertilizer's application and associated GHGs emissions both due to increasing application rates and areas. The promotion of climate technologies is important for limiting the increase in GHGs emissions from agricultural sector during the next ten years.

Fertilizers Europe forecasts slight decrease in nitrogen mineral fertilizers application to 11.1 million ha applied to 133 million hectares of farmland leading to slight reduction in application rate to 83.5 kg N per ha (FE, 2020). At the same time, EU's Farm to Fork Strategy developed as a part of Green Deal envisages the reduction of the use of fertilizers by at least 20% by 2030 to achieve the reduction of nutrient losses by at least 50%, while ensuring that there is no deterioration in soil fertility (EC, 2020). Thus, N application rate could be reduced up to 69 kg N per ha.

Reduction in fertilizers application could negatively impact production volumes and competitiveness of farmers, as well as food security (USDA, 2020). The promotion of the technology could limit the negative effects on productivity, increase efficiency rates of nitrogen use and minimize the negative impact of agriculture on the environment.

Additional information on the technology is presented in Mitigation Technology Barrier Analysis and Enabling Framework report and technology factsheet presented in the Technology Needs Assessment report prepared within the TNA project.

1.1.2.2 Ambition for the TAP

GHGs emission reduction potential stems from lower emissions from mineral fertilizers, fuel combustion and control over land use requirements.

The use of information and telecommunication technologies allows differentiated fertilizer's input using guidance systems for agricultural machinery and variable rate application technologies leading to fertilizers savings. Savings could reach as much as 20% of fertilizers without productivity losses. Potential savings of fertilizers depend significantly on the characteristics of specific fields. In fields with relatively equal soil characteristics, savings would be limited (e.g. 2-3% or lower) and variable rate application technologies would not be feasible. On the contrary, in fields with significant differences in soil characteristics and soil types across different sections, the savings would be the highest (e.g. 12-20%).

Potential in the reduction of GHGs emission due to lower N₂O emissions depends significantly on the expected changes in mineral fertilizer's application rates and changes in land areas where mineral fertilizers are applied. Potential scenarios include the stabilization of GHGs emission volumes, when the improved efficiency is compensated by additional land area treated by mineral fertilizers, and reduction by approximately 1 Mt of CO₂-eq. The additional reduction of GHG emissions in Industry sector could be achieved due to the reduced use of fossil fuel for fertilizer's manufacturing. According to the National Emission Inventory of Ukraine (GHGI, 2018; GHGI, 2020), the average emission factor is estimated at the level of 1.3 tons of CO₂ per ton of ammonia produced in Ukraine or 1.6 tons CO₂ per ton of nitrogen content.

The use of ICT in agriculture could also reduce fuel consumption per hectare of land and lead to GHGs emission reductions. Publicly reported data of Ukrainian large agricultural holdings demonstrate the improvement of fuel efficiency by 10-15% per hectare of land cultivated during several years. This is partly explained by the use of more powerful and larger size vehicles providing lower specific consumption of fuel, but also by the improvement of operation efficiency due to the use of GPS trackers, the remote monitoring of fuel consumption and running machinery in auto-pilot mode. Improving the fuel efficiency by 10% during agricultural operations in Ukraine will allow achieving GHGs emission reduction over 0.5 Mt CO₂-eq.

ICT and, in particular, satellite and aerial images analysis could be an important tool for the control of land use practices and identification of land use changes that lead to increased GHGs emissions. ICT tools also allow farmers to use their land bank more efficiently by identifying excessive unused land areas (e.g. field entry and exit points). According to the estimates of experts, approximately 2-4% of land areas could be added to harvesting area due to the use of ICT. However, agricultural companies could also violate land use requirements by using the land plots that are located in water protection zones, nature protected areas or on slopes. A recent study prepared by NGO Ecoaction, revealed that the satellite imagery analysis and machine learning techniques could provide valuable information about the practices of land use (e.g. arable land within the territories of natural protected areas, water protection zones, forest areas, and on the slopes). The algorithms of machine learning also allows the identification of specific crop's varieties and control over crop's rotation practices (Ecoaction, 2020). ICT could provide effective tools for the identification of such violations and contribute to land conservation efforts.

The technology could be broadly applied in all regions of Ukraine, as there is developed IT infrastructure (e.g. high mobile network coverage, internet access rate, smart-phone adoption rate) and there are both local and international service providers available in the market allowing the extension of technology application in a short-term period. The extensive diffusion of ICT in agriculture could trigger total GHG emission reductions at the level of 2 Mt of CO₂-eq. per year. The effectiveness of the technology will be increasing with time due to both new technology developments and accumulation of data on soil characteristics, agricultural practices and yields.

The development of the proposed mitigation technology could have synergies with the development of an agrometeorological early warning system, which is defined as a priority adaptation technology within the TNA project, and also serve as an enabler for other mitigation technologies in agricultural sector.

1.1.2.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

Economic and financial barriers. Direct capital costs for the implementation of the ICT tools are moderate, however, potential capital expenditures are mainly related to indirect costs for the investment in the machinery and equipment, which will allow the practical application of recommendations, developed using ICT tools (tractors with computer-based guidance systems, specialized software, machinery for differentiated fertilizers input, and other variable rate technologies). In case of differentiated fertilizers input technologies, the economic barrier could be significant, as economic benefits from fertilizers savings could be limited (not accounting for the economic cost of greenhouse gases emissions). Digital technologies have strong economies of scale and scope, making a greater volume required to make them profitable and creating disadvantage for the adoption and operation of ICT in a sustainable manner for small farmers (FAO, 2019). For small and medium farms, economic and financial barriers could be applicable even for smaller investments such as the purchase of drones and software.

Technological barriers for the diffusion of ICT in agriculture include the insufficient coverage of RTK and GSM networks in rural areas, as well as the low availability of agricultural meteorological stations. Besides, due to high priority on cost optimization, integrated technological solutions in some cases do not meet high quality requirements, which along with the lack of service networks leads to technological problems during operation. In addition, lack of interoperability standards and of technical protocols that would allow communication between machinery and tools/instrument is considered as one of the main challenges associated with precision agriculture, which limits the exchange of data between systems, increase administrative burden and creates risks of farmers' dependency on a single technology provider.

Regulatory barrier relates to the lack of approved and enforceable legislative framework for land protection and nutrients management. The Cabinet of Ministers of Ukraine has approved standards for the optimal crop rotation for different regions of Ukraine (CMU, 2010), however the control over compliance with such standards is not effective. Similarly, the Law of Ukraine On Land Protection defines general provisions on soil quality standards and prevention from soil contamination, however lacks effective enforcement measures (LoU, 2003). The provisions of EU's Nitrates Directive are not yet incorporated in the national legislation of Ukraine. The additional regulatory gap, that needs to be addressed to promote the technology, relates to legislation on the use of drones in agriculture.

Capacity barrier relates to the lack of understanding of benefits related to the application of modern information and telecommunication technologies and experience in their implementation, especially in small and medium enterprises. The application of ICT requires the new types of knowledge and skills among farmers from totally new areas of expertise (e.g. data and map processing, use of new software packages, etc.). This barrier relates both to the management, which should have a clear vision of benefits from the technology and support trials and experimentation, and to for workers in fields, that should be trained to use modern machinery and ICT tools. The training of the personnel and changing their mindsets takes time and lower capacity reduces the speed of technology diffusion.

Information barriers are associated with insufficient publicly available information about cost and benefits of the ICT application in agriculture, low quality of available data, as well as different data formats. There is a growing community of AgriTech specialists from business sector and increasing number of specialized events and publications. However, environmental and climate benefits are not among priorities and receive low attention in the growing information coverage of ICT tools in agriculture. The provision of reliable and up-to-date information is especially important, since digital technologies are constantly evolving at high speed. Besides, the available data about soil quality and land use do not meet industry's requirements and businesses spent significant time to accumulate high-quality data, improving their coverage from year to year.

The summary of measures to overcome identified barriers

State Subsidies. In case of supporting the ICT use in agriculture, subsidies could be provided for the purchase of agricultural machinery and equipment that allow variable applications of fertilizers. Taking into account the economy of scale of digital technologies in agriculture, a special focus should be paid

to the financial support of small and medium agricultural enterprises. Additional conditions for state support provision could include requirements for data collection in order to guide the future policy development process.

Regulatory Framework on Nutrients Management. In order to foster the implementation of the technology, it is recommended to develop, adopt and enforce the regulatory framework for ensuring the effective use of nitrogen fertilizers according to the requirements of the EU's Nitrates Directive (Nitrates Directive, 1991). The objective of the directive is to reduce water pollution caused or induced by nitrates from agricultural sources and preventing from such further pollution. The Directive requires the establishment of a code or codes of good agricultural practice, to be implemented by farmers on a voluntary basis. Member States may also include in their code(s) of good agricultural practices for the establishment of fertilizer plans on a farm-by-farm basis and the keeping of records on fertilizer use. The Directive also prescribes setting up, where necessary, a programme, including the provision of training and information for farmers, promoting the application of the code(s) of good agricultural practice. Though the Directive does not specifically target the use of information and telecommunication technologies for GHGs emission reductions in agriculture, the application of this technology could ensure meeting many recommendations mentioned in the Directive and Codes of Good Agricultural Practices.

Capacity building policies. Measures aimed at capacity building for the use of ICT in agriculture for reducing the emissions of greenhouse gas could cover the inclusion of the information about ICT in agriculture in the activities of farm advisory services and establishing and support of educational programs devoted to the technology in educational institutions teaching young professionals for agriculture sector. The development of ICT in agriculture and climate mitigation should be included in national farm advisory services development program, national agriculture and rural development programs, and regional and local socio-economic development programs to be eligible for receiving finance for advisory services from national and local budgets. Representatives from agricultural companies and AgriTech industry are interested in cooperation for developing professional education programs for universities and other educational institutions, but the establishment of such programs requires support from state authorities and management of the universities. There is also a growing interest in establishing the research and development offices of international companies in Ukraine, which could be potentially used as the valuable source of most up-to-date knowledge about ICT in agriculture.

Information Policies. The state authorities can support the dissemination of the technology through the dissemination of information about nitrogen management and ICT in agriculture for reducing the emissions of greenhouse gases among farmers, supporting the development of publicly available decision-support tools that optimize fertilizer application using ICT, and fostering cooperation of industry players and informal industry networks through the support of industry conferences, round-tables, accelerators, field days and other events. Communication channels should be aligned with the preferences of local farmers and could include social media, messengers, electronic newsletters or specially developed dedicated mobile applications. The provision of reliable statistical data on soil quality and land use is another important element of the enabling framework for the diffusion of ICT in agriculture. High quality data will allow the development of analytical tools and scientific studies, which could lead to the increased efficiency of the technology.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

On the basis of measures identified above, the following actions were selected for inclusion in the TAP:

- The introduction of state subsidies for climate technologies in agriculture;
- The approval of the regulatory framework on nutrients management;
- Capacity building policies;
- Information policies.

The table below describes specific activities for each of the action selected for inclusion in the TAP.

Actions	Activities
1. State subsidies	1.1 The amendment of paragraph 3 of the Order of the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with inclusion of ICT in the list of activities supported.
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of ICT in agriculture (Order for the Provision of State Support for ICT in agriculture) with annual adjustment of the procedure
	1.3 Gradual increase in the financing volume for the support of ICT in agriculture in the state program of agricultural support
2. Regulatory Framework on Nutrients Management	2.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers.
	2.2 The approval of the Code of Good Agricultural Practices
	2.3 Setting up and implementation of a programme for promoting the application of the code of good agricultural practice, including the provision of training and information for farmers
3. Capacity building policies.	3.1 The inclusion and promotion of climate technologies in agriculture in the activities of farm advisory services (including ICT in agriculture), involvement of private advisory service providers, and capacity building activities for the experts of farm advisory services in line with the Law of Ukraine On Agricultural Farm Advisory Services
	3.2 Developing educational program for universities and vocational schools about climate technologies in agriculture (including ICT in agriculture)
4. Information policies	4.1 The dissemination of information on nitrogen management and ICT in agriculture for reducing the emissions of greenhouse gases
	4.2 Improving soil monitoring and provision of reliable soil quality data

In order to support the implementation of identified activities, the following actions could be implemented as a part of a Project idea: 1) technical assistance to introduce state subsidies for climate technologies in agriculture; 2) capacity building policies; 3) information policies.

1.1.2.4 Stakeholders and Timeline for the implementation of TAP

Key stakeholders for the implementation of TAP include the following:

- The Ministry of Economy of Ukraine,
- The Ministry of Agricultural Policy of Ukraine,
- The Ministry of Environmental Protection and Natural Resources of Ukraine,
- The Ministry of Finance of Ukraine,
- The State Service of Ukraine on Food Safety and Consumer Protection,
- Committee on the Agrarian and Land Policy Aspects of Verkhovna Rada of Ukraine,
- Committee on the Environmental Policy and Natural Resources of Verkhovna Rada of Ukraine,
- Regional state administrations,
- Ukrainian Agribusiness Club,
- The Food and Agriculture Organization of the United Nations,
- EU-funded EU4Environment program,

- German-Ukrainian Agricultural Policy Dialogue,
- National Association of Agricultural Advisory Services of Ukraine,
- Non-governmental organization Green Dossier,
- Center for Environmental Initiatives Ecoaction,
- The State Institution Scientific and Methodological Center of Higher and Vocational Education.

Activities included in the TAP could be implemented during the period 2021-2030 as detailed for each activity in the TAP overview table below and in Annex VI.

1.1.2.5 Estimation of Resources Needed for Action and Activities

The implementation of actions and activities included in the TAP will require capacity building via promotion of ICT in agriculture within the activities of farm advisory services and developing educational program for universities and vocational schools about climate technologies in agriculture.

Potential capital expenditures are mainly related to indirect costs for the investment in the machinery and equipment, which will allow the practical application of recommendations, developed using ICT tools (tractors with computer-based guidance systems, specialized software, machinery for differentiated fertilizers input, and other variable rate technologies). Direct capital expenditures could be also quite significant in case of establishing own divisions for ICT application as an alternative to use specialized service providers, especially for small and medium farms.

Initial expenses for the implementation of activities required for the creation of the enabling framework for the dissemination of technology is estimated at the level of up to UAH 516 million per year with the most significant share of funds for state subsidies.

1.1.2.6 Management Planning

Key risks for the implementation of technology and activities covered by the proposed TAP include the lack of financial resources for state subsidies, changes of political priorities and reducing the support for sustainable agricultural practices, as well as the lack of sufficient capacity.

The priority actions to mitigate risks and create enabling framework for the technology is the introduction and gradual increase of state subsidies based on available resources and taking into account benefits of climate technologies, the introduction of regulatory framework on nutrient management, information policies and the enhanced soil quality monitoring system.

1.1.2.7 TAP overview table

Sector	Agriculture							
Sub-sector	Crop production							
Technology	The use of information and telecommunication technologies for GHG emission reductions in agriculture							
Ambition	Modern ICT applied at the area of at least 10 million ha GHG emission reductions at the level of 2 Mt of CO ₂ -eq. per year							
Benefits	Increased operational efficiency of agricultural production Reduced runoff pollution of water resources Improved material efficiency (fertilizers, diesel fuel and other input materials)							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. State subsidies	1.1 The amendment of paragraph 3 of the Order for the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with inclusion of ICT in the list of activities supported.	State budget	Ministry of Agricultural Policy of Ukraine	2022	Political (changes of political priorities)	Document adopted	Availability of approved amendments	N/A
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of ICT in agriculture (Order for the Provision of State Support for ICT in agriculture) with annual adjustment of the procedure	State budget	Ministry of Agricultural Policy of Ukraine	2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	1.3 Gradual increase in the financing volume for the support of ICT in agriculture in the state program of agricultural support	State budget	Ministry of Agricultural Policy of Ukraine	2022-2030	Financial (the lack of available budget funds)	Finance secured in state budget	Amount of funding	UAH 50 – 500 million per year
2. Regulatory Framework on Nutrients Management	2.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers	State budget	Ministry of Environmental Protection and Natural Resources (Ministry of Environment), Ministry of Agricultural Policy of Ukraine	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A

	2.2 The approval of the Code of Good Agricultural Practices	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2021	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	2.3 Setting up and implementation of a programme for promoting the application of the code of good agricultural practice, including the provision of training and information for farmers	State budget, development partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2025	Low response rate among targeted audience	Program implemented	Records on promotional activities, training and information materials	UAH 3 million
3. Capacity building policies.	3.1 The inclusion promotion of climate technologies in agriculture in the activities of farm advisory services (including ICT in agriculture), involvement of private advisory service providers, and capacity building activities for the experts of farm advisory services in line with the Law of Ukraine On Agricultural Farm Advisory Services	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine	2022-2030	The lack of sufficient capacity	Program implemented	Records of the advisory support provided to farmers	UAH 5 million
	3.2 Developing educational program for universities and vocational schools on climate technologies in agriculture (including ICT in agriculture)	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine, Ministry of Education and Science of Ukraine	2022-2030	The lack of sufficient capacity	Program implemented	Availability of educational program, number of universities and vocational schools, and students using the program	UAH 5 million
4. Information policies	4.1 The dissemination of information on nitrogen management and ICT in agriculture for reducing the emissions of greenhouse gases	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2021-2030	Low response rate among targeted audience	Program implemented	Records on promotional activities and information materials	UAH 3 million
	4.2 Improving soil monitoring and provision of reliable soil quality data	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2021-2030	The lack of laboratory equipment, software, and expertise	Methodologies in place, soil quality information system developed	Area covered by soil quality information, number of soil quality datasets published	TBD

1.1.3 Action Plan for Technology A2 “Conservation tillage technologies (low-till, no-till, strip-till, etc.)”

1.1.3.1 Introduction

Conservative agriculture reduces the disruption of soil structure by minimizing tillage. The technology allows raising soil carbon content by ensuring carbon dioxide sequestration. Additional mitigation benefits are achieved because of less intensive use of fossil fuels by agricultural machinery (Climate TechWiki, 2019A).

Land preparation for seeding or planting under no-till technology involves slashing or rolling the weeds, previous crop residues or cover crops; or spraying herbicides for weed control and seeding directly through the mulch. Crop residues are retained either completely or to a suitable amount to guarantee soil cover; fertilizer and amendments are either broadcast on the soil surface or applied during seeding (FAO, 2020).

The conservation tillage technology also includes such practices as cover crops and the use of mycorrhiza, which both increase soil carbon content and contribute to carbon sequestration. Mycorrhiza increases the total volume of root systems by 20-100 times improving the supply of water and nutrients. Field tests recently conducted within the project “Carbon stocks of Ukrainian Chornozems as a function of Land Use and Climate change and their significance for GHG-mitigation” demonstrated significantly higher carbon stocks on land plots managed with conservative tillage practices compared to land plots managed with traditional tillage technologies.

Additional information about the technology is presented in Mitigation Technology Barrier Analysis and Enabling Framework report and technology factsheet presented in the Technology Needs Assessment report prepared within the TNA project.

1.1.3.2 Ambition for the TAP

The implementation of the technology has large scale potential in Ukraine. The areas of agricultural land under conservative tillage practices could be significantly extended in the medium-term perspective. The overall potential of conservation tillage in Ukraine is estimated at the level of up to 17 million ha (FAO, 2013). More conservative estimates provided by the experts of the working group Mitigation Technologies in Agriculture is in the range of 10-15 million ha.

The application of the technology and potential limitations should be analysed on a case by case basis, taking into account the types of crops produced and climatic conditions. Conservation tillage technologies are well suited for the plain relief, but more complicated to implement on hilly fields and mineralized soils. Mineralized soils are also not suitable for the application of mycorrhiza.

Conservation tillage contributes to the reduction of GHGs emission because of the reduced emissions of CO₂ from fossil fuel combustion by agricultural machinery, increased CO₂ sequestration and reduced soil mineralization. Scientific literature provides carbon sequestration rates because of no-tillage application in the range of 270 – 500 kg of C per ha per year for US (Olson 2013) and 200 – 400 kg of C per ha per year for Europe (Smith et al. 2005), which correspond to GHGs emission reduction at the level of 0.7-1.8 tons CO₂ per ha per year. Assuming the conservative estimate of carbon sequestration rate of 0.7 ton CO₂ per ha per year and potential for no-tillage technology application at the area of 10 million ha, total potential of reduction of GHG emissions are estimated at the level of 7 Mt CO₂-eq.

The implementation of the technology might be associated with some environmental and social risks related to the increased use of crop protection agents and pesticides, soil compaction, and the reduced labour demand in the agricultural sector. Such risks should be explored during technology implementation and appropriate mitigation measures should be implemented. The use of cover crops in combination with conservation tillage practices could reduce the application of crop protection agents lowering human health risks.

1.1.3.3 Actions and Activities selected for inclusion in the TAP

The summary of barriers

Economic barriers. The implementation of technology allows to enhance the economic efficiency of agricultural production because of reduced operational expenses and crop's yields similar to those achieved under conventional tillage practices. However, it requires significant capital investment in the procurement of specialized planters (direct seeders or modified seeders) as well as the equipment for herbicides and fertilizers input. Therefore, the technology faces financial barrier due to the lack of affordable sources of financial resources to invest in the new machinery. The scale of the required investment depends on the specific technology and equipment to be utilized and could be estimated in the range of USD 100 – 200 per ha. The investment could be partially compensated from operational savings due to reduction of maintenance cost for agricultural machinery, less labour time required, fuel cost savings, and the reduced use of irrigation water compared with conventional practices. Operational expenses for crop protection agents could be increased. At the same time, there is a risk of the reduced economic efficiency due to lower yields after transition to conservation tillage practices, especially during the conversion period (3 to 5 years).

Regulatory barriers. The introduction of land market and the possibility to trade agricultural land, which has been recently approved in Ukraine, pose a regulatory barrier for the diffusion of conservation tillage technology. The effectiveness of conservation tillage technology is increasing over time with the help of the gradual improvement of soil quality. Farmers, who have invested resources in conservation tillage, lease land plots from individual land owners. In case of land market's launch, farmers risk to lose control over land plots, as land owners could be willing to sell their land to third parties.

Technological barriers. Conservation tillage has been used in Ukraine by some agricultural enterprises for many years. However, there is still a technological barrier related to the region- and plant-specific requirements for the application of conservation tillage. Technological barriers relate not only to the use of new planting and tillage equipment, but also other technological aspects of seeds planting and different field operations. The application of conservation tillage technology is associated with the high variability of local conditions and impact of tillage practices and other related practices on the soil quality and crop's yields. In initial stages, the introduction of the technology requires experimentation with different methods and practices and could take approximately 3-5 years to achieve stable positive results. The lack of site-specific advices poses a barrier for technology's implementation for farmers.

Information barriers. In Ukraine, there is limited information about soil quality. The Institute of Soil Protection of Ukraine and its regional divisions conduct scientific studies about soil monitoring in the agricultural land and its classification on the basis of ecological parameters. However, the data reliability of soil quality needs an improvement as soil sampling and information that are based on actual soil tests, including soil organic carbon content, is limited. Existing soil maps are based on the outdated information and have low resolution. Moreover, there are no unified approaches for soil sampling and testing. There are different approaches for the identification of sampling locations, number of samples per hectare, and sample collection methods. Soil sampling locations and tests results are often not registered in information systems with GPS coordinates, which makes it impossible to analyse the dynamic of soil quality on land plots. As well, there are different methods of soil quality tests and different approaches for samples preparation before testing. Such situation leads to different test results for samples collected at one location, but analysed in different laboratories, which undermines the validity of soil quality data for farmers and other users.

Cultural barriers. There is a cultural barrier for the application of conservation tillage, as farmers get used to traditional tillage practices and it is hard to switch to new technologies especially taking into account efficiency risks during the conversion period. Having traditional tillage equipment, farmers sometimes can switch back to traditional practices, while conservation tillage requires time to achieve benefits stemming from the improved soil quality.

The summary of measures to overcome identified barriers

State subsidies. Since the capital expenditure for the specialized machinery and equipment is the main economic barrier for the dissemination of the technology, state support could be focused on providing subsidies for the purchase of such equipment. Currently, such subsidies already exist under the support

of local producers of machinery and equipment for agriculture. During recent years, national producers developed own products for conservation tillage and farmers often give more preferences to national equipment than expensive imported alternatives. Additional subsidies could be provided for the introduction of conservation tillage practices in a form of area-based payments during some limited conversion period. The introduction of such subsidies should be performed along with the development of control procedures, the identification of non-compliance cases and associated penalties. State support through direct payments or other financial measures could be coupled with additional requirements for farmers (e.g. creation of digital maps of the fields, soil sampling and provision of data for the soil quality database, application of certain sustainable agricultural practices, etc.).

Soil quality monitoring system. Since carbon sequestration is one of the most significant potential sources of GHG emissions reductions from agriculture, the information on carbon content in the soil is crucial for monitoring the efficiency of policy measures and progress with climate mitigation goals. The development of the enhanced soil quality monitoring system would contribute to better understanding of soil properties and impact of conservation tillage practices on soil quality and carbon sequestration. The improvement of soil quality monitoring system could include, in particular, the synchronization of approaches, methods and standards for soil sampling and soil analysis; establishing data sharing arrangements and the creation of public soil quality database.

Supporting the development of project-based carbon crediting mechanism. Regulatory framework for project-based carbon offset's generation activities related to land management practices will allow participation of Ukrainian agricultural companies in voluntary carbon markets. In order to participate in voluntary carbon markets, GHG emissions reduction projects should meet a number of eligibility requirements, including conditions related to the additionality of emission reduction, project types constraints, methodology-specific requirements, as well conditions related to the avoidance of double-counting. Although the risk of double-counting is reviewed on a case by case basis, it would most likely require certain state regulation of voluntary carbon projects. Though carbon offsetting projects could be initially driven by the voluntary market demand, the national government could also create additional incentives by either allowing the use of domestic voluntary carbon market credits to meet carbon tax obligations or by creating a special fund for purchasing such carbon credits.

Regulatory changes. Regulatory support could include the preferential rights of lease holders to purchase land plots after the launch of land market.

Capacity building policies. Policies aimed at capacity building activities and the promotion of conservation farming technologies could include capacity building on region-specific and crop-specific aspects of conservation tillage technologies, organization and support of training and educational activities, and the incorporation of the promotion of climate mitigation technologies in the activities of farms advisory services in Ukraine. There are also established informal networks of no-till farmers, which effectively exchange knowledge and experience. The support of such networks and specialized events could contribute to the diffusion of the technology in Ukraine with the involvement of small and medium farmers from different regions. Field days and other site's visit events could be an effective tool for the promotion of the technology as practical cases, which often provide more valuable information and insights for farmers.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

On the basis of measures identified above, the following actions were selected for inclusion in the TAP:

- The introduction of state subsidies for climate technologies in agriculture;
- Developing soil quality monitoring system;
- Supporting the development of project-based carbon crediting mechanism;
- Capacity building policies.

The table below describes specific activities for each of the action selected for inclusion in the TAP.

Actions	Activities
1. State subsidies	1.1 The amendment of paragraph 3 of the Order for the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with the inclusion of conservative tillage technologies in the list of activities supported.
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Conservative Tillage (Order for the Provision of State Support for Conservative Tillage) with annual adjustment of the procedure
	1.3 Gradual increase in the financing volume for conservative tillage support in the state program of agricultural support
2. Soil quality monitoring system	2.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.
	2.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.
	2.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.
	2.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by the National Research Foundation of Ukraine
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions on notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon projects)
	3.2 Developing guidance on monitoring, reporting and verification of GHGs emission reductions during agricultural activities.
4. Capacity building policies	4.1 The inclusion and promotion of climate technologies in agriculture in the activities of farm advisory services (including conservative tillage), involvement of private advisory service providers, and capacity building activities for the experts of farm advisory services in line with the Law of Ukraine On Agricultural Farm Advisory Services
	4.2 Developing educational program for universities and vocational schools about climate technologies in agriculture (including conservative tillage)

In order to support the implementation of identified activities, the following actions could be implemented as a part of a Project idea: 1) technical assistance to introduce state subsidies for climate technologies in agriculture; 2) developing soil quality monitoring system; 3) supporting the development of project-based carbon crediting mechanism; 4) capacity building policies.

1.1.3.4 Stakeholders and Timeline for implementation of TAP

Key stakeholders for the implementation of TAP include the following:

- Ministry of Economy of Ukraine,
- Ministry of Agricultural Policy of Ukraine,
- Ministry of Environmental Protection and Natural Resources of Ukraine,
- Ministry of Finance of Ukraine,
- The State Service of Ukraine for Food Safety and Consumer Protection,
- Committee on the Agrarian and Land Policy Aspects of Verkhovna Rada of Ukraine,

- Committee on the Environmental Policy and Natural Resources of Verkhovna Rada of Ukraine,
- Agricultural enterprises: Agrosoyuz, Kernel, Vinnytska Agro-Industrial Group, Agro Generation, I&U Group, KSG Agro, Agromino, UkrAgroCentr, Ukrlandfarming, etc.,
- Regional state administrations,
- National Association of Agricultural Advisory Services of Ukraine,
- Ukrainian Agribusiness Club,
- The Food and Agriculture Organization of the United Nations,
- Ukrainian Soil Partnership,
- EU-funded EU4Environment program,
- Center for Environmental Initiatives Ecoaction,
- The State Institution Scientific and Methodological Center of Higher and Vocational Education.

Activities included in the TAP could be implemented during the period 2021-2030 as detailed for each activity in the TAP overview table below and in Annex VI.

1.1.3.5 Estimation of Resources Needed for Action and Activities

The implementation of actions and activities included in the TAP will require capacity building via the promotion of conservative tillage within the activities of farm advisory services and developing educational program for universities and vocational schools about climate technologies in agriculture.

The implementation of technology requires significant capital investment in the procurement of specialized planters (direct seeders or modified seeders) as well as the equipment for herbicides and fertilizers input. The scale of the required investment depends on the specific technology and equipment to be utilized and could be estimated in the range of USD 100 – 200 per ha.

Initial expenses for the implementation of activities required for the creation of the enabling framework for the dissemination of technology are estimated at the level of up to UAH 549 million per year with the most significant share of funds for state subsidies.

1.1.3.6 Management Planning

Key risks for the implementation of technology and activities covered by the proposed TAP include the lack of financial resources for the state subsidies and low demand for carbon credits as potential additional source of finance, changes of political priorities and the reduction of support for sustainable agricultural practices, as well as the lack of sufficient capacity.

Priority actions to mitigate the risks and create enabling framework for the technology are the introduction and gradual increase of state subsidies based on available resources and taking into account benefits of climate technologies, supporting the development of project-based carbon crediting mechanism, information policies and enhanced soil quality monitoring system.

1.1.3.7 TAP overview table

Sector	Agriculture							
Sub-sector	Crop production							
Technology	Conservative tillage technologies							
Ambition	10 million ha of agricultural land under conservative tillage technologies GHG emission reduction / increased sequestration at the level of 7 Mt CO ₂ -eq. per year							
Benefits	The reduction of soil erosion (wind erosion and water erosion) through keeping biomass residues in fields. Improving chemical, physical, and biological characteristics of the soil, as well as increase in soil organic content. Adaptation co-benefits due to lower dependency on weather conditions and more efficient water resources (reduced evaporation, higher water retention capacity)							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. State subsidies	1.1 The amendment of paragraph 3 of the Order of the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with inclusion of conservative tillage technologies in the list of activities supported.	State budget	Ministry of Agricultural Policy of Ukraine	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Conservative Tillage with annual adjustment of the procedure	State budget	Ministry of Agricultural Policy of Ukraine	2021-2022	Political (changes in political priorities)	Document adopted	Availability of adopted document	N/A
	1.3 Gradual increase in the financing volume for conservative tillage support in the state program of agricultural support	State budget	Ministry of Agricultural Policy of Ukraine	2022-2025	Financial (the lack of available budget funds)	Document adopted	Amount of funding	UAH 500 million per year
2. Soil quality monitoring system	2.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment and Natural Resources (Ministry of Environment), State Service of Ukraine on	2022-2023	Not identified.	Document adopted	Availability of adopted document	UAH 10 million

			Food Safety and Consumer Protection					
	2.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	2.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.	Development partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2023	Not identified.	Database available	Availability of the database	UAH 10 million
	2.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by National Research Foundation of Ukraine	State budget	Ministry of Education and Science of Ukraine, National Research Foundation of Ukraine	2022-2030	Political (changes of political priorities). The lack of feasible proposals.	Call for proposals published. Publications on project results are available.	Number of projects supported. Amount of funding.	UAH 10 million
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions on notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon credits)	State budget, development partners	Ministry of Environment	2022-2023	Political (changes of political priorities). Economic (the lack of market demand for carbon credits).	Document adopted	Availability of adopted document	UAH 3 million
	3.2 Developing guidance for monitoring, reporting and verification of GHGs emission reductions during agricultural activities.	State budget, development partners	Ministry of Environment	2022-2023	Not identified.	Document adopted	Availability of adopted document	UAH 6 million
4. Capacity building policies	4.1 The inclusion of promotion of climate technologies in agriculture in the activities of farm advisory services (including conservative tillage), involvement of private advisory service providers, and capacity building activities for the experts of farm advisory services in line with the Law of Ukraine On Agricultural Farm Advisory Services	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine	2022-2030	The lack of sufficient capacity	Program implemented	Records of the advisory support provided to farmers	UAH 5 million

	4.2 Developing educational program for universities and vocational schools on climate technologies in agriculture (including conservative tillage)	State budget, development partners, private partners	Ministry of Agricultural Policy of Ukraine, Ministry of Education and Science of Ukraine	2022-2030	The lack of sufficient capacity	Program implemented	Availability of the program, number of institutions and students trained	UAH 5 million
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1.1.4 Action Plan for Technology A3 Biogas production from animal waste

1.1.4.1 Introduction

Biogas is produced as a result of biochemical decomposition of macromolecular compounds of animal manure into methane (CH_4), carbon dioxide (CO_2), and ammonia (NH_3). The process is performed under anaerobic conditions. Animal waste could be used in combination with agricultural crops.

The produced biogas is typically used for heat energy and / or electricity generation. The produced biogas could also be cleaned into biomethane and used as fuel in the transport sector or supplied to the natural gas grid. The key technological equipment used for biogas production include reactors for anaerobic fermentation with substrate mixing units and gas holders, biogas treatment units and co-generation units. The by-products of biogas production (i.e. processed substrate) are used as bio-fertilizers.

Capital expenditures for biogas power plants varies in the range of EUR 2 to 5 million per MW of installed electric capacity with most of the estimates falling in the range of EUR 3 to 4 million per MW (higher marginal CAPEX is typical for smaller biogas units with the capacity below 1 MW that could be of interest for farmers). Biomethane production would require additional investment in gas cleaning and pumping to the grid.

The technology supports national environmental priorities because of the reduction of environmental pollution associated with animal manure management. The utilization of animal waste by anaerobic treatment reduces the surface and groundwater pollution with nitrates, organic substances and biological contamination. Bio-fertilizers, which are the by-products of biogas production process, contribute to soil improvement. The implementation of technology could be combined with natural-based solutions for wastewater treatment such as constructed wetlands further extending environmental benefits.

The implementation of technology has also social benefits, as it leads to job creation in the agricultural industry and reduces health risks related to environmental pollution by animal waste for the people living near farms. The diffusion of technology will also contribute to the economic development and energy security of Ukraine.

Additional information about the technology is presented in Mitigation Technology Barrier Analysis and Enabling Framework report and technology factsheet presented in the Technology Needs Assessment report prepared within the TNA project.

1.1.4.2 Ambition for the TAP

According to the estimate of Bioenergy Association of Ukraine, the total potential of biogas production from animal manure is almost 1 billion cubic meter per year. The potential includes 385.8 million m^3 of biogas from cattle manure, 160.3 million m^3 of biogas from swine manure, and 377.7 million m^3 of biogas from chicken manure (BAU, 2013). The potential of natural gas substitution is 0.5 billion of CH_4 (assuming 50% methane content). The Bioenergy Association of Ukraine estimates that 97% of the theoretical biogas potential for cattle manure, 30% for swine manure, and 68% for chicken manure are available for energy purposes, which is the equivalent of substituting 0.34 billion cubic meters of natural gas.

Technology could be implemented in all regions of Ukraine near animal farms to ensure the stable centralized source of animal manure, as its transportation is not economically feasible. Limitation could include infrastructure constraints to organize export of electricity to the national grid or heat energy to the district heating system or other consumer. The location of biogas plants should also take into account environmental restrictions with respect to sanitary protection zones, water protection zones, etc.

The implementation of the technology leads to the reduction of GHG's emission due to the substitution of fossil fuel-based energy with renewable energy and reduction methane emissions from animal manure management. Assuming the potential for substituting 0.34 billion cubic meters of natural gas (emission factor is 55.95 tons CO_2 per TJ, density 0.708 kg/m^3 , NCV - 48.75 GJ per ton or 34.52 GJ per 1000 m^3 as reported in GHGI, 2018), the reduction of GHGs emission would constitute to 0.7 Mt CO_2 . As animal manure is processed at the place of generation GHG's emissions associated with

biomass collection, transportation and the processing is not taken into account. The actual reduction of emission would be higher as a part of the biogas would substitute electricity generated at coal fired power plants, but for the purpose of technology prioritization process, the conservative estimate mentioned above was applied. The additional reduction in GHG emission is achieved because of the avoidance of animal manure decay in the lagoons or other storages. The potential for the reduction of GHG emissions from this source is estimated at the level of 1 Mt CO₂-eq. Total potential of GHG's emission reduction for the technology is approximately 2 Mt CO₂-eq.

1.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

Economic and financial barriers for the technology diffusion include both general barriers related to the limited access to affordable financial resources, the high cost of capital, and risks for country, and specific risks related to the significant capital investment required for the implementation of biogas projects and the lack of efficient mechanisms for supporting heat energy generation from biogas and biomethane production. Besides, an access to capital is additionally restricted by the situation in Ukrainian electricity market with low payment levels to the producers of renewable electricity during 2020.

Technological barriers: The technical barrier relates to complicated technological processes, various biomass sources used, and low capacity utilization factors of operational biogas plants in Ukraine. Technological equipment should be selected and adjusted by taking into account the specifics of biomass material that will be used for biogas production. The insufficient availability of equipment servicing providers, spare part suppliers and the lack of supplier's guaranty also pose significant technological barriers for the technology.

Capacity barriers: The capacity barrier relates to the insufficient number of qualified managers and operational personnel with the practical experience in biogas plants construction and biogas production. There are no professional training programs in Ukrainian universities for preparing operators of biogas plants and other personnel specific to biogas production.

Regulatory barriers relate to the the lack of environmental control over the use of organic waste and enforceable mitigation measures. According to national legislation, animal waste could be used for the production of organic fertilizers and soil additives, used for composting or biogas production, used as a fuel or for industrial processes. By-products of biogas production could also be used or marketed as organic fertilizers. The number of options for animal manure management has been extended and obligatory sterilization under pressure has been cancelled since 2016. Animal manure could be applied to soil without preliminary processing (LoU, 2015). Environmental monitoring and compliance control system, as well as financial fines for potential violations, are not sufficiently effective to foster business to introduce more efficient animal waste management systems. With respect to biomethane production and use, the regulatory barrier exists due to the lack of legal definition of biomethane and relevant specific policy measures to support biomethane production projects.

The summary of measures to overcome identified barriers

Electricity tariffs: The Law of Ukraine On Alternative Energy Types defines provisions on renewable energy generation support through green tariff. The green tariff for biogas and biomass electricity is EUR 123.86 per MWh. The alternative option introduced in 2019 is participation in renewable energy capacity auctions, where the tariff could not be higher than the green tariff level for biomass power plants, but the validity period could be extended beyond 2030 (CMU, 2019). The existing mechanisms provide reasonable incentives for electricity generation using biomass, however future state policy should ensure the stability of payments and electricity market's operation, as well as the protection of investor's rights. Besides, the legal definition of biomethane and introduction of green tariff for electricity generated from biomethane would support the diffusion of the technology. The relevant draft law introducing changes to the Law of Ukraine On Alternative Energy Types has been developed by Bioenergy Association of Ukraine.

Heat energy tariffs: establishing the incentives of heat energy tariffs for the amount of heat energy produced from biogas (fixed tariff or premium). In case of the incentives of heat energy tariff, the

payment could be limited in time (e.g. 10 to 15 years) and bound to additional eligibility conditions (e.g. proper environmental monitoring, efficiency requirements, etc.). Ireland's Support Scheme for Renewable Heat (SEAI, 2020) could serve as an illustrative example for the design of the policy tool.

Biomethane incentives: the introduction of incentives for biomethane production and its further use as fuel in transport sector or biogas injection into natural gas grid. Financial incentives for biomethane production could be established in a form of exemptions from carbon taxation, green tariffs for renewable gases, direct financial support for production and financial incentives for consumption, non-discriminatory network access, etc. (Matveev, 2019). The certification of biomethane is to allow trading with potential access to international markets of biomethane certificates.

Carbon Tax. The use of biomass and biogas for energy purposes should be excluded from the carbon tax (i.e. environmental tax for CO₂ emissions) or any other carbon pricing mechanisms that could be introduced in Ukraine in the near future (e.g. national emission trading scheme, energy tax on the basis of carbon content). On the contrary, the carbon tax for fossil fuels should be increased from the current low level of UAH 10 per tonne to the scale of about EUR 10 per tonne in order to reflect environmental cost of GHG's emissions. The carbon pricing mechanism should be applied to the fossil fuels used by both businesses and individual households.

Regulatory Framework on Nutrients Management: development, adoption and enforcement the regulatory framework to ensure the effective use of nitrogen fertilizers according to the requirements of the EU's Nitrates Directive (Nitrates Directive, 1991). The Directive requires to establish a code or codes of good agricultural practice, to be implemented by farmers on a voluntary basis, which should contain provisions related to fertilizer's application and manure management (the period of application, restrictions related to land application of fertilizer to steeply sloping ground, near water courses, on water-saturated, flooded, frozen or snow-covered ground, requirements for the capacity and construction of storage vessels for livestock manures, procedures for the land application. Code(s) of good agricultural practices may also include provisions on the establishment of fertilizer plans on a farm-by-farm basis and the keeping of records on fertilizer use. Besides, special action programmes and provisions to monitor their effectiveness should be established with respect to designated vulnerable zones.

Manure and digestate management regulations addressing requirements for animal manure and digestate storage time, storage systems and management practices (e.g. open lagoons vs closed lagoons), quality restrictions and quality control requirements (sampling, testing, etc.) for animal manure and digestate. Requirements for digestated certification (periodic quality control vs certification of each production delivery). Restriction for non-certified digestate use.

Land use requirements: amending national legislation to allow the construction of biogas plants using animal waste on land plots designated to agricultural category similarly to existing rights to construct and operate agricultural products processing units on agricultural lands.

Capacity building activities should target the training of professionals for biogas industry and also the dissemination of information and knowledge about the economic, environment and social benefits of anaerobic digestion of animal waste with biogas production. In particular, educational institutions should adjust their curriculum and train specialists that would meet current industry requirements.

Detailed information about the barriers and actions is presented in BAEF report.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

On the basis of the measures identified above, the following actions were selected for inclusion in the TAP:

- The improvement of incentives for energy generation and consumption using biogas (power, heat energy, transportation);
- Reforming carbon taxation mechanisms;
- Regulatory framework on nutrients management and animal manure management;

- Capacity building policies.

The table below describes specific activities for each of the action selected for inclusion in the TAP.

Actions	Activities
1. The improvement of incentives for energy generation and consumption using biogas (power, heat energy, transportation).	1.1 The adoption of the Order of the Cabinet of Ministers of Ukraine On the Allocation of Annual Support Quota and the Schedule of Auctions for the Next Year and Indicative Forecasted Support Quotas for the Next Four Years with the inclusion of separate annual quotas for biomass and biogas-based power plants.
	1.2 The development and introduction of tariff incentive for heat energy generation from renewable energy, incl. biomass and biogas (fixed tariffs or premiums) by amending the Law of Ukraine On Heat Supply
	1.3 The amendment of the Law of Ukraine On Alternative Fuel Types with the introduction of the definition of biomethane (article 1), defining procedures for the access to natural gas grids and issuing certificates of origin
	1.4. The development and approval of the Decree of the Cabinet of Ministers of Ukraine On Promoting Biomethane Use with the definition of a) quality requirements and quality control procedures for biomethane injection into natural gas grids; b) certification scheme for biomethane; c) financial incentives for certified biomethane.
2. Reforming carbon taxation mechanisms	2.1. The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.
	2.2. The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of carbon dioxide tax rates for fossil fuels.
3. Regulatory framework on nutrients management and animal manure management	3.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers
	3.2 The approval of the Code of Good Agricultural Practices (with incorporation of animal manure management requirements and organic fertilizers use requirements)
	3.3 Setting up and implementation of a programme on promoting the application of the code of good agricultural practice, including the provision of training and information for farmers
	3.4 The amendment of the Law of Ukraine On Animal By-products not Intended for Human Consumption and adoption of related secondary regulations (e.g. Orders of the Ministry of Agricultural Policy of Ukraine) taking into account the provisions of EU Fertilizing Products Regulation EU2019/1009, EU Regulation (EC) No 1069/2009 and Regulation (EU) No 142/2011 with the aim of a) introduction of the definition of digestate and categorization of digestate as animal by-product, b) requirements for animal manure and digestate storage and application (time before land application, storage systems, management practices, quality restrictions and quality control requirements); c) requirements for organic fertilizers (heavy metals and pathogens maximum limits, minimum requirements for primary nutrients and organic carbon content); and d) requirements for collection, transportation, processing, packing, labelling and

	use of animal by-products and relevant processing facilities, including biogas plants.
	3.5 Changes to the Land Code of Ukraine (article 22) allowing construction of biogas production plants using animal waste on land plots designated for agricultural purposes.
4. Capacity building	4.1 Introducing biogas related educational programs in the curriculum of educational institutions
	4.2 Support the creation of demonstration programs and learning centers for biogas technology and animal manure management
	4.3 The dissemination of information on the benefits and the best practices of biogas production from animal manure

1.1.4.4 Stakeholders and Timeline for implementation of TAP

Key stakeholders for the implementation of TAP include the following:

- Ministry of Energy of Ukraine,
- Ministry of Economy of Ukraine,
- Ministry of Agricultural Policy of Ukraine,
- Ministry of Environmental Protection and Natural Resources of Ukraine,
- Ministry of Finance of Ukraine,
- Ministry for Communities and Territories Development of Ukraine
- The State Energy Efficiency and Energy Saving Agency of Ukraine,
- State Service of Ukraine on Food Safety and Consumer Protection,
- Ukrenergo,
- State Enterprise “Guaranteed Buyer”,
- Committee on the Agrarian and Land Policy Aspects of Verkhovna Rada of Ukraine,
- Committee on the Environmental Policy and Natural Resources of Verkhovna Rada of Ukraine,
- Committee on the Energy and Utilities Sectors of Verkhovna Rada of Ukraine,
- Regional state administrations,
- Center for Environmental Initiatives Ecoaction,
- Agricultural enterprises,
- Ukrainian Agribusiness Club.

Activities included in the TAP could be implemented during the period 2021-2030 as detailed for each activity in the TAP overview table below and in Annex VI.

1.1.4.5 Estimation of Resources Needed for Action and Activities

The implementation of actions and activities included in the TAP will require capacity building support in the form of educational programs and establishment of learning centers for biogas technology and animal manure management, as well as the dissemination of information on benefits and the best practices of biogas production from animal manure.

Capital expenditures for the implementation of technology is in the range of EUR 2 – 5 million per MW with higher values applicable for biogas units with additional equipment for biogas and digestate treatment.

Initial expenses for the implementation of activities required for the creation of the enabling framework for the dissemination of technology has not been estimated at this stage.

1.1.4.6 Management Planning

Key risks for the implementation of technology and activities covered by the proposed TAP include changes in political priorities and reducing the support of renewable energy in Ukraine and the lack of financial resources at the electricity and heat energy market.

Priority actions to mitigate risks and create enabling framework for the technology is to improve the incentives for energy generation from biogas, the adoption of legislative and regulatory framework supporting sustainable animal manure management and capacity building policies.

1.1.4.7 TAP overview table

Sector	Agriculture							
Sub-sector	Animal production							
Technology	Biogas production from animal waste							
Ambition	Biogas production in the equivalent of 0.34 billion cubic meters of natural gas to ensure generation of 1,360 GWh of electricity (approximately 250 MW of installed electric capacity of biogas plants using animal manure as biomass source). GHG emission reduction at the level of 2 Mt CO ₂ -eq. per year							
Benefits	<ul style="list-style-type: none"> - job creation in agricultural industry - reduced health risks related to environmental pollution by animal waste for the people living near the farms - contribution to the economic development and energy security of Ukraine - supporting contributing to national environmental priorities because of reduction of environmental pollution associated with animal manure management - the reduction of the surface and groundwater pollution with nitrates, organic substances and biological contamination - soil improvement through the use of bio-fertilizers, which are the by-products of biogas production process, contribute to soil improvement - extending environmental benefits through the combination with the technology could be combined with natural- based solutions for wastewater treatment 							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The improvement of incentives for energy generation and consumption using biogas (power, heat energy, transportation).	1.1 The adoption of the Order of the Cabinet of Ministers of Ukraine On the Allocation of Annual Support Quota and the Schedule of Auctions for the Next Year and Indicative Forecasted Support Quotas for the Next Four Years with the inclusion of separate annual quotas for biomass and biogas power plants.	State budget	Ministry of Energy of Ukraine, State Energy Efficiency and Energy Saving Agency of Ukraine (SAEE)	2021-2030	Political (changes of political priorities) The lack of interest among investors The lack of financial resources on the electricity market / delayed payments	Document adopted	Availability of adopted document Number of auctions held and capacity auctioned (biogas)	TBD
	1.2 The development and introduction of tariff incentive for heat energy generation from renewable energy, incl. biomass and biogas (fixed tariffs or premiums) by amending the Law of Ukraine On Heat Supply	State budget	SAEE, Ministry for Communities and Territories Development of Ukraine	2022-2030	Political (changes of political priorities) The lack of financial resources / delayed payments	Amendment adopted	Availability of adopted document Capacity of heat generation using biogas	TBD
	1.3 The amendment of the Law of Ukraine On Alternative Fuel Types with the introduction of the definition of biomethane (article 1), defining procedures for the access	State budget	SAEE	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD

	to natural gas grids and issuing certificates of origin							
	1.4. The development and approval of the Decree of the Cabinet of Ministers of Ukraine On Promoting Biomethane Use with the definition of a) quality requirements and quality control procedures for biomethane injection into natural gas grids; b) certification scheme for biomethane; c) financial incentives for certified biomethane.	State budget, development partners	SAEE	2021-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	TBD
2. Reforming carbon taxation mechanisms	2.1. The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.	State budget	Ministry of Finance, Ministry of Environmental protection and Natural resources of Ukraine (Ministry of Environment)	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
	2.2. The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of CO ₂ tax rates for fossil fuels.	State budget	Ministry of Finance, Ministry of Environment	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
3. Regulatory framework on nutrients management and animal manure management	3.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers	State budget	Ministry of Environment, Ministry of Agricultural Policy of Ukraine	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	3.2 The approval of the Code of Good Agricultural Practices (with the incorporation of animal manure management requirements and organic fertilizers use requirements)	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2021	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A

	3.3 Setting up and implementation of a programme for promoting the application of the code of good agricultural practice, including the provision of training and information for farmers	State budget, development partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2025	Low response rate among targeted audience	Program implemented	Records on promotional activities, training and information materials	UAH 3 million
	3.4 Amending the Law of Ukraine On Animal By-products not Intended for Human Consumption and adoption of related secondary regulations (e.g. Orders of the Ministry of Agricultural Policy of Ukraine) taking into account the provisions of EU Fertilizing Products Regulation EU2019/1009, EU Regulation (EC) No 1069/2009 and Regulation (EU) No 142/2011 with the aim of a) the introduction of the definition of digestate and categorization of digestate as animal by-product, b) requirements for animal manure and digestate storage and application (time before land application, storage systems, management practices, quality restrictions and quality control requirements); c) requirements for organic fertilizers (heavy metals and pathogens maximum limits, minimum requirements for primary nutrients and organic carbon content); and d) requirements for collection, transportation, processing, packing, labelling and use of animal by-products and relevant processing facilities, including biogas plants.	State budget, development partners	Ministry of Economy of Ukraine, State Service of Ukraine on Food Safety and Consumer Protection, Ministry of Environment, Ministry of Agriculture Policy of Ukraine	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
	3.5 Changes to the Land Code of Ukraine (article 22) allowing construction of biogas production plants using animal waste on land plots designated for agricultural purposes.	State budget	Ministry of Environment, Ministry for Communities and Territories Development	2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD

4. Capacity building	4.1 Introducing biogas related educational programs in the curriculum of educational institutions	State budget, development partners, private partners	SAEE, Ministry of Education and Science of Ukraine, National Academy of Science	2022-2030	The lack of sufficient capacity	Program developed and launched	Availability of educational program, number of institutions and students using the program	UAH 5 million
	4.2 Support the creation of demonstration programs and learning centers for biogas technology and animal manure management	Development partners, private partners	SAEE, Ministry of Environment	2022-2030	The lack of sufficient capacity, the lack of financial resources	Learning centres launched	Number of specialists using the service	TBD
	4.3 Dissemination of information on the benefits and best practices of biogas production from animal manure	Development partners	SAEE, Ministry of Environment	2022-2030	Low response rate among targeted audience	Program implemented	Records on promotional activities	UAH 3 million

1.1.5 Action Plan for Technology A4 Organic agriculture

1.1.5.1 Introduction

Organic agriculture is a production system which avoids or largely excludes the use of synthetic fertilizers, pesticides and growth regulators and promotes the use of crop rotations, green manures, compost, biological pest control and mechanical cultivation for weed control. Natural materials such as potassium bicarbonate and mulches are also used to control diseases and weeds. The most effective techniques used by organic farmers are fertilisation by animal manure, by composted harvest residues and by leguminous plants such as (soil) cover and (nitrogen) catch crops. Introducing grass and clover into rotations for building up soil fertility, diversifying the sequences of crops and reducing the ploughing depth and frequency also augment soil fertility. All these techniques increase carbon sequestration rates in organic fields, whereas in conventional fields, soil organic matter is exposed to more tillage and consequent greater losses by mineralisation (ClimateTech Wiki, 2019 B).

Table. Organic land in Ukraine

Data	2017	2018	2019
Fully converted area, ha	201,000	233,500	384,529
Conversion area, ha	88,000	75,600	83,451
Total organic land in Ukraine, ha	289,000	309,100	467,980

Source: FIBL, 2019; FIBL, 2020; FIBL, 2021

The area of organic land in Ukraine demonstrated significant growth over the last several years and reached almost half a million ha in 2019 or 1.1% of total agricultural land. Organic land is used for growing cereals, oilseeds, dry pulses, vegetables, and temperate fruits. The largest organic agricultural companies include Arnika (15,078 ha), Haleks Agro (8,800 ha), Agroecology (7,500 ha), Agroinvest – Natural Products (6,000 ha), UkrBioLand (5,600 ha), Etnoproduct (4,000 ha), Ritter Bio Agro (3,500 ha) (Baker Tilly, 2018). Detailed information about some major market players that were participating in BIOFACH 2020 is presented in Organic Ukraine Guidebook (Organic Ukraine, 2020).

The technology has been selected for the technology action plans because of climate mitigation and adaptation benefits, other environmental benefits, as well as significant potential for deployment in Ukraine. Organic agriculture increases soil's water retention capacity and contributes to climate adaptation, improves soil quality and soil organic content, as well as it reduces agricultural runoff pollution. Co-benefits of the technology for climate adaption would be even more significant in case of the simultaneous promotion of agroforestry practices, which have been identified as priority adaptation technology for the agricultural sector in Ukraine. Organic producers often use buffer zones between organic and inorganic fields, which can be used for agroforestry practices. Besides, organic agriculture also contributes to the achievement of sustainable development goals.

Additional information about the technology is presented in Mitigation Technology Barrier Analysis and Enabling Framework report and technology factsheet presented in the Technology Needs Assessment report prepared within the TNA project.

1.1.5.2 Ambition for the TAP

The implementation of the technology could be scaled up significantly in the mid-term perspective. Ukraine has large potential for increasing the share of organic agriculture. National Economic Strategy for the period till 2030 approved by the Cabinet of Ministers of Ukraine in March, 2021, defines the target of 3% of all agricultural land under organic farming by 2030 (NES, 2021). According to the estimates of the experts consulted within the TNA project, the share of organic land could be increased up to 10% of the total farmland in the mid-term perspective similar to the leading European countries. For comparison, in 2019, the area of organic land in EU was 14.6 million ha or 8.1% of total farmland with leading countries having 20% share or more (e.g. Sweden – 20.4%, Estonia – 22.3%, Austria – 26.1%) (FIBL, 2021). EU's Farm to Fork Strategy sets an objective of at least 25% of the EU's agricultural land under organic farming by 2030 (Farm to Fork Strategy, 2020).

The ambition of the TAP is defined as 10% from total agricultural land or approximately additional 3.5 million ha under organic farming.

In terms of GHGs emissions reduction potential, organic agriculture has the potential of sequestering carbon into soils at the rate of 200 kg of C per ha per year for arable crops. By combining organic farming with reduced tillage, the sequestration rate can be increased to 500 kg of C per ha per year for arable crops with comparison to ploughed conventional cropping systems, but as the soil C dynamics reach a new equilibrium, these rates will decline in future (ClimateTech Wiki, 2019 B). Other studies report the similar average sequestration potential of about 200 to 400 kg C per ha per year for all croplands (Müller-lindenlauf 2009). This corresponds to the sequestration of 0.7-1.4 tons of CO₂-eq. per ha per year. According to the Thünen Institute study, the comparison of the emissions of soil-based greenhouse gas from organic and conventional agriculture in temperate climates on the basis of empirical measurements shows positive effects from organic management with a cumulative climate protection performance of organic farming of 1.082 kg CO₂-eq. per ha per year (Thünen Report 65, 2019).

In addition, a diversified crop rotation with green manure in organic farming improves soil structure and diminishes the emissions of N₂O due to the ban on the use of mineral nitrogen, although the nitrogen provided by the green manure does contribute to N₂O emissions. Soils in organic farming are more aerated and have significantly lower mobile nitrogen concentrations, which reduce the emissions of N₂O (ClimateTech Wiki, 2019 C).

The ambition of the TAP is defined as reduction of GHG's emissions at a rate of 1 ton of CO₂-eq. per ha of land under organic agriculture practice or 3.5 Mt CO₂-eq. of additional emission reductions per year.

1.1.5.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

Economic barriers. There are various studies which compare the operational cost of organic and non-organic agriculture and examples of both higher and lower cost of organic crop's production could be found in the literature. Even taking into account that the capital expenditures associated with organic agriculture are moderate, there are still important economic and financial barriers for the diffusion of technology in Ukraine. Organic products compete with both organic products from other countries in international market and with conventional products in the Ukrainian market. Besides, expenses for certification and annual inspections could be quite significant for smaller farms (UAH 25,000 – UAH 100,000 depending on the size of the enterprise and the scope of certification).

Export barriers. Although Ukrainian producers are entering new markets in North America and Asia during the recent years, the European Union remains a key market for Ukrainian organic products, as 83% of Ukrainian organic products export went to EU in 2018 (MAPU, 2019; Organic Info, 2019A). There are special procedures for importers of organic products to the EU, which depend on where the goods have originated. For Ukraine, additional controls have been established (i.e. the complete documentation check at point of entry and sampling and analysing for presence of pesticide residues). When pesticide residues or other irregularities are detected, an investigation shall be started and a notification shall be made in the Commission's Organic Farming Information System (OFIS). Such measures lead to higher costs and impact competitiveness.

International competition. The EU sources organic agri-food from 115 countries with China having 12.5% share (mainly oilcakes, soybeans and other oil seeds), Ecuador (mainly tropical fruits), the Dominican Republic (tropical fruits, nuts, spices, and cocoa beans), Ukraine (mainly cereals, soybeans and other oil seeds) and Turkey (mainly cereals, oilseeds, fruits and vegetables) having 8% share (FIBL, 2020). Therefore, producers from China and Turkey along with EU's producers are key competitors for Ukrainian companies. In EU, there are different forms of state support for organic farmers and most of the countries provide area conversion and/or maintenance payments. In Turkey, there has been an Environmentally Based Agricultural Land Protection Scheme since 2009, under which support payments, on the basis of land area, are made annually for three years for agricultural practices with minimum soil tillage (to conserve soil and water structure and prevent from erosion) and environmentally friendly agricultural techniques (water and fertiliser savings, and organic agriculture)

(OECD, 2019). In 2013, payments for organic agriculture amounted to around EUR 200 Euros per hectare for fruits and vegetables, and EUR 40 per hectare for field crops (IFOAM, 2017). Therefore, there is a competitive advantage of foreign producers with comparison to Ukrainian organic farmers.

Undeveloped domestic market. With some exceptions, organic products are typically more expensive than conventional alternatives. Relatively low average income of Ukrainian consumers along with insufficient awareness about the environmental impact of food products, agriculture and benefits of organic products limit the volume of internal organic market. According to different estimates, the export of organic products from Ukraine reached 104-133 million Euro in 2018 (Organic Info, 2019A; FIBL, 2020), while retail sales were at the level of 33 million Euro (FIBL, 2020) or 590 million UAH (18 million Euro) without the imported products sales (Organic Info, 2019B). Per person consumption of organic products is less than 1 Euro, while in Germany every person spends on average 132 Euro and in Poland 7 Euro per year on organic products (FIBL, 2020). The main channels for sales in the domestic market are supermarkets and specialty shops in big cities. The assortment of organic products is not full, but they include dairy, meat products, groats, eggs, flour, macaroni products, vegetable oils, beverages, chocolate, honey, spices, some vegetables, fruits, snacks, etc. (Organic Info, 2020). Most of organic raw products are being exported, while final organic products are mostly consumed in the internal market. The share of final organic products in total organic production is relatively low. Since external markets are becoming more and more competitive, national market could become a significant driver of organic farming diffusion in Ukraine.

Non-financial barriers. The non-financial barriers for the implementation of the technology include the capacity barrier due to the lack of sufficient knowledge about the organic agriculture and the lack of specialists with practical experience, regulatory barriers related to the operation of state registries for organic producers, the information barrier due to low awareness about the benefits of organic products and organic products labelling, as well as the technological barrier due to the lack of seeds and planting material.

The summary of measures to overcome identified barriers

Actions selected for inclusion in the TAP are state subsidies, green procurement schemes, project-based carbon crediting mechanisms, information policies and soil quality regulations.

State subsidies. Organic farming provides environmental (e.g. water conservation, climate change adaptation and mitigation, etc.) and social benefits (e.g. job creation in rural areas, health protection, etc.) but at the same time farmers could bear additional costs due to the loss of income, especially during the conversion period. In the EU, the yields under organic production for wheat could be in the range of 40% (Germany) and 85% (Italy) of conventional yields, and for grain maize, the gap is lower and yields reach 60% to 95% of conventional yields. The yield's gap strongly differs depending on factors such as location, agricultural practice's management or type of crop and could be close to the conventional yields. Lower yields are partly compensated by higher producer prices (EC, 2019). Still, the high variability of potential yields requires state support to incentivise farmers for conversion to organic practices. State subsidies in a form of direct payments would compensate farmers for the environmental and societal benefits they provide and also for potential economic losses. State support through direct payments or other financial measures could be coupled with additional requirements for farmers (e.g. creation of digital maps of the fields, soil sampling and provision of data for the soil quality database, application of certain sustainable agricultural practices, etc.).

The Law of Ukraine On Main Principles and Requirements for Organic Production (hereafter Law On Organic Production) defines that state support for organic market's operator could be provided within national and regional programs by using the funds of budgetary programs for the support of agricultural producers development. The introduction of dedicated funds at national level for the conversion and maintenance periods could provide significant support to organic farms and increase the share of land converted to organic practices. The level of support should be defined on the basis of additional assessments and consultations with the industry's stakeholders, as well as taking into account the availability of public finances. The indicative level of support could be in the range of EUR 50 – 100 per ha, which reflects carbon mitigation benefits of the technology and the price of carbon required to trigger significant carbon emission's reductions. Due to the limited availability of state funds, direct budgetary support initially could be implemented with a set of limiting factors, such as limiting state's

support to conversion period only, total land area for which the support is provided or total sum of direct payments per single farm, as well as introduction of additional conditions for the provision of direct payments.

In April 2021, the Cabinet of Ministers of Ukraine extended the scope of state support coverage and included the provision of state support for producers of organic products (CMU, 2021). For 2021, UAH 50 million were dedicated to the support of organic farming, including the partial compensation of certification cost, subsidies per area of organic land and partial compensation for the purchase of allowed agro-chemicals. Expected results include additional certification of 6,000 ha of organic land, 500 certification procedures and 3,000 heads of certified cattle farms.

Green procurement schemes. State authorities could foster the internal market development through the inclusion of organic products in procurement schemes for schools, kindergartens and hospitals. Such support measures could be introduced through the non-financial criteria for public procurement in line with amendments to the Law of Ukraine On public procurement approved in 2019 (entered into force in April 2020) (LoU, 2019). The introduction of incentives for organic product's procurement would require an additional regulatory and legislative changes, as well as capacity building activities for the development of tendering documentation and organization of procurement process. Currently, the following products are presented in the national market: milk products, cereals and grain products, vegetables and fruits, juices, meat products, spices, and ice-cream.

Project-based carbon crediting mechanisms. An access to project-based carbon offsets generation activities related to land management practices and participation of Ukrainian agricultural companies in voluntary carbon is also applicable for the promotion of organic agriculture technology.

Information policies focusing on the promotion of organic farming could also positively contribute to the dissemination of the technology. Utilizing the improved statistical data that would collect according to the provisions of the Law On Organic Production, the responsible state's authorities could promote organic agriculture by sharing information on successful case studies in conversion from traditional farming to organic farming, supporting organic farms via farm advisory service system, and the publication of statistical information about organic farming.

Most of the organic products grown and manufactured in Ukraine are exported with the EU being the major destination. The internal market of organic products is currently limited. Policy measures that could promote the development of internal market could include, for instance, the following:

- the promotion of environmental, climate and health benefits of organic product through information campaigns, including those developed in cooperation with businesses and civil society;
- the support of small organic farmers and cooperatives of organic farmers to foster their access to internal market (e.g. super market chains);
- support for the organization of local organic product fairs in cooperation with local state's authorities.

Information support should target not only the promotion of organic products, but also the relevant requirements for organic farming and labelling requirements. Consumers should have reliable information about the benefits of organic products and distinguish them from other products that could use environmental or biological related terms in their naming and marketing materials.

Soil quality regulations: the improved quality of soil monitoring and soil quality information would allow the demonstration of the benefits of organic agriculture.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

On the basis of the measures identified above, the following actions were selected for inclusion in the TAP:

- The introduction of state subsidies for climate technologies in agriculture;
- The inclusion of organic products into green procurement schemes;
- Developing soil quality monitoring system;

- Supporting the development of project-based carbon crediting mechanism;
- Information policies.

The table below describes specific activities for each of the action selected for inclusion in the TAP.

Actions	Activities
1. State subsidies	1.1 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Agricultural Organic Goods Producers (Order for the Provision of State Support for Organic Agriculture) with annual adjustment of the procedure
	1.2 Gradual increase in the financing volume for organic agriculture support in the state program of agricultural support
2. Green procurement schemes	2.1 Developing guidance document for procurement specialists, central procurement organization and Prozorro Marketplace for the application of non-price criteria in public procurement of food products (state classification code 15890000-3) and catering services
	2.2 Market analysis study with market engagement activities and the focus on potential matches between organic product supply and food products demand in public procurement schemes
	2.3 Capacity building activities among procurement specialists on the development of tendering documentation using non-price criteria for food products and catering services and support the execution of pilot tenders
	2.4 The development of a special module on organic products procurement for the electronic education course on green public procurement for Prozorro Infobox
	2.5 To develop and approve the action plan for green public procurement and include the support of organic products procurement
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions for the notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon projects)
	3.2 Developing guidance for monitoring, reporting and verification of GHGs emission reductions during agricultural activities.
4. Information policies	4.1 Awareness raising campaign about environmental, climate and health benefits of organic products
	4.2 Information campaign about the best practices in organic farming, organic products manufacturers, and successful organic products procurement case studies
	4.3 The support of scientific and research projects related to organic farming
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.
	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by National Research Foundation of Ukraine

In order to support the implementation of identified activities, proposed Project ideas include assisting relevant state authorities for developing MRV system for agriculture, as well as capacity building and information dissemination activities.

1.1.5.4 Stakeholders and Timeline for implementation of TAP

The key stakeholders for the implementation of TAP include the following:

- Ministry of Economy of Ukraine,
- Ministry of Agricultural Policy of Ukraine,
- Ministry of Environmental Protection and Natural Resources of Ukraine,
- Ministry of Finance of Ukraine,
- Ministry of Economic Development, Trade, and Agriculture of Ukraine,
- The State Service of Ukraine on Food Safety and Consumer Protection,
- Committee on the Agrarian and Land Policy Aspects of Verkhovna Rada of Ukraine,
- Committee on the Environmental Policy and Natural Resources of Verkhovna Rada of Ukraine,
- Regional state administrations,
- Non-governmental organization Organic Ukraine,
- The Federation of Organic Movement of Ukraine,
- The Quality FOOD Trade Program implemented by the Research Institute of Organic Agriculture (FiBL) and SAFOSO,
- German-Ukrainian Cooperation in Organic Agriculture (COA) project implemented by AFC Agriculture and Finance Consultants,
- EU-funded EU4 Environment programme,
- Main organic products producers in Ukraine.

The role of the state authorities is to develop, approve and implement state policies supporting organic farming, while the role of businesses, NGOs and other interested stakeholders is to promote organic market development.

Activities included in the TAP could be implemented during the period 2021-2030 as detailed for each activity in the TAP overview table below and in Annex VI.

1.1.5.5 Estimation of Resources Needed for Action and Activities

The implementation of actions and activities included in the TAP will require capacity building support form for procurement specialists on the development of tendering documentation using non-price criteria for organic products, as well as for farmers on monitoring, reporting and verification of GHGs emission reductions from sustainable agricultural practices.

Expenses for the implementation of activities required for the creation of the enabling framework for the dissemination of technology is estimated at the level of up to UAH 560 million with the major share devoted to state subsidies for organic farmers.

1.1.5.6 Management Planning

Key risks for the implementation of technology and activities covered by the proposed TAP include the lack of financial resources for the state subsidies and low demand for carbon credits as potential additional source of finance, changes in political priorities and reducing the support for sustainable agricultural practices, as well as the lack of feasible proposals for scientific and research projects.

The priority actions to mitigate the risks and create enabling framework for the technology is gradual increase of state subsidies based on available resources and taking into account benefits of climate technologies, introducing organic products into green procurement schemes in order to foster internal market, supporting the development of project-based carbon crediting mechanism, information policies and enhanced soil quality monitoring system.

1.1.5.7 TAP overview table

Sector	Agriculture							
Sub-sector	Cropland							
Technology	Organic agriculture							
Ambition	10% of total agricultural land under organic farming by 2030 or 3.5 million ha of additional organic land 3.5 Mt CO ₂ -eq. of additional emission reductions per year.							
Benefits	The development of rural areas, including small and medium enterprises in rural areas Environmental benefits due to the reduction of soil pollution and water resources contamination, positive impact on biodiversity Climate adaptation benefits due to the improved water retention capacity and the accumulation of soil organic carbon Economic benefits due to export growth and increase of sales in internal market							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. State subsidies	1.1 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Agricultural Organic Goods Producers (Order for the Provision of State Support for Organic Agriculture) with annual adjustment of the procedure	State budget	Ministry of Agricultural Policy of Ukraine	2021	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	1.2 Gradual increase in the financing volume for organic agriculture support in the state program of agricultural support	State budget	Ministry of Agricultural Policy of Ukraine	2021-2025	Financial (the lack of available budget funds)	Document adopted	Amount of funding available	UAH 500 million per year
2. Green procurement schemes	2.1 Developing guidance document for procurement specialists, central procurement organization and Prozorro Marketplace for the application of non-price criteria in public procurement of food products (state classification code 15890000-3) and catering services	State budget, development partners	Ministry of Economy of Ukraine	2022	No material risks identified	Document prepared	Availability of published document	UAH 0.5 million
	2.2 Market analysis study with market engagement activities and the focus on potential matches between organic product supply and food products demand in public procurement schemes	State budget, development partners	Ministry of Economy of Ukraine	2022	No material risks identified	Document prepared	Availability of published document	UAH 0.5 million

	2.3 Capacity building activities among procurement specialists on the development of tendering documentation using non-price criteria for food products and catering services and support the execution of pilot tenders	State budget, development partners	Ministry of Economy of Ukraine	2022-2025	Low engagement of the targeted audience	Capacity building activities conducted	Number of training hours Number of participants	UAH 3 million
	2.4 The development of a special module on organic products procurement for the electronic education course on green public procurement for Prozorro Infobox	State budget, development partners	Ministry of Economy of Ukraine	2022-2025	No material risks identified	Module developed and is operational	Availability of operational special module Number of trained specialists	UAH 1 million
	2.5 To develop and approve green public procurement action plan and include the support of organic products procurement	State budget, development partners	Ministry of Economy of Ukraine	2022-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions on notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon projects)	State budget, development partners	Ministry of Environmental Protection and Natural Resources of Ukraine (Ministry of Environment)	2022-2023	Political (changes of political priorities). Economic (the lack of market demand for carbon credits).	Document adopted	Availability of adopted document	UAH 3 million
	3.2 Developing guidance for monitoring, reporting and verification of GHGs emission reductions during agricultural activities.	State budget, development partners	Ministry of Environment	2022-2023	Not identified.	Document adopted	Availability of adopted document	UAH 6 million
4. Information policies	4.1 Awareness raising campaign about environmental, climate and health benefits of organic products	State budget, development partners	Ministry of Environment; Ministry for Health of Ukraine	2021-2030	Not identified.	Campaigns conducted	Number of information products developed. Number of people engaged.	UAH 3 million

	4.2 Information campaign about the best practices in organic farming, organic products manufacturers, and successful organic products procurement case studies	State budget, development partners	Ministry of Economy; Ministry of Environment	2021-2030	Not identified.	Campaigns conducted	Number of information products developed. Number of people engaged.	UAH 3 million
	4.3 The support of scientific and research projects related to organic farming	State budget, Horizon Europe funds	The National Research Foundation of Ukraine, Ministry of Education and Science of Ukraine	2022-2030	The lack of financial resources. The lack of feasible proposals.	Call for proposals published. Publications about results are available.		UAH 10 million
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment, State Service of Ukraine on Food Safety and Consumer Protection	2022-2023	Not identified.	Document adopted	Availability of adopted document	UAH 10 million
	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.	State budget	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.	Development partners	Ministry of Agricultural Policy of Ukraine, Ministry of Environment	2022-2023	Not identified.	Database available	Availability of the database	UAH 10 million
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by National Research Foundation of Ukraine	State budget, Horizon Europe Funds	Ministry of Education and Science of Ukraine, National Research Foundation of Ukraine	2022-2025	Political (changes of political priorities). The lack of feasible proposals.	Call for proposals published. Publications about project results are available.	Number of projects supported. Amount of funding. Publications.	UAH 10 million

1.1.6 Action Plan for Technology A5 “The production and use of solid biofuels from agricultural residues”

1.1.6.1 Introduction

The technology foresees the direct combustion of biomass residues or combustion of biofuels produced from biomass residues (e.g. pellets, briquettes, biogas) to produce heat and/or electricity. Biomass residues could be used in combination with other sources of biomass (e.g. animal manure or corn silo) or fossil fuels (e.g. in case of co-firing). Besides, the technology could also include biochar production from agricultural residues using pyrolysis process (thermochemical conversion under low oxygen level), which result in generation of both soil additives (called charcoal or biochar) and energy source (pyrolysis gas or syngas). Pellets production allows extending the area of solid biofuel use due to high density and energy content, as well as the standardization of quality parameters.

Main agricultural residues, which could be used for energy generation, include straw, sunflower seed's husk, as well as corn and sunflower stalks and other residues. The availability of biomass residues depends on the yield's volumes in a particular year, but the overall trend in Ukraine is the increasing yields and increasing biomass volumes that could be used for energy purposes.

Biomass residues should partly remain in fields in order to ensure soil protection from erosion, compensating the loss of organic content and reducing evaporation. For Ukraine, it is recommended that 30%-40% of cereal's straw could be used for energy purposes (Renewable Energy Agency, 2018; IFC, 2013). The percentage of crop residues that could be removed from each particular farm should be defined on a case-by-case basis, taking into account the full range of local conditions (crop yield, the level of development of local animal husbandry, soil condition, application of mineral and organic fertilizer, etc.).

The use of agricultural biomass residues for energy generation leads to the reduction of GHG's emission because of the substitution of fossil fuels.

Key limitations for the technology are associated with infrastructural requirements (e.g. power substations for electricity's export, district heating infrastructure or nearby heat energy consumer for heat energy's supply, road infrastructure for organizing biomass residues logistics, etc.). Besides, environmental impact and mitigation measures, as well as competing the use of agricultural crops residues (as substitutes of organic fertilizers, feed for livestock, etc.) should be considered on case by case basis.

In case of agricultural enterprises with more than 5,000 ha in operation, complex bioenergy projects could be considered based on available biomass streams, including covering own energy demand from renewable energy sources, pellets production and energy supply to the national grid and/or district heating systems. The technology would contribute to the economic development of Ukraine by fostering the development of renewable energy sector.

Additional information about the technology is presented in Mitigation Technology Barrier Analysis and Enabling Framework report and technology factsheet presented in the Technology Needs Assessment report prepared within the TNA project.

1.1.6.2 Ambition for the TAP

In 2019, biofuel ensured 3.8% (3,362 ktoe) of the total primary energy supply and 4.2% of final energy consumption (2,087 ktoe) in Ukrainian energy balance (SSSU, 2020). Most of the biomass is consumed in a form of wood by residential sector for heating and cooking purposes. However, during recent years, the use of biomass in industry, district heating, and individual boiler houses for heating of public buildings is also increasing.

According to the Energy Strategy of Ukraine for the period till 2035 “Security, Energy Efficiency, Competitiveness” (CMU, 2017) the share of biomass will be increasing in heat and power generation. Biomass and solid municipal waste would cover 11 Mtoe out of 96 Mtoe of the total primary energy supply already in 2035. In order to achieve this goal, additional 7.6 Mtoe of biomass should be brought in Ukraine's energy balance. The share of biomass and solid municipal waste in the total primary energy supply will be increased to 11.5% in 2035 and will ensure approximately half of all renewable energy sources used in the country. Specifically, for the heating sector, the Concept of State Policy

Implementation in the Area of Heat Supply aims to achieve the 30% share of renewable sources in heat generation by 2025 and 40% share by 2035 (CSPIHS, 2017). As of 2018, the share of biomass in heat generation was 7%, while other renewable energy sources covered additional 1% (BAU, 2020).

Therefore, biomass is a crucial component of national energy strategy and the use of biomass is expected to increase more than threefold during next 15 years. Solid biofuels from agricultural residues will play an important role in reaching renewable energy targets in Ukraine and will contribute to decarbonization of electricity and heating sectors.

According to the estimation of Bioenergy Association of Ukraine based on 2018 yields data (BAU, 2020), the economically feasible energy potential of agricultural residues is over 10 Mtoe, including straw of grain crops – 3.36 Mtoe; by-products of grain maize production (stalks, cobs) – 3.56 Mtoe; by-products of sunflower production (stalks, heads) – 1.54 Mtoe; secondary agricultural residues (sunflower husk) – 1.00 Mtoe; and rapeseed straw – 0.68 Mtoe. The potential is expected to be further increased during the next decades due to expected growing yields of cereals (mainly wheat and corn).

The figures mentioned above reflect the maximum potential, which will require time and proper enabling framework to materialize. The Bioenergy Development Roadmap proposes the targets of 3.61 Mtoe of solid agricultural residues (straw, stalks, sunflower seed husk) for 2030 and 8.69 Mtoe for 2050. Only about 1 Mtoe is being already in use (mostly sunflower seed husk and partly straw). Greenhouse gases emission reduction potential due to additional use of 2.6 Mtoe (109 million GJ) of agricultural residues is conservatively estimated at the level of 3.8 Mt CO₂-eq. for 2030. In case of biochar production, the additional GHG's emission reduction could be achieved due to carbon sequestration in agricultural soils.

1.1.6.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The summary of barriers presented below is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report.

Capital expenditures. Significant capital expenditures required for biomass to energy projects pose a financial barrier for their implementation in Ukraine. According to the estimations of experts from the working group, Mitigation Technologies in Agricultural capital expenditures for biomass boiler's houses varies in the range of EUR 0.1-0.3 million per MW of the installed heat capacity with the most of estimates falling in the range of EUR 0.15-0.25 million per MW and for biomass CHP could be in the range of EUR 2.5 – 3.5 million per MW.

Operational expenditures. Main operational costs are related to the biomass fuel cost (the market price of biomass residues or biomass residues collection and logistics cost). The price of biomass fuel from agricultural residues could vary from 20 Euro per ton in case of straw to as much as 100 EUR per ton or more in case of agricultural pellets. The high volatility of biomass prices during the heating season and in medium-term perspective creates additional risks for the feasibility of biomass to energy projects.

The economic value of biomass residues as a substitute for mineral fertilizers: farmers are often reluctant to use straw and other crop's residues for energy purposes because of nutrient (N, K₂O, P₂O₅) level contained in the residues and compare their value with the relevant cost of mineral fertilizers.

Technological barriers relate to the specific characteristics of agro-biomass fuels and the limited availability of specialized equipment suitable for agricultural biomass combustion, as well as the lack of the specialized machinery for the harvesting of crop production by-products (e.g. balers, loading and unloading equipment, transportation equipment). Straw combustion, in particular, is accompanied by the emissions of carbon monoxide, particular matters, hydrogen chloride, and other polluting substances. It is important to follow operational requirements for the equipment and ensure appropriate maintenance and operation control procedures, including the control of fuel quality and air emission. In case of biomass residues collection, there is growing experience for the collection, transportation and storage of cereal's straw, however for corn and sunflower residues, technological solutions are much less known and only initial technical and economic feasibility studies are being performed in Ukraine. Technological barriers are also applicable for the production of high-quality pellets, since this is a complicated technological process, where the quality of raw materials, equipment and requirements for

final products should be taken into account. Significant number of national pellets producers use equipment and technologies designed for animal feed production, which leads to the low quality of pellets and high energy consumption.

The lack of developed supply chains: barriers related to biomass supply chain relate to the complexity of organizing the stable supply chain of biomass and the reliable biomass logistic system for energy generation. The development of supply chains for agro-biomass include the evaluation of agro-biomass resource base, technical feasibility and economic efficiency of logistical operations (baling, transportation, storage, etc.), the sourcing of biomass resources and concluding agreements with specific biomass suppliers, and arranging biomass logistics. The experience is limited in the development of reliable and economically sustainable supply chains in Ukraine and would require investment in equipment and infrastructure, as well as capacity building, information sharing and organizational innovations.

The lack of established biomass fuel market. Currently, biomass market is characterized by the high volatility of prices and seasonality of both the biomass supply and demand. Biomass production from agricultural residues could start after the beginning of the harvesting period and last for a limited period of time depending on available storage capacities and arrangements with suppliers. Prices could be changing significantly each month or even weeks and there were examples of twofold increase in the price of biomass during one-year period or even the heating season. Usually, prices are relatively lower after the end of the heating season starting from March, and grow before the start of the next heating season due to increasing demand. The national biomass trading industry is at the early stage of development with limited number of players, the lack of biomass standards, constantly evolving market and mainly short-term contracts for the supply of specific volumes of biomass.

Environmental barrier due to soil degradation risk associated with the removal of crop residues from fields. The excessive removal of biomass residues could contribute to the reduction of soil organic content and soil fertility. The level of sustainable removal rates would depend on which of the many important roles residues play in the agronomic system (e.g. soil erosion from wind and water; soil organic carbon; plant nutrient balances; soil, water, and temperature dynamics; soil compaction; and off-site environmental impacts) are taken into account (Muth et al. 2013). Assuming mitigation priorities for climate change, the most relevant environmental limitation is the loss of soil organic carbon (SOC). In this case, the sustainable removal rate of residues is defined by the quantity of residue that must be left in the field to maintain the levels of existing soil organic matter (SOM). Increase in grain yield will result higher biomass residues availability for removal. Certain crop management practices, such as the use of cover crops with prolific rooting systems and vegetative growth in rotations, adding animal and/or green manure or compost to field crops, and adding soil amendments that can increase both the active and heavy fractions of SOM could also increase the sustainable removal rate for residues (Kludze et al. 2013).

Environmental barrier due to air pollution. The combustion of biomass leads to atmospheric air emissions, which include PM, CO, NO_x, SO_x and other substances. The level of emissions depends on the installed air quality control systems (e.g. cyclones, bag filters, electric filters, etc.), operation mode of the equipment and the quality of biomass. In case of biomass combustion with high content of water, the level of emissions increases significantly. Examples of biomass to energy installations without the appropriate flue gas treatment systems, insufficient fuel quality control procedures and not optimal operation modes resulted in the decreased acceptance of the technology among some local state authorities and general public. There were a number of cases, when residents complained about air emissions from biomass installations, which lead to public protests and negative publications in the local media.

Regulatory barriers relate to the lack of a specific action plan and underlying policy measures to achieve the goals of the National Energy Strategy for the period up to 2035 as well as the lack of quality standards for biomass fuels.

Informational barriers include the lack of sufficient information about the energy potential of agricultural residues and available bioenergy technologies, especially at the local level, as well as about successful projects for energy production from agro biomass and biomass supply chains.

Capacity barriers include the lack of sufficient expertise in setting up and servicing of equipment, which is being installed within the biomass to energy or district heating modernization projects (e.g., the operation of cogeneration units on biomass and biomass boilers), as well as pellets production lines. There are no dedicated programs in educational institutions, preparing a broad range of specialists required for biomass to energy projects.

The summary of measures to overcome identified barriers

The summary of measures to overcome identified barriers is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report and additional stakeholder consultations.

Biomass trading platform: an introduction of a digital biomass trading platform to create a transparent and competitive biomass market and contribute to price stability. The concept of biomass trading platform includes mechanism for ensuring the initial biomass supply and demand. In particular, state and municipal enterprises would be obliged to sell the part of the biofuel produced on the electronic platform. On the other side, biofuel consumers who receives state support in a form of green tariff for electricity or tariff incentives for heat energy would be also obliged to purchase biofuel through the electronic platform. The relevant draft law has been developed and is being actively discussed by relevant stakeholders, including central state authorities (MCTDU, 2019).

According to the information of Bioenergy Association of Ukraine, the introduction of biomass trading platform will require the approval of the following regulatory documents:

- the rules of conducting electronic trading of biofuels (access to electronic trading platform, trading rules, typical agreement, dispute settling procedures, etc.);
- requirements for the quality of biofuel traded at the platform;
- the procedure for the selection of operator of the electronic trading platform (documents required for the application, composition of the selection committee, requirements for the operator, cost of services, etc.);
- reporting requirements for the participants of electronic trading platform and operator of the platform.

Environmental policies. The Law of Ukraine On Environmental Impact Assessment and the draft Law of Ukraine On Industrial Pollution Prevention, Reduction and Control targets energy installations with the heat energy capacity of more than 50 MW. Environmental regulations should establish the requirements of clear and justified emission's limits for biomass capacities with the capacity below 50 MW. EU Directive 2015/2193 On the Limitation of Emissions of Certain Pollutants into the Air from Medium Combustion Plants could be used as a guidance in setting emission limits.

Electricity tariffs: The Law of Ukraine On Alternative Energy Types defines provisions on renewable energy generation support through green tariff. The green tariff for biogas and biomass electricity is EUR 123.86 per MWh. The alternative option introduced in 2019 is participation in the auctions of renewable energy capacity, where for biomass power plants, the tariff could not be higher than the green tariff level, but the validity period could be extended beyond 2030 (CMU, 2019). Existing mechanisms provide reasonable incentives for electricity generation using biomass, however the future state policy should ensure the stability of payments and electricity market's operation, as well as the protection of investor's rights.

Heat energy tariffs: establishing heat energy tariffs incentives for the amount of heat energy produced from biomass. In case of heat energy tariff incentives, the payment could be limited in time (e.g. 10 to 15 years) and bound to additional eligibility conditions. Ireland's Support Scheme for Renewable Heat (SEAI, 2020) could serve as an illustrative example for the design of the policy tool. District heating sector has a significant potential for the integration of renewable energy sources and, in particular, biomass. The targeted subsidy program could create material incentives on the basis of tariff incentives mechanism for renewable district heating with additional requirements with respect to efficiency, air quality control and reporting and will allow to decarbonize the heating sector.

Carbon Tax. The use of biomass and biogas for energy purposes should be excluded from the carbon tax (i.e. environmental tax for CO₂ emissions) or any other carbon pricing mechanisms that could be

introduced in Ukraine in the near future (e.g. national emission trading scheme, energy tax based on carbon content). On the contrary, the carbon tax for fossil fuels should be increased from the current low level of UAH 10 per tonne to the scale of about EUR 10 per tonne in order to reflect environmental cost of GHG's emissions and provide incentives for mitigation technologies. The carbon pricing mechanism should be applied to fossil fuels used by both businesses and individual households (KeepWarm, 2020).

Soil quality monitoring system. State land monitoring foresees the regular observation of land conditions and the assessment of processes causing soil fertility changes (water and wind erosion, humus loss, salination, etc.) and soil contamination by pesticides, heavy metals, and other toxic substances (CMU, 1993). Monitoring foresees the development of information data on the basis of soil conditions on agricultural lands and analytical system to define soil preservation measures (MAPU, 2004). The development of the enhanced monitoring system for soil quality would contribute to better understanding of soil properties and impact of crop residues removal on soil quality and carbon sequestration.

The improvement of soil quality monitoring system could include, in particular, the following measures:

- the synchronization of approaches, methods and standards for soil sampling and soil analysis;
- establishing data sharing arrangements with state authorities, scientific institutions, universities, local agencies and other parties on implementation of the monitoring, evaluation, and reporting process;
- the creation of public soil quality database.

The implementation of this policy measure could include actions foreseen in the National Action Plan to Combat Land Degradation and Drought, in particular the development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility and approval of soil quality standards (CMU, 2016).

Information policies. Information policies to support the diffusion of the technology should such aspects as building biomass residues supply chains, the best practices for the use of agricultural biomass residues in district heating systems, the impact of the use of biomass residues for energy purposes on soil nutrients management. Due to the high variability and site specifics for the sustainable removal rates of biomass residues, dedicated scientific studies should be done for major crop rotation systems, soil types and regions in Ukraine. Such studies should aim to take into account not only high-level regional differences, but also specific field characteristics and provide estimation with the high spatial resolution for better and more informed decision making at national, regional, local, and farm levels. Other areas of scientific focus could be the optimization of combustion process for local renewable biofuels, taking into account their chemical and physical properties, as well as combustion conditions.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

On the basis of the measures identified above, the following actions were selected for inclusion in the TAP:

- 1) Establishing biomass trading platform to ensure the transparent market information and contribute to price stability for biomass fuels;
- 2) The adoption of air emission requirements for small and medium size energy installation using biomass fuel;
- 3) The development of renewable heat energy incentive mechanism for district heating systems to promote crop residues utilization for energy purposes;
- 4) Carbon tax reform in order to increase climate mitigation incentive for biomass to energy projects;
- 5) The development of enhanced soil monitoring system to create decision support tools for farmers to define sustainable removal rates for crops residues;
- 6) Information policies to promote the diffusion of the technology.

The table below describes specific activities for each of the action selected for inclusion in the TAP.

Actions	Activities
1. Establishing biomass trading platform	1.1 Approving the Law of Ukraine On the Development of Solid Biofuel Market with the introduction of electronic biomass trading platform
	1.2 Approving the rules of conducting electronic trading of biofuels (incl. selection of operator, eligibility conditions, reporting requirements, etc.)
	1.3 Approving requirements for the quality of biofuel traded at the platform and quality control procedures
2. The adoption of air emission requirements for small and medium size energy installation using biomass	2.1 Approve regulation with established maximum allowed air emission limits for the installation with different capacity.
3. The development of renewable heat energy incentive mechanism for district heating systems	3.1 Adopt changes to the Law of Ukraine On Heat Supply with the introduction of renewable heat energy incentive mechanism for district heating systems defining the level and duration of support.
	3.2 Define eligibility requirements for the subsidy scheme, including types of technologies, efficiency, air quality control and reporting.
4. Reforming carbon taxation mechanisms	4.1 The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.
	4.2. The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of carbon dioxide tax rates for fossil fuels.
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.
	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by the National Research Foundation of Ukraine
6. Information policies to promote crop residues use for energy purposes	6.1 The development and dissemination of guidance document describing the supply chain of crop residues (equipment, practices, cost, etc.) and management options (combustion, biochar production and use, pelleting, etc.).
	6.2 The development and dissemination of guidance document describing environmental mitigation measures for biomass to energy projects (fuel quality control, optimization of combustion process, air quality control systems, monitoring, etc.), emission monitoring and reporting
	6.3 Support scientific studies for the identification of sustainable removal rates for different regions, crops management systems and soil quality; impact of biochar application on soil and yields.

Proposed project idea includes activities aimed at improving soil quality monitoring system since it could create enabling conditions for several climate mitigation technologies in agriculture.

1.1.6.4 Stakeholders and Timeline for implementation of TAP

Key stakeholders for the implementation of TAP include the following:

- Ministry of Energy of Ukraine,
- Ministry of Economy of Ukraine,
- Ministry of Agricultural Policy of Ukraine,
- Ministry of Environmental Protection and Natural Resources of Ukraine,
- Ministry of Finance of Ukraine,
- Ministry for Communities and Territories Development of Ukraine
- State Energy Efficiency and Energy Saving Agency of Ukraine,
- Ukrenergo,
- State Enterprise “Guaranteed Buyer”,
- Committee on the Agrarian and Land Policy Aspects of Verkhovna Rada of Ukraine,
- Committee on the Environmental Policy and Natural Resources of Verkhovna Rada of Ukraine,
- Committee on the Energy and Utilities Sectors of Verkhovna Rada of Ukraine,
- Regional state administrations,
- Centre for Environmental Initiatives Ecoaction,
- Agricultural enterprises.

Activities included in the TAP could be implemented during the period 2021-2030 as detailed for each activity in the TAP overview table below and in Annex VI.

1.1.6.5 Estimation of Resources Needed for Action and Activities

The implementation of actions and activities included in the TAP will require capacity building support in the form of developing and dissemination among interested stakeholders of guidance documents on crops residues supply chain and management options, as well as environmental mitigation measures for biomass to energy projects, emission monitoring and reporting. The preparation of guidance documents could be supported by capacity building activities in the form of training, seminars and workshops.

Capital expenditures for the implementation of technology is in the range of EUR 0.15-0.25 million per MW for biomass boiler houses and EUR 2.5 – 3.5 million per MW for biomass CHP.

Initial expenses for the implementation of activities required for the creation of the enabling framework for the dissemination of technology is estimated at the level of UAH 41 million (soil quality monitoring system and information policies).

1.1.6.6 Management Planning

Key risks for the implementation of technology and activities covered by the proposed TAP include changes in political priorities and reduce the support of renewable energy in Ukraine and the lack of feasible proposals for scientific and research projects.

Priority actions to mitigate risks and create enabling framework for the technology is the adoption of legislative and regulatory framework for supporting production and the use of solid biofuels from agricultural residues (e.g. establishing biomass trading platform to foster biomass supply and demand, heat energy incentives and carbon taxation) and information policies to promote the use of crop residues for energy purposes and overcome some of the key barriers for the technology (e.g. establishing reliable supply chains, defining sustainable removal rates, environmental monitoring and mitigation measures, etc.).

1.1.6.7 TAP overview table

Sector	Agriculture							
Sub-sector	Crop production							
Technology	The production and use of solid biofuels from agricultural residues							
Ambition	3.6 Mtoe of solid agricultural residues (straw, stalks, sunflower seed husk) for 2030 3.8 Mt CO ₂ -eq. of greenhouse gases emission reduction for 2030							
Benefits	- contribution to the economic development and energy security of Ukraine; - job creation in rural areas; - reduced air pollution because of substitution of fossil fuel combustion and using air quality control systems;							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. Establishing biomass trading platform	1.1 Approving the Law of Ukraine On the Development of Solid Biofuel Market with the introduction of electronic biomass trading platform	State budget, development partners	Ministry of Energy of Ukraine, State Energy Efficiency and Energy Saving Agency of Ukraine (SAEE)	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	TBD
	1.2 Approving the rules of conducting electronic trading of biofuels (incl. selection of operator, eligibility conditions, reporting requirements, etc.)	State budget, development partners	SAEE	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	TBD
	1.3 Approving requirements for the quality of biofuel traded at the platform and quality control procedures	State budget, development partners	SAEE	2021-2022	Political (changes of political priorities)	Document adopted	Availability of adopted document	TBD
2. The adoption of air emission requirements for small and medium size energy installation using biomass	2.1 Approving regulation with established maximum allowed air emission limits for the installation with different capacity.	State budget	Ministry of Environmental protection and Natural resources of Ukraine (Ministry of Environment)	2021-2022	Not identified.	Document adopted	Availability of adopted document	TBD

3. Development of renewable heat energy incentive mechanism for district heating systems	3.1 Adopt changes to the Law of Ukraine On Heat Supply with the introduction of renewable heat energy incentive mechanism for district heating systems defining the level and duration of support.	State budget, development partners	Ministry for Communities and Territories Development of Ukraine, SAE	2022-2023	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
	3.2 Define eligibility requirements for the subsidy scheme, including types of technologies, efficiency, air quality control and reporting.	State budget, development partners	Ministry for Communities and Territories Development of Ukraine, SAE	2022-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	TBD
4. Reforming carbon taxation mechanisms	4.1 The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.	State budget	Ministry of Finance, Ministry of Environment	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
	4.2. The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of carbon dioxide tax rates for fossil fuels.	State budget	Ministry of Finance, Ministry of Environment	2021-2022	Political (changes of political priorities)	Amendment adopted	Availability of adopted document	TBD
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.	State budget	Ministry of Agricultural Policy of Ukraine (Ministry of Agriculture), Ministry of Environment, State Service of Ukraine on Food Safety and Consumer Protection	2022-2023	Not identified.	Document adopted	Availability of adopted document	UAH 10 million

	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with National Action Plan to Combat Land Degradation and Drought.	State budget	Ministry of Agriculture, Ministry of Environment	2022-2023	Political (changes of political priorities)	Document adopted	Availability of adopted document	N/A
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.	Development partners	Ministry of Agriculture, Ministry of Environment	2022-2023	Not identified.	Database available	Availability of the database	UAH 10 million
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by National Research Foundation of Ukraine	State budget	Ministry of Education and Science of Ukraine, National Research Foundation of Ukraine (NRFU)	2022-2025	Political (changes of political priorities). The lack of feasible proposals.	Call for proposals published. Publications on results are available.	Number of projects supported. Amount of funding.	UAH 10 million
6. Information policies to promote crop residues use for energy purposes	6.1 The development and dissemination of guidance document describing crop residues supply chain (equipment, practices, cost, etc.) and management options (combustion, biochar production and use, pelleting, etc.).	Development partners	Ministry of Agriculture	2022-2023	Not identified.	Document prepared and published.	Availability of the document.	UAH 0.5 million
	6.2 The development and dissemination of guidance document describing environmental mitigation measures for biomass to energy projects (fuel quality control, optimization of combustion process, air quality control systems, monitoring, etc.), emission monitoring and reporting	Development partners	Ministry of Environment	2022-2023	Not identified.	Document prepared and published	Availability of the document.	UAH 0.5 million
	6.3 Support scientific studies for the identification of sustainable removal rates for different regions, crops management systems and soil quality; impact of biochar application on soil and yields.	State budget, Horizon Europe funds	Ministry of Agriculture, NRFU	2022-2030	The lack of financial resources. The lack of feasible proposals.	Call for proposals published. Publications on results are available.	Number of projects supported. Amount of funding. Publications.	UAH 10 million

1.2 Project Ideas for Agriculture Sector

1.2.1 Brief summary of the Project Ideas for Agriculture sector

On the basis of the outcomes of TNA process, a project idea, focusing on enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine, has been developed and discussed with interested stakeholders. The implementation of the project idea will support the implementation of Technology Action Plan for Agriculture sector and contribute to the dissemination of climate mitigation technologies in agriculture.

The summary of the project idea “Enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine”:

- **Location:** crop production areas throughout Ukraine
- **Short description:** the provision of loans and technical support to agricultural producers willing to implement selected climate technologies
- **Scale:** up to 500,000 ha in total
- **Financing:** USD 50 million
- **Technical assistance:** farm level emission inventories and MRV systems for carbon farming, access to carbon market mechanisms, climate risks vulnerability assessment and adaptation measures
- **Time period:** 5 years (2022 – 2026)
- **Clients:** agricultural enterprises, including SMEs and farmers
- **GHGs emission reduction potential:** 0.2 – 1 tonnes of CO₂-eq. per ha per year; up to 500,000 tonnes CO₂-eq. per year in total

1.2.2 Specific Project Ideas - Enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine

Introduction / Background	<p>In Ukraine, activities related to agricultural sector were responsible for approximately 98 million tons CO₂eq as of 2018. of GHGs emissions per year, mainly from agricultural soils, loss of soil organic carbon, enteric fermentation and diesel fuel combustion by agricultural machinery. Despite emissions related to husbandry farming are declining, the overall volume of emissions demonstrates an upward trend because of crop production activities. Agriculture sector also faces the most significant climate-related risks, which are already being materialized in the form of water deficit and impact on yields. At the same time, there is a large potential for GHGs emission reductions and adapting to climate change by applying climate mitigation and adaptation technologies. The proposed project will support the following climate technologies prioritized within TNA process for climate mitigation in agriculture:</p> <ul style="list-style-type: none">• The use of information and telecommunication technologies for GHG emission reductions in agriculture - the technology employs drones, satellite maps, automated guidance systems, variable rate technologies, software and other tools and contribute to more efficient use of resources and greenhouse gases emission reductions;• Conservative tillage – the technology reduces the disruption of soil structure by minimizing tillage and allows to raise soil carbon content due to ensuring carbon dioxide sequestration; additional mitigation benefits are achieved because of less intensive use of fossil fuels by agricultural machinery;• Organic agriculture - production system which avoids or largely excludes the use of synthetic fertilizers, pesticides and growth regulators and promotes the use of crop rotations, green manures, compost, biological pest control and mechanical cultivation for weed control.
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	<p>There are significant synergies between the technologies and enabling conditions required, therefore all three technologies are proposed to be included in the project. For instance, the use of ICT increases the operational efficiency of farm operation because of the targeted application of input materials and reduced operational expenses, thus it minimizes the impact of reduced yields during the transition period after switching to other climate technologies. Besides, both conservative tillage and organic farming apply such practices as cover crops and the use of mycorrhiza, which increase soil carbon content and contribute to carbon sequestration.</p> <p>Technologies could be applied at the most of enterprises involved in crop production in Ukraine, including small and medium enterprises and farmers. The total area of arable land in Ukraine according to the data of State Statistical Service of Ukraine is 33 million ha and sown agricultural area is 28 million ha (2019), including approximately 4 million ha operated by farmers and 8 million owned by households.</p>
Objectives	<p>The objectives of the Project include:</p> <ul style="list-style-type: none"> • Support the dissemination of climate mitigation technologies in agricultural sector of Ukraine; • Reduce GHGs emissions from agriculture, including emissions from Agriculture, Land Use and Land Use Change and Forestry sector and Energy sector as defined in the national GHGs emission inventories; • Reduce negative environmental impact of agricultural activities in Ukraine.
What are the outputs and are they measurable?	<p>The main expected outputs of the Project include GHGs emission reductions and other society benefits that could be measured using indicators proposed in “Measurement / evaluation” section.</p> <p>The main sources of direct GHGs emission reductions include:</p> <ul style="list-style-type: none"> • More efficient use of mineral nitrogen fertilizers and lower N₂O emissions from agricultural soils; • CO₂ emission reduction due to lower levels of soil organic carbon losses and carbon sequestration in soils; • More efficient use of diesel fuel by agricultural machinery and lower CO₂ emissions from fuel combustion activities in transport category (off-road transport). <p>Other society benefits will include:</p> <ul style="list-style-type: none"> - Increased economic efficiency and reduced operational costs for agricultural enterprises; - Health protection due to lower nitrates content in agricultural products, soil pollution and water contamination; - Reduced soil pollution and soil erosion; improved chemical, physical, and biological characteristics of the soil; - The reduction of runoff pollution from agricultural activities, including the reduced contamination of major water basins (both national and transboundary); - Climate adaptation benefits due to lower dependency of weather conditions, the reduced vulnerability of production and more efficient water resources use; - Job creation to support rural development and reduce work migration to EU.
Relationship to the country’s sustainable development priorities	<p>Ukraine’s updated NDC has an economy-wide target not to exceed 35% of 1990 GHG emissions level in 2030. Agriculture is one of the key sectors to achieve GHGs emission reductions and adaptation benefits. Selected technologies will contribute to the target of updated NDC target by reducing GHGs emissions in Agriculture, Fuel Combustion and LULUCF sectors with the help of more efficient use of mineral</p>

	<p>nitrogen fertilizers (reduced emissions), lower levels of soil organic carbon loss and carbon sequestration (increased removals), and more efficient use of diesel fuel.</p> <p>Low Emissions Development Strategy (2017) covers aspects related to agriculture in all three main objectives:</p> <ul style="list-style-type: none"> - Objective I: Transition to energy system which envisions the use of energy sources with low carbon content and the development of the sources for clean electricity and heat energy; - Objective II: Increase in the volumes of carbon absorption and uptake with the help of best climate change mitigation practices in agriculture and forestry; - Objective III: Reduction in GHG emissions such as methane gas and nitrogen oxide predominantly associated with fossil fuel production, agriculture and waste. <p>Technology's prioritization for the Agriculture sector was carried out in first phase of the Technology Needs Assessment for climate change mitigation in Ukraine. Within the second stage, the analysis of existing barriers and developing recommendations for the enabling framework for prioritized technologies in Ukraine were conducted. The analysis was performed on the basis of the guidance document developed by UNEP DTU Partnership (the Second Edition of Overcoming Barriers to the Transfer and Diffusion of Climate Technologies guidebook).</p> <p>The implementation of selected technologies will contribute environmental objectives defined in the EU regulation 2020/852 on the establishment of a framework to facilitate sustainable investment, in particular, substantial contribution to climate change mitigation, climate change adaptation, and sustainable use and protection of water resources. Technical screening criteria for agriculture could be incorporated into eligibility criteria for potential project partners at later stages (e.g. farm level GHGs emission inventories, avoiding agricultural activities on high carbon stock lands, etc.).</p>
Project deliverables e.g. value / benefits / messages	<p>Proposed climate technologies have the potential to be implemented on the area of over 10 million ha (at least one technology on a particular area / enterprise), including:</p> <ul style="list-style-type: none"> - 4 million ha for organic farming; - 4 million ha for conservative tillage practices; - 10 million ha for ICT in agriculture (the combination of tools and technologies). <p>Approximately 500,000 ha could be targeted at the initial scale of climate technologies promotion.</p>
Project scope and possible implementation	<p>Project scope include institutional, financial, technical and capacity building support for the dissemination of climate technologies in agricultural sector of Ukraine.</p>
Project activities	<p>Project could focus on the following main activities:</p> <ul style="list-style-type: none"> • Assisting relevant Ukrainian state authorities on developing MRV system for agriculture and policies to create enabling framework for climate technologies; • Financing pilot projects, including at small and medium enterprisers and farms; • Technical support to estimate GHGs emission reduction and carbon sequestration potential; • Capacity building and information dissemination activities.
Timelines	<p>Project timeline: 5 years (2022-2026).</p>
Budget / resource requirements	<p>Capital expenditures:</p> <ul style="list-style-type: none"> - ICT - mainly related to indirect cost for the investment in the machinery and equipment, which will allow the practical application of recommendations

	<p>developed using ICT tools (tractors with computer systems, specialized software, machinery for differentiated fertilizers input, etc.);</p> <ul style="list-style-type: none"> - Conservative tillage - USD 100 – 200 per ha depending on the specific technology and equipment to be utilized; - Organic agriculture - no significant capital expenditures associated with organic agriculture; certification expenditures are relatively low. <p>Operational cost:</p> <ul style="list-style-type: none"> - ICT - operational cost ranges from USD 10 per ha for satellite and drones images used in inputs planning to USD 100 per ha and more depending on the complex of technologies applied and additional soil monitoring tests required; - Conservative tillage – allows the reduction of operational and maintenance cost for agricultural enterprises at the level of USD 15 per ha; - Organic agriculture - examples of both higher and lower cost of organic crops production could be found in the literature; overall, the organic agriculture has similar operational cost to the non-organic agriculture. <p>Approximately USD 50 million of financing would be required to target climate technologies application at the area of 500,000 ha.</p>
Measurement / evaluation	<p>Impact indicators for the proposed Project are the following:</p> <ul style="list-style-type: none"> • GHG emission reduction, Mt of CO₂-eq. • Soil organic carbon content, tC/ha • Land area covered by sustainable agriculture practices (by types of practices), ha • Number of people employed by farmers/enterprises adopting sustainable agriculture practices (total and by gender), number of people • Co-benefits achieved (soil quality, biodiversity, water protection, etc.), qualitative indicator
Possible complications / challenges	<p>Possible complications and challenges for the implementation of the Project include financial and non-financial barriers for the dissemination of climate technologies in agriculture as described in the Technology Action Plans. The main possible complications include potential changes of political priorities, lack of financial resources and capacity barriers.</p>
Responsibilities and Coordination	<p>Responsibilities and Coordination: International financial institution or other development partner, Ministry of Environment Protection and Natural Resources of Ukraine, Ministry of Agricultural Policy of Ukraine.</p> <p>Other partners: a) Agricultural enterprises already active in organic production and conservative tillage practices; b) Agricultural enterprises, including SMEs and farmers, that could switch to climate technologies; c) Financial organizations: local banks, credit unions, other IFIs and technical assistance projects.</p>

Chapter 2 Technology Action Plan and Project Ideas for Waste Sector

2.1 TAP for Waste Sector

2.1.1 Sector overview

Waste management is one of the most conservative types of economic activity in Ukraine. Despite numerous governmental and non-governmental incentives over the past decades, no principal changes in the parameters of national waste management have occurred. In particular, the share of landfilled municipal solid waste (MSW) fluctuated from 93.3 % to 95.8 % from officially collected amount for the period of 2014-2020. Changes were mostly influenced by the operational conditions of acting waste incineration plant in Kyiv. Certain successful results have been achieved with the help of the flexible economy mechanism under Kyoto Protocol and introduction of green tariffs for electricity production on the basis of renewable energy sources since 2013. Thus, about 18.4 % of methane generated at MSW landfills in 2018 was used for the needs of electricity generation sector (GHGI, 2020).

The amount of generated (physically collected) MSW was 10.7 Mt in 2020, 79 % of the population was covered by centralized MSW collection system, the reported share of landfilling was 93.7 %. The rest 6.3 % was reused, recycled or incinerated. In particular, 1.7 % was incinerated, 4.6 % was collected at secondary raw materials procurement points and treated at waste processing facilities (MSWTS, 2020).

Separate MSW collection was introduced in 1707 municipalities. Landfill gas was collected and used as renewable energy source for electricity production at 19 landfills in Ukraine. The following treating facilities were in operation: 4 waste incinerators (one big incineration plant in Kyiv and three small facilities in Kharkiv oblast) and 35 sorting lines. It has to be noted that official statistics don't cover all MSW sorting lines as soon as some of them are involved in grey sector of the economy.

The acting legislation for waste management is out-of-date. Presently, it is still based on the Law "For Waste" (LW, 1998), which is planned to be replaced. The draft law No. 2207-1 from 16.10.2019 "For Waste management" (for the implementation of EU requirements in waste treatment system (DLW, 2017)", which involves the implementation of waste hierarchy principles, extended producer's responsibility, electronic licensing system, and also implying changes in waste classification and accounting system is still at the stage of approval procedures.

In order to facilitate transformation processes on the basis of EU principles and practices, the National Waste Management Strategy up to 2030 was approved by the Cabinet of Ministers of Ukraine (CMU) in 2017 (NWMS, 2017) as well as National Waste Management Plan up to 2030 approved in 2019 (NWMP, 2019). National Waste Management Strategy up to 2030 included three phases:

- Phase I (2017-2018) – the preparatory stage provided basis for the modern waste management system in Ukraine;
- Phase II (2019-2023) – the implementation of policy measures proposed in phase I;
- Phase III (2024-2030) – the implementation of new MSW management policy fully harmonized with EU legislation and achievement.

Table 2.1 below shows intermediate and final targets to be achieved by 2030 (for more details, see Technology Needs Assessment Report. Mitigation. Ukraine (TNA, 2019).

Table 2.1–Targets set up in the National Waste Management Strategy up to 2030 (NWMS, 2017)

Indicator for MSW	Base value, 2016	Target, %			Statistics (MSWTS, 2020)
		2017-2018	2019-2023	2024-2030	2020
Reuse	5	7	8	10	4.6
Processing (recycling and composting)	3.04	5	15	50	
Incineration	2.37	5	7	10	1.7
Disposal/landfilling	95	80	50	30	93.7
Total (estimated)	105.41	97	80	100	100.0

Based on the data in table 2.1 it can be concluded that:

1. National Waste Management Strategy up to 2030 identifies the ambitious target for the decreasing of MSW disposal share from 95 % in 2016 to 30 % in 2030 during the period of 15 years.
2. The internal inconsistency of preliminary targets shows that they were set up by political decisions without the solid preliminary study.
3. Internal inconsistency for basic 2016 year shows that policy makers have not sufficient statistical data regarding MSW treatment system in Ukraine.
4. Three years later, after entering into force in 2017, none of intermediate MSW management targets were achieved. Thus, the share of MSW landfilling was 93.3 % in 2020 with comparison to the set-up target of 80 % by 2018; incineration was 1.7 % instead of 5.0 %; sum of reuse, recycling and composting was 4.6 % instead of 12 %.
5. Paying attention to actual trends, Waste Management Strategy of Ukraine will not be fully implemented by 2030, as well as both intermediate and key goals will not be achieved due to actual trends in the waste management system of Ukraine.

Historical GHG's emissions. According to Ukraine's GHG's Inventory (GHGI, 2020), GHG emissions in the Waste sector amounted to 12.18 Mt CO₂-eq. in 2018 that is equal to 3.59 % of total national emissions (excluding LULUCF). Nevertheless, it's the only sector where the GHG's emission upward trend has been observed since 1990 increasing by 2.19 % in 2018 with comparison to 1990.

Such overall sectorial trend was caused by the two main factors: the rapid increasing of landfilled MSW since 1997 and the gradual reduction of wastewater generation in industrial and household sectors since global economy crisis in 2008.

More than two-thirds (66.8 %) of overall GHG emissions in the Waste sector are caused by MSW landfilling. It is expected that this share will increase constantly in future, if significant changes do not take place in national MSW management system. Approximately 33 % of emissions correspond to the wastewater treatment, the rest 0.2 % and 0.1 % belongs to the biological treatment of solid waste and incineration respectively. GHG emissions from waste incineration (without energy recovery) and biological treatment are minor, because these types of waste treatment are limited.

GHG emissions projections. Initial NDC of Ukraine included a target of not exceeding 60% of 1990 GHG's emission level in 2030 (NDC, 2016). Initial Nationally Determined Contribution (NDC) was approved on the basis of scientifically justifying documentation for the Intended Nationally Determined Contribution of Ukraine to a New Global Climate Agreement (INDC).

Recently, within the process of NDC update with the financial and technical support, provided by the European Bank for Reconstruction and Development and the Government of Sweden, Ukraine has prepared representative GHG emission projection scenarios (SGUNDC, 2020), its cost assessment and the set of priority mitigation technologies (SGUNDC, 2021), as well as conducted numerous consultations with the main stakeholders.

Ukraine's updated NDC includes GHGs emission reduction target at the level of 65 % till 2030 (which is, GHG emissions including LULUCF should not exceed 35 % of corresponding value of emissions in 1990).

At the stage of scientific justification of NDC2, the four key scenarios were developed in the Waste sector:

1. *Business as Usual* scenario is based on existing waste management practice in Ukraine (2017) and cross sectoral macroeconomic and socio-demographic projections;
2. *Reference* scenario is based on the assumption that all targets set in existing legislation (laws, strategies, plans, concepts, programs) would be achieved. The core legislation would be fully

implemented including National Waste Management Strategy up to 2030 and National Waste Management Plan up to 2030;

3. *Climate Neutral Economy* scenario is based on the assumption that all targets set in the existing legislation would be significantly over-achieved with the help of the wide implementation of modern technologies and the best international practices (after the example of Germany, Denmark Sweden etc.) in the next decade;

4. *Combined Sensitivity scenario S3G (Target)*

During preliminary consultations under NDC2 preparation process, it was highlighted by the stakeholders, including NGOs, that the National Waste Management Strategy will not be fully implemented due to goals that are not achievable until 2030 and long approval of new legislation in the waste management. *Combined sensitivity scenario S3G* (hereinafter – *Target* scenario) was developed corresponding the limited implementation of National Waste Management Strategy till 2030 with the subsequent rapid development of the sector in 2030-2050 because of the need of drastic change in roles and responsibilities in the new waste management that should be created from scratch, which is time consuming task.

GHG emission trends corresponding to four above mentioned scenarios are shown in the fig. 2.1.

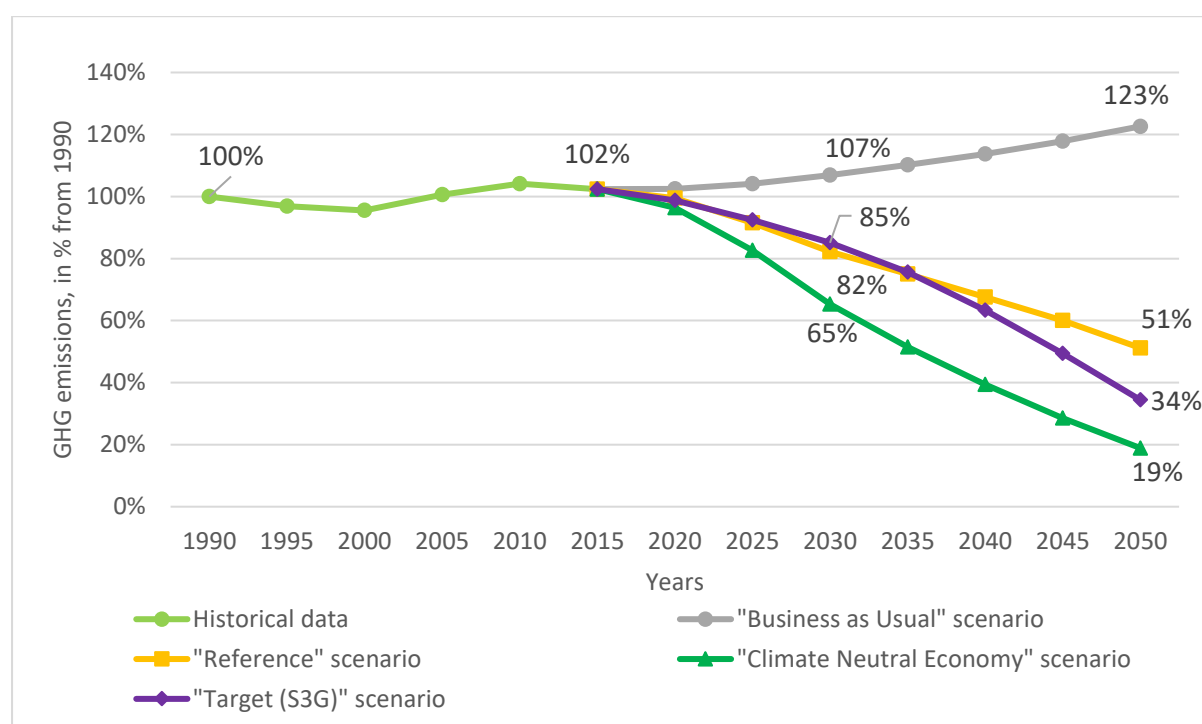


Figure 2.1. GHG emission projections in the Waste sector of Ukraine till 2050

Along with acting and planned regulations, the outcomes of Technology Needs Assessment reports (TNA, 2019 and TNA, 2020) played a key role to develop and evaluate waste management scenarios in the scientific justification process for NDC2 preparation and approval. Thus, TNA report (TNA, 2019) was used to form a short list of climate friendly technologies for scenario's development (SGUNDC, 2020), as well as for the cost assessment of four scenarios implementation. Mitigation Technology Barrier Analyses and Enabling Framework (TNA, 2020) report was used to develop *Target* (S3G) scenario, which is ambitious on the one hand and realistic on the other, being an acceptable compromise for all the stakeholders involved in NDC2 preparation (SGUNDC, 2021).

Technology Needs Assessment in Ukraine. Technology's prioritization was carried out for the Waste sector in first phase of Technology Needs Assessment for climate change mitigation in Ukraine (TNA, 2019). The results of technology's prioritization were developed for Waste sector on the basis of activity

of waste working group, composed of representatives from business, science, government, non-governmental organizations and international donors. The maximal scores were obtained for technologies:

- Methane capture at landfills and waste dumps for energy production (LFG-to-E);
- Waste sorting – the sorting of valuable components of MSW with subsequent treatment of waste residual by other technologies (Sorting);

The following technologies were also positively evaluated:

- The closure of old waste dumps with methane destruction, e.g. flaring, bio-covers, passive vent etc. (Closure);
- The aerobic biological treatment (composting) of food and green residuals (Composting);
- The mechanical-biological treatment of waste with biogas and energy production – anaerobic digestion of organic fraction of MSW (MBT-AD);
- The mechanical-biological treatment of waste with the alternative fuel (SRF) production for cement industry (MBT-Cement).

The rest technologies were evaluated with less than average scores:

- The construction of new regional sanitary MSW landfills (Construction);
- The mechanical-biological treatment of waste with alternative fuel (RDF/SRF) for district heating and/or electricity production (MBT-DH);
- The biological stabilization of municipal solid waste (Bio-stabilization);
- The combustion of residual municipal solid waste for district heating and/or electricity production (combustion);
- The gasification/pyrolysis of MSW for large-scale electricity/heat applications (Gasification).

Thus, the dissemination of technologies is a consensus among the wide ranges of stakeholders for methane capture at landfills and waste dumps for energy production, waste sorting, the closure of old waste dumps with methane destruction, composting, mechanical-biological treatment of waste with biogas and energy production, with the alternative fuel (SRF) production for cement industry and anaerobic digestion of sewage sludge in order to implement climate friendly technologies in the Waste sector of Ukraine.

The second phase of Technology Needs Assessment included the analysis of technology barrier and enabling framework (TNA, 2020). This phase was aimed to outline existing barriers and enabling framework for technologies selected in the first phase. The analysis was carried out on the basis of development by UNEP DTU Partnership, the Second Edition of Overcoming Barriers to the Transfer and Diffusion of Climate Technologies guidebook (Nygaard, I. & Hansen, U. E., 2015).

The following key stakeholders were involved in the development of enabling framework for further dissemination of prioritized mitigation technologies in waste sector:

- The Ministry of Community and Territorial Development of Ukraine,
- The Ministry of Environmental Protection and Energy of Ukraine (reorganized to two independent central authorities: the Ministry of Energy of Ukraine and the Ministry of Ecology and Natural Resources of Ukraine),
- The Ministries (the Ministry of Health of Ukraine, State Energy Savings and Energy Efficiency Agency of Ukraine, the Ministry of Economy of Ukraine of Ukraine, the Ministry of Education and Science of Ukraine;
- Regional and local state authorities, including regional state administrations and local communities;

- Business associations and private companies;
- Scientific institutions;
- Non-governmental organizations.

At that stage, general and technology specific barriers were identified for the dissemination of climate friendly technologies and corresponding measures to overcome them.

The following **economic and financial barriers** are general for the dissemination of modern MSW treatment technologies in Ukraine:

- Low feasibility or even unprofitability (low IRR, NPV, long payback period);
- Low tariffs for MSW management for population and other waste generators;
- Low tariffs for MSW disposal (no funds for closure, care and aftercare monitoring);
- Inadequate access to financial resources, or high cost of finance, disincentives to foreign investment;
- The absence of economy incentives to process and recycle MSW;
- The absence of producer responsibility on the generated waste;
- Low population income.

Common non-financial barriers for dissemination of modern MSW treatment technologies in Ukraine are:

Regulation/legislation barriers:

- The lack of comprehensive and strategic waste management policy implementation;
- Insufficient institutional framework;
- The lack of legislation development, for example, in some cases unclear ownership of MSW;
- The lack of non-financial stimulus for MSW treatment;
- The absence of producer's responsibility for the potentially generated waste;
- The poor stimulation of specific waste components separate collection, such as glass, packaging, batteries accumulators, etc;
- The lack of control for unofficial landfilling and other activities.

Market conditions barriers:

- Over-bureaucratic procedures and corruption;
- No possibility to sign long-term contract;
- No possibility to sign direct contracts between local governments and waste processing companies;
- Involvement of informal sector.

Technological barriers:

- Few local equipment and service suppliers and local references;
- Bad quality of mixed waste;
- Insufficient skilled manpower for O&M.

Information barriers:

- The limited awareness of technology used in the developed countries;
- The lack of available information, pure population knowledge and involvement in waste issues;
- Missing feedback among interested parties.

Moreover, it was highlighted, that existing waste management system does not give equal gender opportunities, wherein barriers that lead to such an inequality, could be conditionally divided into two groups: passive and active. **Passive gender barriers** reduce the attractiveness of jobs for women due to the specific requirement of human resource in the acting system, particularly hired workers should be able to operate in difficult physical and sanitary conditions, as well as the system itself is conservative and is not flexible itself. **Active gender barriers** are reflected in the fact that men are used to have higher average salaries at the similar positions and have higher chances for career paths in this field.

Common measures to overcome economic and financial barriers for waste treatment technologies could be identified as follows:

- The development and implementation of waste management plans at regional level and at the level of all administrative entities;
- The implementation of the principle "community is the owner of the waste and responsible entity for its processing in accordance with the regional waste management plan"
- The introduction of tariffs for waste management sufficient to cover associated expenses for project life time (20 years);
- The implementation of "pay as you throw" principle;
- The implementation of "extended producer responsibility" principle;
- The introduction of "circular economy" principles;
- The introduction of economic incentives for domestic equipment for modern waste processing technologies dissemination;
- Temporary VAT exemption for reuse services, recyclable materials and products, RDF/SRF.

Common measures to overcome non-financial barriers for waste treatment technologies could be identified as follows:

- The creation of general conditions for modern regional landfill construction program and old waste dumps closure;
- The creation of general conditions for modern waste treatment technology development;
- The creation of central authority responsible for waste management's policy implementation;
- The implementation of national waste list (classification) on the basis of European practice;
- The creation of guidelines on sustainable green public procurement;
- The implementation and use of cost-effective tools in order to encourage the development of infrastructure for waste treatment facilities;
- The introduction of economic incentives for the dissemination of environmentally friendly technologies and the expansion of recycling practice;
- The introduction of inter-municipal cooperation as legal mechanism supported by the Government;
- Levelling an influence of informal sector;
- The creation of an interagency coordination board for waste reuse, processing and utilisation;
- Support for new jobs in waste management sector;
- The support of new specialties for sustainable waste management in universities;
- The consideration of waste management issues when developing mid and higher education standards;
- The support of new specialties for sustainable waste management in universities;
- The creation of guidelines in modern waste management opportunities for municipalities;
- The creation of working platforms for the dissemination of the best practices in Ukraine;
- Carrying out of national awareness campaign for the sustainable waste management;
- The implementation of MSW management awards;
- Waste management awareness activities in school and pre-school institutions.

The implementation of new model for waste management system in Ukraine, which should be based on the dissemination of wide modern waste treatment technology, fair and transparent market rules and mechanisms of control, as well as good governing in the whole will lead to overcome the passive gender barriers in waste management system of Ukraine.

In order to overcome the additional specific measures of active gender barriers, these have to be implemented in waste management system, which are:

- The implementation of quotas for woman representativeness in central and local authority bodies;
- Gender neutral requirements about vacancies for both government and business;
- The implementation of awards focused on promoting the women's involvement in waste management issues;
- Ensuring social guaranties for pregnant women and women with children;
- The implementation of supporting mechanisms stimulating the migration of hired workers in waste management from informal sector to legal business.

Technology specific barriers were identified in TNA, 2020 as soon as the measure to overcome them. They are discussed in each specific technology chapters.

The third phase of TNA process is aimed in the preparation of Technology Action Plans (TAPs), which supports the implementation of the prioritized technologies at the desired scale to achieve climate and development benefits from the modernization of waste management sector.

TAP preparation is built upon measures identified in TNA for overcoming barriers to technology implementation and specifies how implement these measures, including who is responsible, when, and from where to secure funding. As such, TAP serves as a bridge between the analysis of prioritized technologies and their implementation. TAPs are developed in accordance with the Guidelines provided by UNEP-DTU Partnership (IETNA, 2017).

Action plans for each technology include the descriptions of respective sector and sub-sector, the ambition related to the implementation of the technology, the list of actions, as well as the activities to be implemented under each action. For each activity, there are details about the sources of implementation funding, responsible bodies, implementation timeframe, relevant risks, success criteria, indicators for monitoring of implementation and the budgets.

The main pillar for the preparation of TAPs for prioritized waste treatment technologies is the identification of acceptable level of ambition for the dissemination of each technology or group of principally similar technologies.

The level of ambition for prioritized technologies. National Waste Management Strategy till 2030 (NWMS, 2017) is the main document which sets goals for technology development in the waste sector of Ukraine in straightforward manner. However, NDC2 preparation process (public and personal consultations with stakeholders) has revealed that it's not realistic to achieve the existing set of goals in the Strategy. This is one of the few cases in Ukraine where both authorities (central and local) and public (including most NGOs) have a common position that previously set goals are too ambitious and have to be revised on the basis of actual conditions in Ukraine. There is understanding among stakeholders that National Waste Management Strategy till 2030 as well as National plan for its implementation have to be updated and revised. It means that goals set in the Strategy (table 2.1) are not acceptable for preparation of TAPs.

In this regard, the most appropriate source for identification of ambitions for prioritized technologies is *Target scenario S3G* for waste management sector prepared within NDC2 (SGUNDC, 2021). Wherein, the intermediate targets for 2040 are set on the basis of the expectation that National Waste Management Strategy will be fully implemented by 2040. Arguments for such an approach are:

- Key indicators of *Target scenario* were used to set the sector specific mitigation's goal in the waste sector of NDC2, these indicators were already discussed and agreed by the wide range of stakeholders.
- The TNA process is closely related to NDC2 preparation. The outcomes of TNA phases became an integral part of NDC2 preparation in the waste sector, and vice versa, the phases of NDC2 preparation became an integral part of TNA process. Thus, the reporting format, terminology and main assumptions are similar in TNA reports and reports dedicated to scientific justification of NDC2.

Table 2.2 provides the level of ambition used for TAPs preparation.

Table 2.2 – The level of ambition for waste management development in Ukraine up to 2050

Indicator for MSW	Base value, 2020	Target	Long-term vision	
		2030 ²	2040 ³	2050 ²
Reuse	4.6	8	10	10
Recycling		10	34	40
Biological treatment ¹		5	16	20
Incineration	1.7	7	10	25
Disposal/landfilling	93.7	70	30	5
Total (estimated)	100	100	100	100

¹includes composting and anaerobic digestion of organic waste

² waste management indicators for *Target scenario S3G* in corresponding year

³ waste management targets set in National Waste Management Strategy till 2030. Disaggregation of processing waste treatment practice by recycling and composting was carried out in accordance with *Reference* scenario.

Time tables in detail illustrating waste sector TAPs implementation are presented in Tables V.1-V.6 of Annex V.

Consultations with stakeholders as an integral part of TAP preparation process. TAP phase in the waste sector was implemented in close cooperation with stakeholders. Due to global pandemic caused by COVID-19, all consultations were carried out virtually with the stakeholders as well as the meetings of sectoral working groups. At that stage, the project's experts have prepared zero draft version of the specific TAPs for each prioritized technology in accordance with the guidance provided by UNEP DTU. Then at the next stage, personal consultations were organized with interested parties including key national experts and stakeholders' representatives.

The approach of these two stages has created preconditions for dialogue with stakeholders regarding further TAP preparation activity. This dialogue was organized by the Ministry of Ecology and Natural Resources of Ukraine through online conference. The event was headed by Iryna Stavchuk, the Deputy Minister of Ecology and Natural Resources of Ukraine. During the conference, the main results of the Technology Prioritizations and Barrier Analysis and Enabling Framework phases were presented. The vision of final phase of the project execution was discussed.

Then sectoral experts of the project prepared and sent the questionnaires to stakeholders aiming to reveal the most important actions which implementation would be crucial for further diffusion of the prioritized technologies. At the last stage, final versions of technology TAPs were completed paying attention to stakeholders' responds provided in questionnaires. Project's ideas were prepared for the most popular technologies among stakeholders and included in the report. Questionnaires have played two important roles - to perform QA for the draft TAP version and to ensure the active participation of stakeholders in TAP preparation process.

The outcomes of stakeholder's survey in the waste sector are presented in Annex III, particularly in Tables III.1-III.8 and Figures III.1-III.8.

2.1.2 Action Plan for Technology W1: Methane capture at landfills and waste dumps for energy production

2.1.2.1 Introduction

Ukrainian technical standard DBN V.2.4-2-2005 "Solid waste landfills" includes such main provision as the utilization of LFG formed by the anaerobic decomposition of the organic component of solid waste. LFG could be used as fuel for power plants (boiler units, industrial furnaces, stationary generators) or for refuelling in fuel tanks. The method of LFG's utilization is determined during the technical specification development for the design of LFG recovery system.

It is considered that the recovery and energy's utilization of LFG makes sense with average thickness of waste layer at least 10 meters and one million tons of accumulated solid waste. The great importance is given to the time of accumulation for the required amount of waste. Typically, these conditions are met at landfills that accept waste from settlements with the total population of 200,000 inhabitants or more.

LFG recovery is an effective environmental measure at landfills and waste dumps. As a result of LFG combustion (in power unit or by flare), GHG's emission is reduced, organic volatile compounds responsible for unpleasant odours are destroyed, the probability of fire events is reduced or eliminated. In addition, LFG is local and renewable energy source that can substitute any kind of fossil fuel like coal, oil and natural gas.

The combustion of LFG for the production of energy contributes to the reduction of GHG's emission in two ways. LFG capture prevents the release of methane into the atmosphere and the electricity subsequently produced by LFG combustion produces less CO₂ emission than conventional fossil fuel combustion. Total potential for the reduction of GHG emission is evaluated as 1.7 Mt CO₂-eq./yr for present Ukrainian conditions.

2.1.2.2 Ambition for the TAP

The technology is under development in Ukraine. In the beginning Ukrainian biogas collection plants were implemented within joint implementation (JI) projects in 2008...2012 during the first period of Kyoto Protocol. The introduction of green tariff for electricity produced from biogas and landfill gas led to the fact that a significant part of the energy potential of LFG in Ukraine, it has already been implemented by private companies. There were almost 30 MW_{el} of total installed capacity at 26 Ukrainian landfills and waste dumps in 2020. The total economic potential of existing Ukrainian landfills is evaluated as 40-50 MW in term of the installed electrical capacity.

In spite of the fact that technologies of mechanical biological treatment of waste with biogas production will probably be developed in future in specialized reactors, a certain part of LFG potential may be related to the construction of regional sanitary landfills in the framework of waste management strategy by 2030 and further. The role of landfilling will remain significant in Ukraine for at least several decades. The concentration of waste resources on large scale and in strict compliance with operation rules for sanitary landfills would allow to recover up to 75...85% of the generated LFG and even total amount of LFG will be reduced due to avoiding direct landfilling of biodegradable waste.

2.1.2.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The summary of barriers presented below is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report.

Existing economic and financial barriers are associated with the possible low feasibility of projects, achieving less than the expected efficiency of LFG recovery. Measures, in order to overcome economic and financial barriers for methane capture for energy production, may include the creation of economic and financial conditions for modern regional landfill's construction program, the creation of economic and financial conditions for old waste dump's closure, the introduction of high gate fee/tax for waste disposal, and at last, at least the creation of economic and financial condition for LFG utilization stands not only for electricity, but also for heat use and biomethane production as direct substitution of natural gas.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

In order to achieve goals provided in Table 2.2, efforts should be made by central and local authorities, business, and financial institutions, scientific and non-governmental organizations. The mission of the central and local authorities is to ensure new regional landfill's construction and the closure of old

disposal sites immediately to control gate fee (taxes) for landfilling. In this regard, key actions to be implemented are:

- The creation of necessary infrastructure;
- The development of economic and financial conditions for regional landfill construction and old waste dumps closure;
- The provision of long-term and low-interest loans or grants through state funds, private sources and international funds;
- The creation of stakeholder and technical expert's networks for technology development and transfer.

The corresponding activities to be implemented to make these actions work are shown in the table below.

2.1.2.4 Stakeholders and Timeline for the implementation of TAP

The following Stakeholders would be involved to develop methane capture at landfills and waste dumps for energy production:

- The Ministry of Communities and Territories Development of Ukraine being responsible for the formation and implementation of state policy including municipal service in order to create a comfortable, high quality and safe living space for population;
- The Ministry of Ecology and Natural Resources of Ukraine being responsible for the state control of environmental protection, rational use and protection of natural resources;
- The National Energy and Utilities Regulatory Commission of Ukraine leading the process of new tariff's introduction at the central authority level;
- The Ministry of Finance of Ukraine providing support for enabling the legal framework;
- Local authorities, municipal companies (landfill operators) as entities control local budgets and man power;
- Technical and financial experts as components of capacity building;
- NGOs for ensuring the connection among central and local governmental bodies and Ukrainian population.

Specific activities will be implemented mostly within the period 2022-2030 along with the program of old landfill and waste dumps closure and new regional sanitary landfill construction.

2.1.2.5 Estimation of Resources Needed for Action and Activities

Capacity building is required to carry out actions and activities including the creation of stakeholder and technical expert networks for technology development and transfer. That may be achieved by the creation of the platform for national technical experts and stakeholders on the basis of governmental or non-governmental organizations, the exchange of information and lessons learned by the organisation of information campaigns, workshops and conferences.

Capital expenditures depend on physical conditions formed during exploitation process for LFG recovery and the construction of utilization system in landfills and solid waste dumps. The specific cost of project, which involves the production of electricity from LFG, usually ranges from 1500 to 2500 €/kW_{el} of the installed electrical capacity. The lower value is more associated with controlled landfills, the upper one with waste dumps. There are at least two reasons for that. At uncontrolled waste dumps, it is possible to collect less LFG per unit of accumulated waste. In addition, the construction of recovery system at waste dumps involves additional costs because of the complex geometry of the waste body and the requirement to form the upper airtight layer covering the waste.

The investor must be aware that, at relatively small capital costs, dumpsite projects are associated with an increased risk because of uncertainty in the baseline conditions and the inability to reliably predict LFG generation rate. The payback period of the project will depend on the actual LFG amount and the

efficiency of its recovery. At present, green tariff for electricity sale and achieved efficiency of LFG recovery 50%, projects can pay off in 2-3 years, with possible recovery efficiency of 20% in 6-8 years or even longer.

As soon as LFG potential of large landfills is realized to big extend, it is necessary to build LFG collection systems at medium and small landfills in Ukraine. For many of them, electricity generation will not be feasible option. For such landfills, another possibility may be heat recovery or simple flare combustion to reduce methane emissions. Construction's costs can be the part of the closure of project and will be determined by landfill area on a case-by-case basis. For new landfills, the cost of LFG recovery system may be included as minor part of the landfill construction cost.

2.1.2.6 Management Planning

The main risk of the technology is associated with the low level of operation, insufficient information for operational history for old and unofficial landfills, low activity in legislation development, unstable financial situation in the country, the lack of funds and grant program.

The introduction of face-out stimulating tariffs for waste disposal may support to raise the level of operation practice. However, the tariff for waste disposal could often be limited by political reason in Ukraine. In order to avoid that, the independent verification has to be carried out for the introduced tariffs for waste disposal.

The immediate requirements to implement development of LFG technology along with waste disposal site closure are the following:

- a) enacting the new Laws for Waste and Landfilling of Municipal Solid Waste;
- b) the update and revision of National Waste Management Strategy till 2030 and National Waste Management Plan till 2030;
- c) the development of portfolio for technology transfer, technical and financial support projects requested with a purpose to disseminate the waste disposal site's closure and new landfill construction in Ukraine.

2.1.2.7 TAP overview table

TAP overview table								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Methane capture at landfills and waste dumps for energy production								
Ambition: The reduction of GHG emission up to 1.2 Mt CO ₂ -eq, developing of total installed electrical capacity up to 50 MW								
Benefits: GHG emission reduction, eliminated fire events, minimization of odours, fossil fuel substitution								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The creation of MSW disposal sites inventory	State and regional budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2024	The lack of information for old and unofficial landfills	All landfills and waste dumps covered by inventory	Percentage of landfill and dumps covered by inventory	UAH 10 million
	1.2. The development and adoption of list of MSW disposal sites with priorities for LFG systems implementation	State and regional budget, environmental funds	The ministry of Communities and Territories Development of Ukraine	2024-2025	The lack of information for old and unofficial landfills	All landfills and dumps got priorities for LFG systems	The list of landfills and dumps with priorities for LFG systems implementation	UAH 5 million
	1.3. The development of LFG (LFG-to-E) projects	Local budgets, environmental funds	Local authorities, municipal companies (landfill operators)	2025-2040	The lack of available funds	Percentage of landfill and dumps covered by LFG systems	The list of landfills and dumps with implementing LFG systems	UAH 3 million per project
2. The creation of economic and financial conditions for regional landfill construction and old waste dumps closure	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission	State budget	The National Energy and Utilities Regulatory Commission of Ukraine	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development by Supreme Council of Ukraine (SCU), Decree of NEURCU	N/A
	2.2 The creation of economic and financial condition for the use of LFG not only for electricity, but also for heat and biomethane	State budget	Supreme Council of Ukraine , the National Energy and Utilities Regulatory Commission of Ukraine	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development by Decree of NEURCU	N/A

	production by Decree of NEURCU							
3. The provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2021-2022	Unstable financial situation in the country	The list of available funding sources	The list of available funding sources	TBD
	3.2 Training in development of proposal for funding	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	The lack of funds and grant program	Number of trainees	Number of trainees	UAH 5 million
	3.3 The preparation of funding proposals to be submitted	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	The lack of funds and grant program	Presence of supported proposals	Number of supported proposals	UAH 3 million per project
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations	State and international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	-	Number of the platform active participants, number of supported NGOs	Number of the platform active participants, number of supported NGOs	UAH 10 million
	4.2 Exchange information and lessons learned (info campaigns, workshops and conferences)	State and international funds	The ministry of Communities and Territories Development of Ukraine, NGOs	2024-2030	-	Number of the workshops and conferences	Number of the workshops and conferences	TBD

2.1.3 Action Plan for Technology W2: Sorting

2.1.3.1 Introduction

The sorting of valuable components of MSW produces marketable valuable material from MSW with the subsequent treatment of waste residual by other technologies (MSW sorting technology). This technology can be considered as an integral part of efficient MSW management system in general, which forms the feasibility of other treatment technologies such as biological treatment or incineration. MSW sorting technology can be divided by the following components, which mutually increase the efficiency of MSW sorting:

- a) the sorting of MSW at MSW generation point (containers, temporary storage areas, etc.);
- b) the transportation of bulky or separately collected MSW (infrastructure and transportation vehicles);
- c) waste reception/collection centres;
- d) waste sorting lines.

The efficiency of MSW sorting at the stage of its generation mostly depends on the culture of population and its motivation to contribute to the quality of sorting, as well as the availability of separate collection infrastructure. Efficiency of other components of MSW sorting technology depends on the success of cooperation between local authorities and business, market conditions, introduction of modern technologies etc. The central but not independent component of MSW sorting technology is sorting line. There are two main types of them – “clean” and “dirty”.

Clean Sorting Lines typically receive mixed ‘dry’ recyclables from the MSW separate collection such as paper, cardboard, plastic, metals and glass. These materials are separated or sorted into the different fractions after which they are typically baled for transfer to industrial plants that can proceed with secondary materials. Waste sorting lines can use the combination of manual and mechanical handling operations. Depending on the level of awareness, the efficiency achieved in such lines can be high (up to 80%) and the captured materials tend to be ‘clean’ and readily marketable.

Dirty Sorting Lines typically receive mixed ‘wet’ MSW with recyclables, such as paper, cardboard, plastic, metals and glass mixed with organic and other wastes. Sorting lines for such waste streams predominantly use manual handling techniques and materials separated or sorted into the different fractions are also typically baled for transfer to industrial plants that can use the secondary raw materials. Some mechanical components, such as drums, bag opening devices and over-ban magnets may also be present. The level of contamination of the captured recyclables can be significant which will reduce the revenue from the sale of recyclables. Efficiency achieved in such plants is typically low (at the level of 10% of waste input). Most of the sorting facilities in Ukraine can actually be considered as *Dirty Sorting lines*.

MSW collection system of Ukraine included 35 sorting lines and approximately 4,000 specially equipped vehicles with 17,500 involved employees in 2020. MSW separate collection system was developed in 53 settlements in 2010, and in 1707 settlements in 2020 (MSWTS, 2021). This sorting capacities and infrastructure is able to take only 4.6 % of recyclables from total MSW collected stream.

According to actual Ukrainian Law “On Waste” it’s prohibited to dispose non-treated (unprocessed) MSW since the 1st January, 2018, for which appropriate processing technology is available (LW, 1998). Thus, separate collection of MSW components is the mandatory element of MSW management system of Ukraine. However, the development of the present separate collection system does not provide the desired effect on MSW management system.

MSW sorting technology was identified as one of the most desirable technology for wide introduction in Ukraine with the highest priority for further development along with methane capture technology at first TNA phase (TNA, 2019).

2.1.3.2 Ambition for the TAP

The proposed level of MSW sorting technology's diffusion should ensure 10 % of recycling in 2030, 34 % in 2040 and 40 % in the long term of prospect till 2050. Such level of ambition for recycling corresponds to the implementation of Waste sector Target Scenario S3G to achieve sectoral goal stated in the NDC2 as well as to the implementation of National Waste Management Strategy in Ukraine with ten-year postponement.

The level of MSW sorting technology diffusion, which corresponds to above stated targets for waste management sector's development (see Table 2.1), is presented in table 2.3

Table 2.3 – Level of ambition for sorting technology dissemination in Ukraine up to 2050: additional capacity to be introduced

Component of MSW sorting technology	Measurement units	2020 ¹	2022-2030 ²	2031-2040 ³	2041-2050 ³	Cumulative, 2022-2050
Sorting lines	units	35	91	214	61	366
Collection/reception stations	units	-	271	-	-	271
Containers	thousand units	No data	116	42	12	170
Collection vehicles	units	3862	930	275	79	1284

¹statistical data for existing infrastructure

²(EBRD, 2017) Supporting investments in sustainable municipal management and recycling in Ukraine. Draft MSW strategy. – EBRD. Kyiv. – 2017. – p. 149. Available at: http://publications.chamber.ua/2017/F_B/WMStrategy_ukr.pdf

³ derived from EBRD, 2017 based on specific technology needs to achieve targets on coverage of population by centralized collection system, the share of separate collection and the share of processing provided in Table 2.2.

The introduction of the sorting technology at the level presented in Table 2.3 will ensure the following progress in MSW management sector of Ukraine:

- 90 % of population will be covered by the centralized MSW collection system since 2030;
- 48 % of the centralized MSW collection system will be represented by efficient separate collection infrastructure by 2030; 88 % – by 2040; 100 % – by 2050;
- The share of processing (including recycling and biological treatment) will increase by 15 % in 2030; 50 % – by 2040; 60 % - by 2050.
- Favourable conditions for the introduction of other modern waste treatment technologies at the desirable level will be created in the light of their economy attractiveness because of the high quality of separated MSW flows.

2.1.3.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The following barriers and measures to overcome them were identified at the second stage of TNA project, BAEF (TNA, 2020) for waste sorting technologies dissemination at the level, which would be enough to ensure achievement of proposed targets, see Table 2.3.

Economic and financial barriers for waste sorting technologies:

- Low tariffs for MSW disposal (do not include costs for closure, monitoring and re-cultivation);
- Low costs for secondary raw materials;
- Inadequate access to financial resources, high cost of capital, disincentives to foreign investment;
- Limited raw material base;
- The absence of economy incentives to process and recycle MSW;

Non-financial barriers include legal and regulatory, network, institutional and organizational capacity, human skills; social, cultural and behavioural, information and awareness, technical and others.

Legal and regulatory. The state regulatory policy was changed for the last five years. However, this is a fairly conditional improvement, as a number of changes in the legislation is still expected for meeting the requirements of the EU's directives on waste management and the environment. Thus, the following issues are still insufficiently regulated:

- Unclear definition for the generated MSW ownership;
- The lack of stimulation of MSW recycling;
- The absence of producer responsibility for the potentially generated waste;
- The lack of stimulus and involvement of population in the MSW sorting activities;
- The poor stimulation of specific waste components separate collection, such as glass, packaging, batteries accumulators etc.

Network. Existing MSW treatment infrastructure is totally focused on MSW disposal as a dominant treatment practice. Local authorities, communities and MSW collecting companies haven't an alternative to waste disposal, moreover local (municipal) MSW collection systems cover the fixed area determined by the administrative boundaries.

Information and awareness. The lack of knowledge and awareness of the population on the importance of MSW separation at the stage of generation. Moreover, people have no enough knowledge about the health risks related to green waste's residue, plastics and glossy paper open burning. Moreover, there are not enough training courses and programs focused on the MSW sustainable treatment for school children and other representatives from young generation.

Legal and regulatory, infrastructure issue, as well as information and awareness barriers play a key role among other non-financial barriers to limit and even curtail the further introduction about waste sorting technologies. Institutional and organizational capacity, human resources, social, cultural and behavioural, as well as technical barriers also do exist, being analysed for waste sorting technology diffusion in detail in (TNA, 2020).

The summary of measures to overcome identified barriers

The summary of measures to overcome identified barriers is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report and additional stakeholder consultations.

Measures to overcome economic and financial barriers for waste sorting technologies have been identified as follows:

- Increasing of tariffs for waste removal;
- The implementation of "pay as you throw" principle. The idea is to pay depending on the type of waste (MSW component) and its amount, which was transferred to the third parties (collecting companies);
- The implementation of "extended producer responsibility" principle. The idea is that producers' responsibility for reducing environmental impact and managing their products extends over the entire product life cycle, from the selection of materials and design to the end of its life cycle;
- Temporary VAT exemption for reuse services, waste recycling equipment and recyclable materials and products;
- Subsidizing communities with low population density or living in highland areas.

Measures to overcome non-financial barriers for waste sorting technologies were identified as follows.

Legal and regulatory. A new Law "For Waste Management" should be entered into force. Wherein, following issues have to be regulated:

- The introduction of national waste classification on the basis of European practice;
- The development of guidelines for the sustainable green public procurement;
- The implementation and use of cost-effective tools to encourage the creation of waste management facilities infrastructure;
- The introduction of economic incentives for the dissemination of environmentally friendly technologies and expansion of recycling practice;

- The introduction of a mechanism for providing subsidies for the collection and transportation of vegetable waste suitable for the production of animal feed.

Network (infrastructure). The expansion of inter-municipal cooperation. It is ensured that at least the amount of additional sorting lines, reloading stations, collection/reception stations, containers and collection vehicles will be at the level presented in Table 2.3.

Information and awareness should include activity on:

- national awareness company for the sustainable waste management;
- the implementation of MSW management awards;
- waste management's awareness activities in school and pre-school institutions.

Analyses of measures to overcome existing institutional and organizational capacity, human resources, social, cultural and behavioural, as well as technical barriers for waste sorting technology diffusion is provided in detail in (TNA, 2020).

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

In order to achieve the goals provided in Table 2.2, efforts should be made by all participants of waste management's service market e.g.: central and local authorities, business, financial institutions, scientific and non-governmental organizations as well as the population. The mission of the Government is to ensure the friendly environment for the dissemination of modern sorting technologies, as well as to control prices for the waste management service at the acceptable level for population and business. In this regard, *actions* to be implemented by the Government are as follows: the provision of support to create necessary infrastructure; enabling framework for the creation of fair and transparent market conditions; and raising the motivation of population to ensure the efficient MSW separate collection.

The following *activities* should be implemented by central authorities to make the *waste sorting actions* work:

1. The creation of necessary infrastructure:

- 1.1. The division of oblasts into "coverage areas" / clusters and their approval within the framework of regional waste management plans;
- 1.2. The establishment of an interdepartmental coordination council for research about the reuse of natural resources and processing (recycling);
- 1.3. The creation of waste management registers and the adoption of the decree of their maintenance.

2. Enabling framework for the creation of market conditions:

- 2.1. The development of national waste classifier on the basis of the EU legislation;
- 2.2. The introduction of economic incentives for the introduction of environmentally friendly production technologies and expansion of processing (recycling);
- 2.3. Development and submission to the Cabinet of Ministers of Ukraine a draft act about the procedure for calculating the actual targets for processing (recycling) and recovery of MSW.

3. Raising motivation of population to ensure efficient MSW separate collection:

- 3.1. The development and dissemination of information materials dedicated to waste management issues and sustainable consumption;
- 3.2. Organizing conferences and workshops dedicated to waste management issues;
- 3.3. The promotion of MSW separate collection practice in the media.

Enabling framework for the creation of market conditions *action* can be considered as the most comprehensive *action* for further introduction of waste sorting technologies in Ukraine. Its successful

implementation will facilitate the interest of investors to launch the mitigation of efficient MSW sorting projects in Ukraine. A large range of potential project ideas can be specified to facilitate the successful enabling framework for the creation of market conditions. Nevertheless, the absence of reliable, transparent and profitable secondary raw material's sales market is a crucial challenge, which is faced by the MSW management service investors and incentives, industry and municipalities.

In this regard, the creation of Ukraine's Circular Economy Platform was proposed as a project idea for the dissemination of waste sorting technologies in Ukraine. The main idea of the potential project is to create a platform for market players and other stakeholders, which would be a knowledge hub, an e-commerce platform (Ukraine Materials Marketplace), measurement tools, and offers training, financial opportunities, and consultancy services for companies that are truly looking to accelerate their transition to circular economy.

2.1.3.4 Stakeholders and Timeline for implementation of TAP

The following Stakeholders have to be involved to successfully implement the waste sorting *activities*.

1.1. The division of oblasts into "coverage areas" / clusters and their approval within the framework of regional waste management plans:

- The Ministry of Communities and Territories Development of Ukraine (MCTDU) leading the process at the central authority level;
- regional and Kyiv city regional state administrations, leading the process at the local authority level;
- local governments (by consent) ensuring the implementation of the population's will.

1.2. The establishment of an interdepartmental coordination council for research about the reuse of natural resources and processing (recycling):

- The Ministry of Ecology and Natural Resources of Ukraine (MENRU) leading the key role of interdepartmental coordination establishment and functioning;
- The National Academy of Medical Sciences of Ukraine (by consent) providing scientifically based specific analyses and proposals;
- other interested central authorities.

1.3. The creation of waste management registers and adoption of the decree for their maintenance:

- MENRU leading the key role of development's procedures to create registers and to maintenance them;
- other interested central authorities.

2.1. The development of national waste classifier on the basis of EU legislation:

- MENRU, the main Stakeholder leading the process of development and adoption of the document;
- The Ministry of Healthcare of Ukraine leading the role in classifying waste by hazard level groups;
- MCTDU leading the role of dissemination of new unified classifier in-between regions and clusters, as well as collecting statistics in accordance with new waste structure;
- The Ministry for Development of Economy, Trade and Agriculture of Ukraine justifying economy issues of document development;
- The Ministry of Energy of Ukraine leading the role of proper classification of waste types for its further potential use as an alternative fuel;
- other interested central authorities.

2.2. The introduction of economic incentives for the introduction of environmentally friendly production technologies and expansion of processing (recycling):

- MENRU leading the process for initiating economic incentive;
- The Ministry for the Development of Economy, Trade and Agriculture of Ukraine justifying profitability of proposed economic incentives;
- The Ministry of Finance of Ukraine providing to the extent possible state financial support to the proposed and approved economic incentives;
- The Ministry of Education and Science of Ukraine providing educational activities for the implementation of proposed and approved economic incentives;
- other interested central authorities.

2.3. Development and submission to the Cabinet of Ministers of Ukraine a draft act about the procedure for calculating the actual targets for processing (recycling) and recovery of MSW:

- MCTDU leading the key role in drafting and lobbying the document;
- MENRU processing the issues under its authority;
- other interested central authorities.

3.1. The development and dissemination of information materials dedicated to waste management issues and sustainable consumption:

- MENRU leading the key role in developing information materials;
- The Ministry of Education and Science of Ukraine providing support in the dissemination of information materials in the educational institutions;
- The Ministry of Information Policy of Ukraine providing information support in the public area;
- regional and Kyiv city regional state administrations, leading the process at the local authority level;
- local governments (by consent) ensuring the implementation of the population's will.

3.2. Organizing conferences and workshops dedicated to waste management issues:

- MENRU leading the key role in organizing conferences and workshops;
- MCTDU involving municipal and private companies to participate in conferences and workshops;
- The Ministry of Education and Science of Ukraine involving education staff to participate in the conferences and workshops;
- The Ministry of Information Policy of Ukraine promoting participation in conferences and workshops;
- State Committee for Television and Radio Broadcasting in Ukraine providing an informational support for publicity;
- other interested central authorities;
- regional and Kyiv city regional state administrations, leading the process at the local authority level;
- local governments (by consent) ensuring the implementation of the population's will.

3.3. The promotion of MSW separate collection's practice in the media:

- The Ministry of Information Policy of Ukraine leading the key role in the process;

- State Committee for Television and Radio Broadcasting in Ukraine providing an informational support for publicity;
- MCTDU involving municipal and private companies to participate in promotion process;
- The Ministry of Education and Science of Ukraine involving education staff to participate in the promotion process;
- MENRU sharing the new incentives;
- regional and Kyiv city regional state administrations, leading the process at the local authority level;
- local governments (by consent) ensuring the implementation of the population's will.

Time schedule for the implementation of above listed *activities* is directly defined in the National Waste Management Plan up to 2030 (NWMP, 2019). Nevertheless, this document is not being implemented due to the fact that the new Law of Waste is not adopted yet, as it was planned to be done in 2019. Thus, the scheduling and sequencing of specific activities was revised on the basis of the expectation that the new Law for Waste would be adopted by the end of 2021.

2.1.3.5 The Estimation of Resources required for Action and Activities

Support for capacity building plays an important role for the successful implementation of actions for the provision of support to create necessary infrastructure; enabling framework for the creation of fair and transparent market conditions; and raising the motivation of population in order to ensure the efficient MSW separate collection.

Many developed countries, such as Denmark, Germany, Japan and Sweden as well as some developing countries such as the Republic of Korea have successfully created well-functioning national waste management systems. At the same time, Ukraine couldn't start moving towards climate friendly MSW managing despite many incentives implemented during the last decades. Thus, the international technical support is desirable to introduce modern waste treatment technologies and practices. Requirements for the following capacity building do exist to implement waste sorting actions and activities in the future:

1. The creation of necessary infrastructure:

- a) the mapping of waste sorting facilities on the basis of logistic optimization, wherein GIS technologies could be very useful;
- b) the sharing of successful international MSW management's experience with the members of interdepartmental coordination council for research about the reuse of natural resources and processing (recycling), which is planned to be established in future;
- c) the implementation of the best practices when creating waste management registers.

2. Enabling a framework for the creation of market conditions:

- a) the verification of consistency between new national waste classifier and EU legislation⁷, as well as terminology unification;
- b) sharing international successful experience for the creation of fair and transparent MSW management's services market;
- c) the provision of technical support to implement incentives leading to the creation of fair and transparent MSW management services market;
- d) the provision of technical support for calculating actual targets for the processing (recycling) and recovery of MSW.

⁷ Implementation of the Waste Framework Directive (europa.eu)

3. Raising the motivation of population to ensure efficient MSW separate collection:

- a) the provision of technical support for the development and dissemination of information materials dedicated to waste management issues and sustainable consumption;
- b) involving well-known international and domestic experts in conferences and workshops dedicated to waste management issues;
- c) sharing international best approaches in the promotion of MSW separate collection practice in the media.

Ukraine needs a lot of such supports for capacity building in order to introduce the efficient functioning of waste sorting technologies in the country. The budget of such capacity building support has to be calculated in concrete project's proposals depending on the type of foundation and the level of desired ambition to be achieved.

In general, in order to achieve the proposed level of ambition for sorting technology dissemination in Ukraine, 1.24 bln euro of capital investment is needed by 2050, e.g.: for sorting lines – 1.04 bln euro; for collection/reception stations – 0.04 bln euro; for containers and collection vehicles – 0.16 bln euro. The cost assessment for the dissemination of waste sorting technologies in Ukraine is presented in Table 2.4 for the period 2022-2050.

Capital cost should be covered by international and domestic investors as well as by municipalities. International financial and technology support may play a significant role in implementing and/or facilitating the implementation of the proposed level for the dissemination of MSW sorting technology.

Table 2.4 – Requirements for capital investment for the dissemination of sorting technology, in million euro

Component of MSW sorting technology	2022-2030 ¹	2031-2040 ²	2041-2050 ²	Cumulative, 2021-2050
Sorting lines	255.00	612.50	175.00	1042.50
Collection/reception stations	40.65	-	-	40.65
Containers and collection vehicles	117.60	33.92	9.69	161.21
Total	413.25	646.42	184.69	1244.36

¹(EBRD, 2017) Supporting investments in sustainable municipal management and recycling in Ukraine. Draft MSW strategy. – EBRD. Kyiv. – 2017. – p. 149. Available at: http://publications.chamber.ua/2017/F_B/WMStrategy_ukr.pdf

² derived from EBRD, 2017 on the basis of specific capital investment needs and the values of needed equipment, provided in Table 2.3.

2.1.3.6 Management Planning

The main and common implementation for all the *actions and activities* provided in the TAP is the risk that the new Law for Waste would not be enacted during the year, particularly by the middle of 2022. If the new Law for waste is enabled later than in 2022, the time frame for the implementation of individual activities is recommended to be revised accordingly. The other general risk is the systematic reorganization of Ukrainian central authority bodies and their responsibilities. If one of acting stakeholders is reorganized, the list of stakeholders has to be revised in accordance with the reauthorization, which potentially may be done in future.

Main activity-specific risks are as follows:

1.1. The division of oblasts into “coverage areas” / clusters and their approval within the framework of regional waste management plans: the division will not be fully implemented on voluntarily basis. In this case, administrative mechanism has to be developed to finalize the division of all the territories by clusters.

1.2. The establishment of an interdepartmental coordination council for research about the reuse of natural resources and processing (recycling): key experts and decision makers will not be included or not be interested to take an active role in the interdepartmental coordination council. In this case, non-financial stimulus has to be proposed for active participation of these persons.

1.3. The creation of waste management registers and the adoption of the decree of their maintenance: registers will not be substantially informative as a tool for analyses. In this case, the structure of required

information has to be revised, as well as the included waste management facilities and companies has to be verified.

2.1. The development of national waste classifier on the basis of EU legislation: the terminology of national waste classifier will not be in line with EU legislation. In this case, it has to be independently analyzed and revised accordingly.

2.2. The introduction of economic incentives for the introduction of environment friendly production technologies and expansion of processing (recycling): introduced economic incentives will not be focused on modern waste management technologies and the dissemination of practices, or will lead to the inefficient use of economic mechanisms. In order to avoid it, all the incentives have to be analysed before entering into force, and the achieved effect has to be monitored.

2.3. The development and submission of a draft act to the Cabinet of Ministers of Ukraine about the procedure for calculating actual targets for the processing (recycling) and recovery of MSW: the procedure will not include activity of informal sector. In order to avoid it, MSW generation's flows have to be periodically analysed by treatment pathways in order to ensure the balance of mass.

3.1. The development and dissemination of information materials dedicated to waste management issues and sustainable consumption: information material will not be successfully perceived by the population. In order to avoid it, periodic surveys among the population have to be carried out to determine and to implement necessary corrections.

3.2. Organizing of conferences and workshops dedicated to waste management issues: key experts and decision makers will not take an active role in events. In this case, stimulus for an active participation of these persons have to be proposed.

3.3. The promotion of MSW separate collection's practice in the media: promotion activity will not be successfully perceived by the population. In order to avoid it, periodic surveys among the population have to be carried out to determine and to implement necessary corrections.

Immediate requirements to implement waste sorting actions are the following:

- d) enacting the new Law for Waste;
- e) the update and revision of National Waste Management Strategy till 2030 and National Waste Management Plan till 2030;
- f) the development of portfolio for technology transfer, technical and financial support projects to be requested by Ukraine with a purpose to disseminate waste sorting technologies in Ukraine.

Critical requirements to implement waste sorting actions are the following:

- a) the timely implementation of updated and revised National Waste Management Strategy and National Waste Management Plan;
- b) levelling the risks listed in para "Risks and contingency planning" of the chapter 2.1.2.6.

2.1.3.7 TAP overview table

TAP overview table for the time frame 2021-2030								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Sorting of valuable components of MSW with the subsequent treatment of waste residual by other technologies								
Ambition: The rate of reuse and recycling in 2030 – 18% (50% in 2050)								
Benefits: GHG emission reduction, reduction of landfilling, landfill lifetime prolongation, substitution of valuable materials								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The division of oblasts into “coverage areas” / clusters and their approval within the framework of regional waste management plans	State and regional budget, environmental funds	The ministry of Communities and Territories Development of Ukraine, oblast councils	2022-2023	Not full implementation on voluntarily basis	The inclusion of all the clusters in regional waste management plans	The coverage of clusters, in % from the territory of Ukraine	UAH 5 million per oblast
	1.2. The establishment of an interdepartmental coordination council for research about the reuse of natural resources and processing (recycling).	State and regional budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Key experts and decision makers are not actively involved	Coordination council is established	Decree for the Establishment of coordination council is published	N/A
	1.3. The creation of waste management registers and adoption of the decree of their maintenance	State and regional budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Low legislation development	Decree for the maintenance of the waste management registers is adopted by the CMU	The adopted decree for the maintenance of the waste management registers is published	TBD
2. Enabling framework for creation of market conditions	2.1. The development of national waste classifier based on EU legislation	State budget	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Low legislation development	National waste classifier is developed	National waste classifier is submitted to the Parliament of Ukraine	UAH 5 million
	2.2. The introduction of economic incentives for the introduction of environmentally friendly	State budget	Supreme Council of Ukraine , the ministry of Ecology and	2022-2023	Low legislation development	economic incentives are developed	Economic incentives are submitted to the	N/A

	production technologies and expansion of processing (recycling)		Natural Resources of Ukraine				Parliament of Ukraine	
	2.3. Development and submission to the CMU draft act about the procedure for calculating the actual targets for MSW processing and recovery	State budget, International funds	The ministry of Communities and Territories Development of Ukraine	2022-2023	Low legislation development	Act is entered into force	Draft act is adopted by the CMU	UAH 5 million
3. Raising motivation of population to ensure efficient	3.1. The development and dissemination of information materials dedicated to waste management issues and sustainable consumption	State and international funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2030	The lack of funds and grant program	Information material are provided to the society	Information materials are created and disseminated	TBD
	3.2. Organizing of conferences and workshops dedicated to waste management issues	State and international funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2030	The lack of funds and grant program	Participants from all clusters and regions took part in the events	Conferences and workshops are carried out	UAH 5 million per year
	3.3. The promotion of MSW separate collection practice in the media	State and international funds	The ministry of Information Policy of Ukraine	2022-2030	The lack of funds and grant program	Wide audience is informed on separate collection issues periodically	Telecommunication events are carried out	TBD

2.1.4 Action Plan for Technology W3: The closure of old waste dumps with methane destruction

2.1.4.1 Introduction

Waste disposal is a trailing treatment practice of MSW management system being the most inefficient method in terms of resource conservation, energy efficiency and environmental impact. In essence, these types of technologies are a final stage of a product's life cycle.

Transition from dominating MSW disposal practice to other modern MSW treatment methods is an integral part for the sustainable MSW management system. Accordingly, the modernization of Ukraine's MSW management system should imply the widespread use of landfills and waste dump's closure technologies. Landfill closure procedures may include the stabilization of closed landfill, that takes from 1–10 years depending for climate conditions and the planned activity in the territory in future, and closure takes up to 4 years (SBR, 2005).

The hardware component of landfill and dump closure include: landfill gas degassing system (perforated pipes, sensors, flaring equipment etc.), multifunctional upper covering layer (soils, plants, drainage system etc.), filtrate collection and treatment system (anti-filtration curtains, dams, drainage and piping, control ponds, filtrate treatment facility etc.), monitoring infrastructure (measuring stations, wells etc.), specialized vehicles (bulldozers and excavators), roads, technical buildings (including security post), and environmental monitoring programs.

Software component includes the personnel's knowledge and experience for how to adhere to building codes, carry out construction and monitoring activity, use modelling software and analyse obtained results etc.

Orgware component includes cooperation among state institutions, business and society, legislation for landfill and dump's closure procedures; funding mechanisms and further introduction of the landfill area into the economic activity of region or at least the mitigation of negative impact on surrounding areas; tariffs, taxes and penalties, activity for people's awareness about the environmental influence of the closed landfills and dumps.

More than 10 Mt or 93.7 % of officially collected volumes of MSW were disposed in 6045 operating landfills and dumps occupying 8761 hectares in Ukraine during 2020 (MSWTS, 2021). Waste management strategy sets the target for decreasing MSW landfilling share up to 30 %, as well as the closure of all existing landfills/dumps and exploitation of only 300 new sanitary landfills by 2030, which seems to be hardly done, taking into account existing trends and efforts. Thus, statistics indicate that there are a number of barriers to implement landfill and dump closure technologies, among which are economic and financial, as well as non-financial ones.

At the Technology Needs Assessment phase (TNA, 2019), the closure of old waste dumps with methane destruction technology (hereinafter – disposal site closure technology) was identified as the third desirable technology for its wide introduction in Ukraine with one of the highest priority for further development along with methane capture and MSW sorting technologies.

2.1.4.2 Ambition for the TAP

The proposed level of the technology diffusion for disposal site closure should be consistent with the target for decreasing MSW disposal, presented in Table 2.2, particularly waste disposal sites have to be ready for 70 % of generated MSW in 2030; 30 % in 2040 % and 5 % in 2050. Such level of ambition decreasing of MSW disposal corresponds to the implementation of Waste sector Target scenario S3G to achieve sectoral goal stated in the NDC2, as well as to the implementation of National Waste Management Strategy of Ukraine with a ten-year postponement.

The level of technology diffusion for disposal site closure, which corresponds to above stated targets for decreasing of MSW disposal, is presented in table 2.5.

Table 2.5 – The level of ambition for disposal site closure’s dissemination in Ukraine up to 2050

Component of MSW sorting technology	UoM	2020	2022-2030	2031-2040	2041-2050	Cumulative, 2022-2050
Amount of solid waste disposal sites to be closed	units	6045 ¹	2249 ²	3796 ²	-	6045 ³

¹statistical data of acting landfill disposal sites

²derived on the basis of the assumption that the amount of closed landfills is proportional to decreasing of the MSW share, which was disposed at acting landfills, the trend for decreasing of MSW disposal share is presented in table 2.2.

³It’s expected that 99.9 % of acting landfills as of 2020 would be closed by 2050 (EBRD, 2017), as well as all the newly created landfills for the period of 2022-2050 will be in operation in 2050.

The introduction of disposal site closure’s technology at the level presented in Table 2.5 will ensure following progress in MSW management sector of Ukraine:

- only 300 sanitary MSW landfills will be in operation by 2040, all of them will meet strict requirements with minimum negative impact on the environment;
- 99.95 % of acting MSW landfills will be closed by 2040;
- The available capacity of MSW landfills will be enough to deal with 70 % of generated MSW in 2030; 30 % – in 2040; and 5 % – in 2050 respectively.

2.1.4.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The following barriers and measures to overcome them where they are identified at the second stage of TNA project, BAEF (TNA, 2020) for the technology dissemination of disposal site closure at the level, which would be enough to ensure the achievement of proposed targets, see Table 2.5.

The following economic and financial barriers for disposal site closure’s technology do exist in Ukraine:

- Inadequate access to financial resources, high cost of capital, disincentives to foreign investment;
- Low tariffs on MSW disposal (do not include costs for closure, monitoring and recultivation);
- The absence of producer responsibility on the generated waste;
- The improper use of environmental protection fund.

Non-financial barriers include legal and regulatory, network, institutional and organizational capacity, human skills; social, cultural and behavioural, information and awareness, technical and others.

Legal and regulatory. A new Law “For Waste Management” and following Law “For landfilling” should be entered into force. Wherein, these issues have to be regulated:

- low requirements on procedures of landfill operation;
- inadequately low responsibility for the violation of legislation in waste treatment system, in particularly waste disposal procedures;
- the responsibility of operators for landfill post-operational period in practice;
- the issue of secondary raw materials extraction/mining from the closed or old landfills.

Network (infrastructure) barrier is another main non-financial barrier to disseminate waste disposal site closure’s technology, because the existing MSW treatment infrastructure is totally focused on MSW disposal as a dominant treatment practice. Local authorities, communities and MSW collecting companies haven’t an alternative to waste disposal, moreover local (municipal) MSW collection systems cover the fixed area determined by the administrative boundaries.

Information and awareness, institutional and organizational capacity, human resources, social, cultural and behavioural, as well as technical barriers also do exist, being analysed for waste disposal site closure’s technology diffusion in detail in (TNA, 2020).

The summary of measures to overcome identified barriers

The summary of measures to overcome identified barriers is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report and additional stakeholder consultations.

The measures to overcome economic and financial barriers for waste disposal site closure's technologies have been identified as follows:

- Increase in tariffs for waste disposal, which have to cover all expenditures including environment and operation, as well as related to landfill closure;
- Increase in environmental tax on waste disposal;
- The introduction of penalties for the violation of legislation in waste disposal issues.

Measures to overcome non-financial barriers for waste disposal site's closure were identified as follows.

Legal and regulatory. A new Law "For Waste Management" and following Law "For landfilling" should be entered into force. Wherein, at least following issues have to be regulated:

- The alignment of landfill's operation procedures in Ukraine with the requirements of Directive 1999/31/ EC for the waste disposal (D. 1999/31/EC, 1999);
- The significant increase of responsibility for the violation of legislation in waste treatment system, especially waste disposal procedures;
- The responsibility of landfill operators for the post-operational period of landfills (closure and monitoring);
- The legalization and regulation of landfill mining activity (Burlakovs J., et al., 2013).

Network (infrastructure). To provide economically feasible alternative for MSW management, which would include at least additional available sorting lines, reloading stations, collection/reception stations, containers and collection vehicles at the level presented in Table 2.4. The rest of MSW have to be disposed at available landfills, wherein 300 units of them in operation since 2040 would be enough.

Analyses of measures to overcome existing information and awareness institutional and organizational capacity, human resources, social, cultural and behavioural, as well as technical barriers for the technology diffusion of waste disposal site closure is provided in detail in (TNA, 2020).

In order to achieve goals provided in Table 2.2, efforts should be made by all the participants of waste management service market e.g.: central and local authorities, business, financial institutions, scientific and non-governmental organizations as well as the population.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

The mission of the Government is to ensure the environment friendly for the technologies dissemination of MSW disposal site closure, as well as to control prices (tariffs) for waste disposal service at the acceptable level for population and business. In this regard, key *actions* to be implemented by the Government are as follows: the provision of support to create necessary infrastructure and introduction of efficient financial mechanisms to stimulate and ensure sustainable approach for the closure of old dumps and landfills. It's expected that legal and regulatory barriers are to be overcome since the new Law for waste would be enacted. The following *activities* should be done by central authorities to make the *MSW disposal site closure actions* work:

1. The creation of necessary infrastructure:

- 1.1. The creation of MSW disposal sites inventory;
- 1.2. The development and adoption of list of MSW disposal sites, which operation has to be stopped;
- 1.3. The development of projects for MSW disposal sites closure, which do not meet the established operational requirements.

2. The introduction of disposal face-out motivating financial mechanisms:

- 2.1. The introduction of disposal face-out stimulating tariffs for waste disposal;
- 2.2. The introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills.

The introduction of *action* for disposal face-out stimulating financial mechanisms can be considered as the most efficient *action* for waste disposal face-out by introducing waste disposal site closure technologies. Its successful implementation will facilitate the closure of old dumps and landfills and ensure enough funding for environmentally focused recultivation of the closed waste disposal sites.

In this regard, the conduction of research to justify disposal face-out stimulating tariffs for waste disposal was proposed as a project idea for the dissemination of waste disposal site closure technologies. The main idea of the project is to justify such waste disposal tariffs, which from one hand would stimulate the introduction of modern MSW management practice with the subsequent dissemination of waste disposal site closure technologies, and from the other hand would be acceptable for population, business and industry. The main output of the project idea is to provide the Government recommendations about the introduction of economically stimulating waste disposal tariffs for its further approval.

2.1.4.4. Stakeholders and Timeline for implementation of TAP

The following Stakeholders have to be involved to successfully implement *activities* for the waste disposal site closure.

1.1. The creation of MSW disposal site's inventory:

- MENRU leading the process at the central authority level;
- other interested central authorities.

1.2. The development and adoption of list of MSW disposal sites, which operation has to be stopped:

- MCTDU leading the process of development and further adoption of the list of MSW disposal sites to be closed;
- regional and Kyiv city state administrations, implementing the activity at the local level;
- local governments (by consent), to represent the will of local communities.

1.3. The development of projects for MSW disposal sites closure, which do not meet the established operational requirements:

- MCTDU leading the process of development and further adoption of projects at the central authority level;
- regional and Kyiv city state administrations, implementing the activity at the local level;
- local governments (by consent), to represent the will of local communities.

2.1. The introduction of disposal face-out stimulating tariffs for waste disposal:

- National Energy and Utilities Regulatory Commission of Ukraine leading the process of new tariffs introduction at the central authority level;
- MENRU being responsible for source issues within its competence;
- MCTDU being responsible for source issues within its competence;
- The Ministry of Healthcare of Ukraine leading the role in estimating the impact on human health;
- The Ministry for the Development of Economy, Trade and Agriculture of Ukraine justifying economy issues of tariffs;
- other interested central authorities;

- regional and Kyiv city state administrations, implementing the activity at the local level;
- local governments (by consent), to represent the will of local communities.

2.2. The introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills:

- MENRU leading the process of introduction of landfill operators' responsibility;
- The Ministry of Finance of Ukraine providing support on enabling of legal framework;
- The Ministry for Development of Economy, Trade and Agriculture of Ukraine justifying the profitability of proposed landfill operators' responsibility mechanism;
- other interested central authorities.

Capacity building plays an important role for the successful implementation of actions for the provision of support to create infrastructure as well as to introduce efficient financial mechanisms for the dissemination of waste disposal site's closure technologies. Until now, disposal is the cheapest waste management practice in Ukraine. This is one of key challenges for the introduction of climate friendly MSW treatment technologies in Ukraine.

EU countries present the good example of providing successful policy about waste disposal phase-out. Thus, the share of MSW disposal is reduced significantly during last decades in these countries due to a number of stimulating measures. These measures led to the fact, that waste disposal practice is not economically feasible with comparison to alternatives for MSW management service providing companies, such as recycling, mechanical-biological treatment, composting etc. Thus, providing international assistance for sharing the best practice how to make MSW disposal not economically feasible would be important support for further development of waste management sector in Ukraine. At the same time, such actions must be acceptable for population, business and industry.

Requirements for the following capacity building would contribute a lot to implement waste disposal site's closure actions and activities in future:

1. The creation of necessary infrastructure:

- a) the provision of expert assistance for the creation of MSW disposal sites inventory;
- b) the verification of list of MSW disposal sites, which operation has to be stopped;
- c) the provision of technical support to carry out feasibility study about MSW disposal sites closure in climate friendly manner for a number of pilot landfills.

2. The Introduction of disposal face-out motivating financial mechanisms:

- a) the involvement of experienced international experts to assist in introduction of disposal face-out stimulating tariffs on waste disposal;
- b) the involvement of experienced international experts to assist in the introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills.

Ukraine needs such capacity building support to make waste disposal practice not economically feasible with comparison to other treatment technologies in an acceptable manner for population, business and industry. The budget of such capacity building support has to be calculated in concrete project proposals depending on the type of foundation and the level of desired ambition to be achieved.

By the estimation of costs of actions and activities, 1.69 bln euros are needed to achieve the proposed level of ambition for waste disposal sites closure, which is to close 99.95 % of acting landfills or 6045 units by 2040 in Ukraine, in detail: 0.63 bln euro for the 2022-2030 period; 1.06 bln euro for the period 2041-2050. This cost assessment is based on the requirement in solid waste disposal sites to be closed presented in (EBRD, 2017), with average cost of landfill closure 280,000 EUR. Capital and operational

cost for closure of the waste disposal sites should be covered by newly introduced disposal face-out stimulating tariffs for waste disposal.

The main and common risk for the implementation of all the *actions and activities* provided in the TAP is the risk that the new Law for Waste would not be enacted during the year, particularly by the middle of 2022. If the new Law for waste is enabled later than in 2022, the time frame for the implementation of individual activities is recommended to be revised accordingly. The other general risk is a systematic reorganization of central authority bodies and their responsibilities. If one of the acting stakeholders is reorganized, the list of stakeholders has to be revised in accordance with the reauthorization, which potentially may be done in future.

Main activity-specific risks are as follows:

1.1. The creation of MSW disposal sites inventory: outdated or incorrect information will be provided by certain MSW landfill operators, as well as all the closed landfills will not be included. In order to avoid it, the selected verification for the provided data has to be carried out, as well as local authorities have to check the inclusion of all closed MSW disposal sites.

1.2. The development and adoption of list of MSW disposal sites, which operation has to be stopped: not all the landfills, which have to be closed, will be identified with the help of potential interest in their further operation. In order to avoid that, the independent selected verification has to be carried out for acting landfills.

1.3. The development of projects for MSW disposal sites closure, which do not meet the established operational requirements: all the projects will not be developed due to the lack of funding. In this cases, financial support has to be provided for the documentation of landfill closure in cases of deficit of funding by responsible institutions.

2.1. The introduction of disposal face-out stimulating tariffs for waste disposal: the level of introduced tariffs for waste disposal will be set politically. In order to avoid it, the independent verification has to be carried out on the newly introduced tariffs for waste disposal.

2.2. The introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills: all the environmental damage factors will not be taken into account. In order to avoid it, independent experts have to be involved in the development of landfill operators' responsibility mechanism.

Requirements to extend LFG recovery would be enacting the new Laws for Waste and landfilling of waste, National Waste Management Strategy will be updated till 2030 and National Waste Management Plan will be carried out till 2030, technology transfer, technical and financial projects support will be developed with the purpose to disseminate old landfills closure and new sanitary regional landfill construction in Ukraine.

2.1.4.7 TAP overview table

TAP overview table								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Closure of old waste dumps with methane destruction								
Ambition: Minimization of disposal/landfilling (70% in 2030 and 5% in 2050)								
Benefits: GHG emission reduction, air and water pollution reduction, eliminated fire events, minimization of odours, fossil fuel substitution								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The creation of MSW disposal sites inventory	State and regional budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2024	Outdated or incorrect information will be provided by certain MSW landfill operators	All the landfills and dumps are included in the inventory	The share of landfills and dumps included in the inventory from the total amount of them in Ukraine	UAH 10 million
	1.2. The development and adoption of list of MSW disposal sites, which operation has to be stopped	State and regional budget, environmental funds	The ministry of Communities and Territories Development of Ukraine	2024-2025	Not all the landfills will be identified	All landfills and dumps that are advisable to be closed are included in the list of landfills and dumps to be closed	The list of landfills and dumps to be closed is approved by the CMU	UAH 5 million
	1.3. The development of projects for MSW disposal sites closures, which do not meet the established operational requirements	State and regional budget, environmental funds	The ministry of Communities and Territories Development of Ukraine	2025-2040	Not all the projects will be developed due to the lack of funding	All landfill closure projects are prepared	The share of prepared closure projects from the total amount of landfills planned to be remediated	UAH 5 million per project
2. The introduction of disposal face-out motivating	2.1. The introduction of disposal face-out stimulating tariffs for waste disposal	State budget	The National Energy and Utilities Regulatory	2022-2023	The level of introduced tariffs for waste disposal	New tariffs on waste disposal entered into force	The resolution of tariffs for waste disposal is adopted	N/A

financial mechanisms			Commission of Ukraine		will be set politically			
	2.2. The introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills	State budget	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Not all the environmental damage factors will be taken into account	Responsibility of landfill operators is entered into force	Decree of the CMU is adopted	N/A

2.1.5 Action Plan for Technology W4: The aerobic biological treatment (composting) of food and green residuals

2.1.5.1 Introduction

Green and food waste can be processed biologically by aerobic methods. Final material after aerobic composting of green waste can be used in the garden and parks as well as for landscape construction.

At least three composting techniques available are windrow, aerated static pile and in-vessel composting. Supporting techniques include sorting, screening and curing, too. Each technique varies in procedures and equipment's needs. Other variations of technologies are issues, such as air supply, temperature control, mixing and time required for composting. Moreover, their capital and operating costs also differ widely.

The windrow compost process includes the following:

- The shredding of the green waste using a tub grinder;
- Moving the shredded green waste into long rows (windrows), using a loading shovel;
- Turning rows on a weekly basis to improve porosity and oxygen content, to mix in or remove moisture and to redistribute cooler and hotter portions of the rows.

In Ukraine, composting is still not common practice, the overall level of MSW composting is low in Ukraine. Only about 1640 tons (0.018%) of waste were composted in 2018.

In relation to recycling and other recovery including composting, key challenge is the the lack of organized system capable of efficiently collecting the secondary raw materials of high quality.

Composting also provides benefits for waste handling companies. For the composting part of the waste, companies increase the landfill's lifetime and the marketable product in the form of compost.

The economy of Ukraine is based on the agrarian sector among others. When farms utilize compost, the requirement to purchase chemical fertilizers is reduced which thereby results in reduction in human's and soil's health problems. The compost application in farm fields also results in economic benefits by enhancing the availability of nutrients in the soil for crops and improving the effectiveness of other fertilizers.

Producing compost is found to be a profitable business in many parts of the world, if it is implemented in the models of public private partnerships and the right choice of centralized and decentralized composting units.

The technology is applicable for both small-scale and large-scale applications. Each of these supports the generation of local employment.

The composting of one ton of MSW is approx. equivalent to 0.6 t CO₂-eq. GHG emission's reduction.

2.1.5.2 Ambition for the TAP

The proposed level of MSW biological treatment's diffusion including composting should ensure 5% in 2030, 16% in 2040 and up to 20% in long term prospect till 2050. Such level of ambition for recycling corresponds to implementation of Waste sector target scenario S3G will achieve the sectoral goal stated in the NDC2 as well as the implementation of National Waste Management Strategy of Ukraine with ten-year postponement. The 5% share correspond approx./ 500,000 tons of food and green waste.

2.1.5.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The summary of barriers presented below is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report.

The key challenge for composting is the lack of an organized system capable of efficiently collecting the organic waste of high quality. There is the requirement of the progressive implementation of MSW separate collection and establishing the mechanism for the practical implementation of extended producer responsibility (EPR) principle, in order to improve the quality of secondary raw materials. Another challenge is the implementation of home composting in suburban areas of towns and cities and in the rural areas.

Existing economic and financial barriers are associated with low tariffs for waste collection, treatment and landfilling. It means that waste disposal is still the cheapest option of MSW management in parallel with low population income.

Regulation/legislation barriers are associated with the lack of comprehensive and strategic energy policy implementation, insufficient institutional framework, over-bureaucratic procedures, the lack of control for unofficial landfilling and activities, and there are no incentives for organic waste separate treatment

Technical barriers are associated with low collecting efficiency of the high-quality organic waste and the lack of separate waste collection. There are also information barriers. They are limited awareness of technology, the lack of available information, pure knowledge to the population and involvement, and missing feedback among interested parties. There is also no culture of home composting in suburban and rural areas.

The summary of measures to overcome identified barriers

The summary of measures to overcome identified barriers is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report and additional stakeholder consultations.

Measures should be implemented to overcome economic and financial barriers for composting technologies. Among them are creation of conditions for modern home and industry composting, development of composting program including home composting, development, and the use of compost as organic fertilizer or soil improver.

Measures to overcome non-financial barriers for composting should be the improvement of legislation and regulatory system, the creation of condition for industry composting, capacity building activities, and the involvement of population including children in composting and sorting activities.

New framework law “For Waste Management” should be entered into force. Issues have to be regulated including among others introduction of economic incentives for the dissemination of environment friendly technologies and the expansion of recycling/composting practice, and the introduction of mechanism for providing subsidies for the collection and transportation of green waste suitable for compost production.

The expansion of inter-municipal cooperation may play an important role. It ensures that Waste Reception/Collection and Compost Centres in cities with a population above 20,000 are put into operation by 2030. The introduction of inter-municipal cooperation as a legal mechanism should be supported by the Government within the development of institutional and organizational capacity.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

In order to achieve goals provided in Table 2.2, efforts should be made by central and local authorities, business, financial institutions, scientific and non-governmental organizations. The mission of the central and local authorities is to ensure the development of regional waste management plans on the basis of cluster structure as soon as there is the creation of technical and economic condition for the use of compost as fertilizer and soil improver. In this regard, key actions that should be implemented are:

- The creation of necessary infrastructure;
- The creation of economic and financial conditions for source separation and home and industry composting;

- The provision of long-term and low-interest loans or grants through state funds, private sources and international funds;
- The creation of the stakeholder and technical expert networks for technology development and transfer.

The corresponding activities to be implemented to make these actions work includes:

- The development of regional waste management plans on the basis of cluster structure;
- The Establishment of coordination council for research for the reuse of natural resources and processing (recycling);
- The creation of waste management registers and adoption of the decree of their maintenance;
- The support of the development of inter-municipal cooperation;
- The introduction of high gate fee/tax for waste disposal and CO₂ emission;
- The creation of technical and economic condition for the use of compost as fertilizer and soil improver;
- The preparation of funding proposals to be submitted;
- The creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations;
- The exchange of information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties).

The development of pilot project for one of the Ukrainian United territorial community is based on the facility for composting of food and green residuals through windrow method with the help of the production of compost for forest and agriculture.

2.1.5.4 Stakeholders and Timeline for the implementation of TAP

The following Stakeholders will be involved to develop the composting of food and green residuals:

- The Ministry of Communities and Territories Development of Ukraine being responsible for the formation and implementation of state policy including municipal service in order to create a comfortable, high quality and safe living space for population;
- The Ministry of Ecology and Natural Resources of Ukraine being responsible for the state control of environmental protection, rational use and protection of natural resources;
- The Ministry for Development of Economy, Trade and Agriculture being responsible for technical regulation and trade development;
- The National Energy and Utilities Regulatory Commission of Ukraine leading the process of new tariffs introduction at the central authority level;
- The Ministry of Finance of Ukraine providing support for enabling of legal framework;
- Local authorities, municipal companies as entities control local budgets and man power;
- Technical and financial experts as components of capacity building;
- NGOs for ensuring the connection among central and local governmental bodies and Ukrainian population.

Specific activities will be implemented mostly within the period 2022-2030 along with the program of development and implementation for regional waste management plans.

2.1.5.5 Estimation of Resources Needed for Action and Activities

Capacity building is required to carry out actions and activities including the creation of stakeholder and technical expert networks for technology development and transfer. That may be achieved by the creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations and exchange information and lessons learned by organizing information campaigns, workshops and conferences.

Home composting units are being used in individual houses in suburban areas in cities and towns and in rural areas (approximately 2.5 million households), indicative estimate of EUR 105.5 million⁸.

The cost of GHG reduction in enclosed, building with concrete floors, MRF⁹ processing equipment and in-vessel composting; enclosed building for the curing of compost product would vary between 50 and 85 EUR per t CO₂-eq.

2.1.5.6 Management Planning

The main risk of the technology is associated with the low level of separate collection, the lack of local initiative, low activity in legislation development, unstable financial situation in the country, the lack of funds and grant program.

The introduction of face-out stimulating tariffs for waste disposal may support to raise the level of separate collection to minimise the amount of landfilled waste. However, the tariff for waste disposal could often be limited by political reason in Ukraine. In order to avoid that, the independent verification has to be carried out for the introduced tariffs of waste disposal.

The immediate requirements to implement the development of SSOW composting technology along with waste disposal site's closure are the following:

- a) enacting the new Laws for Waste and Landfilling of Municipal Solid Waste;
- b) the update and revision of National Waste Management Strategy till 2030 and National Waste Management Plan till 2030;
- c) the development of portfolio for technology transfer, technical and financial support projects requested with the purpose to disseminate composting in Ukraine.

⁸ Supporting investments in sustainable municipal management and recycling in Ukraine. Draft MSW strategy. - EBRD. - March 2017.

⁹ Material Recovery Facilities

2.1.5.7 TAP overview table

TAP overview table								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Aerobic biological treatment (composting) of food and green residuals								
Ambition: Composting level – 3% in 2020 and 10% in 2040								
Benefits: GHG emission reduction, reduction of biodegradable waste landfilling, replacement of chemical fertilizers, landfill lifetime prolongation								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans on the basis of cluster structure	State, regional, and local budgets, environmental funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	All clusters covered by regional waste management plans	The percentage of clusters covered by regional waste management plans	UAH 5 million per oblast
	1.2. The establishment of coordination council for research about waste reuse and processing (recycling).	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Key experts and decision makers are not actively involved	Coordination council is established	Decree for the establishment of coordination council is published	N/A
	1.3. The creation of waste management registers and adoption of the decree of their maintenance	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	-	Decree on maintenance of the waste management registers is adopted by the CMU	Adopted decree for maintenance of the waste management registers is published	TBD
	1.4 The support of the development of inter-municipal cooperation	State and international funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	Most of the clusters covered by inter-municipal cooperation agreements	The percentage of clusters covered by inter-municipal cooperation agreements	UAH 10 million per year
2. The creation of economic and financial	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission	State budget	The National Energy andUtilities Regulatory	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation	N/A

conditions for source separation and home and industry composting			Commission of Ukraine				development in SCU	
	2.2 The creation of technical and economic condition for the use of compost as fertilizer and soil improver	State budget	The ministry for Development of Economy, Trade and Agriculture	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development in SCU	TBD
3. Provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2021-2022	Unstable financial situation in the country	List of available funding sources	List of available funding sources	TBD
	3.2 Training in the development of proposal for funding	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	The lack of funds and grant program	Number of trainees	Number of trainees	UAH 5 million per year
	3.3 The preparation of funding proposals to be submitted	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	The lack of funds and grant program	Presence of supported proposals	Number of supported proposals	UAH 0.3-1.0 million per project
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations	State and international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	-	Number of the platform active participants, number of supported NGOs	Number of the platform active participants, number of supported NGOs	UAH 10 million
	4.2 Exchange information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)	State and international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	-	Number of the workshops and conferences	Number of the workshops and conferences	TBD

2.1.6 Action Plan for Technology W5: The Mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of MSW)

2.1.6.1 Introduction

MBT is a common approach for all concepts that involve the treatment of waste with a combination of mechanical and biological methods. The main difference between different approaches is the order of the process stages and the purpose of biological treatment

There is considerable discrepancy in the cost of various MBT plants, because there is no "universal" way for mixed MSW processing. Various solutions can be considered to be the most beneficial for different areas/clusters. The expediency of biogas generation from MSW with the further production of electricity is determined by the possibility of selling electricity at a fixed green tariff (0.1239 EUR/kWh without VAT).

One more source of income for MBT could be compost from digestate after biogas production or without biogas component in the project. However, in order to make the production of commodity compost possible, it is essential to improve separate waste collection to get relatively clean SSOW.

Capital expenditures for the implementation of MBT technologies depend on many factors. Specific capital cost will vary depending on:

1. Initial MSW content (solid waste after separate collection or mixed solid waste);
2. The availability and type of sorting process before MBT (manual, automatic);
3. treatment capacity (scale effect).

The cost of the MBT plant in the capacity range of 50-150 kt/yr can range from 10 to 25 M€. The cost of similar capacity projects may vary in two or more times probably mainly due to the difference in technological solutions. According to (Ramboll, 2018), the cost of MBT projects with a capacity of 85-200 kt/yr, which were implemented in Germany and the UK from 2001 to 2012, was in the range of 20 to 75 M€ with average CAREX around 250 €/t of MSW processed during the year.

Typical specific costs for the projects in capacity range of 100-200 kt/yr are from 150 to 400 €/t in countries such as France, Spain, USA, and Australia.

2.1.6.2 Ambition for the TAP

The proposed level of MSW biological treatment's diffusion including mechanical-biological treatment of waste with biogas and energy production should ensure 5% in 2030, 16% in 2040 and up to 20% in long term prospect till 2050. Such level of ambition for recycling corresponds to the implementation of Waste sector Target scenario S3G to achieve sectoral goal stated in the NDC2 as well as to the implementation of National Waste Management Strategy of Ukraine with ten-year postponement.

2.1.6.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The summary of barriers presented below is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report.

Financial and economic barriers include low feasibility (low IRR, NPV, long payback period) of MBT projects for mechanical-biological treatment of waste with biogas and energy production because of low tariffs for waste treatment, low tariffs for waste landfilling, low population income, inadequate access to financial resources, and high cost of capital and finance.

Non-financial barriers include the low technical standards of waste management, the lack of information regarding waste content and amount, the lack of local suppliers.

Regulation/legislation barriers includes the lack of comprehensive and strategic energy policy implementation, insufficient institutional framework, over-bureaucratic procedures, and the lack of control for unofficial landfilling and activities.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

In order to achieve the goals provided in Table 2.2, efforts should be made by central and local authorities, business, financial institutions, scientific and non-governmental organizations. The mission of the central and local authorities is to ensure the development of regional waste management plans on the basis of cluster structure, as soon as there is the creation of technical and economic condition for MBT development with energy's use component. In this regard, key actions to be implemented are:

- The creation of necessary infrastructure;
- The creation of economic and financial conditions for MBT with biogas and energy production (incl. electricity production, heat utilization and biogas upgrade to biomethane quality with subsequent delivery to natural gas grid);
- The provision of long-term and low-interest loans or grants through state funds, private sources and international funds;
- The creation of the stakeholder and technical expert's networks for technology development and transfer.

The corresponding activities to be implemented to make these actions work includes:

- The development of regional waste management plans on the basis of cluster structure;
- The Establishment of coordination council for research on waste reuse and processing;
- The creation of waste management registers and adoption of the decree of their maintenance;
- The support of the development of inter-municipal cooperation;
- The introduction of high gate fee/tax for waste disposal and CO₂ emission;
- The creation of technical and economic condition for MBT with biogas and energy production;
- The preparation of funding proposals to be submitted;
- The creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations;
- The exchange of information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties).

The development of pilot project for one of the Ukrainian cluster/set of united territorial communities is based on the facility for mechanical-biological anaerobic treatment of waste with biogas and energy production.

2.1.6.4 Stakeholders and Timeline for implementation of TAP

The following stakeholders will be involved to develop composting of food and green residuals:

- The Ministry of Communities and Territories Development of Ukraine being responsible for the formation and implementation of state policy including municipal service in order to create a comfortable, high quality and safe living space for population;
- The Ministry of Ecology and Natural Resources of Ukraine being responsible for state control of environmental protection, rational use and protection of natural resources;
- The Ministry for Development of Economy, Trade and Agriculture being responsible for technical regulation and trade development;
- The Ministry of Energy of Ukraine being responsible for energy production issues;
- State Agency for Energy Efficiency and Energy Saving being responsible for renewable energy development;
- The National Energy and Utilities Regulatory Commission of Ukraine leading the process of new tariffs introduction at the central authority level;

- The Ministry of Finance of Ukraine providing support for enabling the legal framework;
- Local authorities, municipal companies as entities controlled local budgets and man power;
- Technical and financial experts as key components of capacity building;
- NGOs for ensuring the connection among central and local governmental bodies and Ukrainian population.

Specific activities will be implemented mostly within the period 2022-2030 along with the program of development and implementation for regional waste management plans.

2.1.6.5 The Estimation of Resources Needed for Action and Activities

Capacity building is required to carry out actions and activities including the creation of stakeholder and technical expert networks for technology development and transfer. That may be achieved by the creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations and exchange of information and lessons learned by organizing of information campaigns, workshops and conferences.

In Ukraine, the project's planned cost could be in the range of 120 to 250 €/t. Operational costs (OPEX) for MBT technology are primarily related to electricity consumption, repairs and maintenance costs, staff remuneration, and cost of residuals disposal. They are typically in the range from 8 to 12% of capital expenditures.

The final cost of MSW processing is determined by CAPEX and OPEX as well as the terms of project financing. If the project's specific capital cost amounts 150 €/t, the final cost of MSW treatment is 30-40 €/t depending on the conditions and share of involved bank capital.

1.1.2.6 Management Planning

The main risk of the technology is associated with the lack of local initiative, low activity in legislation development, relatively high cost, unstable financial situation in the country, the lack of funds and grant program.

The introduction of face-out stimulating tariffs for waste disposal may support to raise the level of separate collection to minimise the amount of landfilled waste. However, the tariff for waste disposal could often be limited by political reason in Ukraine. In order to avoid that, the independent verification has to be carried out for the introduced tariffs for waste disposal.

The immediate requirements to implement development of MBT technology along with waste disposal site closure are the following:

- a) enacting the new Laws on Waste and Landfilling of Municipal Solid Waste;
- b) The update and revision of National Waste Management Strategy till 2030 and National Waste Management Plan till 2030;
- c) the development of portfolio for technology transfer, technical and financial support projects requested with the purpose to disseminate mechanical-biological treatment of waste in Ukraine.

2.1.6.7 TAP overview table

TAP overview table								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of MSW)								
Ambition: MBT level – 2% in 2020 and 6% in 2040								
Benefits: GHG emission reduction, reduction of biodegradable waste landfilling, replacement of chemical fertilizers, fossil fuel substitution								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans on the basis of cluster structure	State, regional, and local budgets, environmental funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	All clusters covered by regional waste management plans	Percentage of clusters covered by regional waste management plans	UAH 5 million per oblast
	1.2. The establishment of coordination council for research on waste reuse and processing	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Key experts and decision makers are not actively involved	Coordination council is established	Decree for the establishment of coordination council is published	N/A
	1.3. Creation of waste management registers and adoption of the decree of their maintenance	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	-	Decree on maintenance of the waste management registers is adopted by the CMU	Adopted decree on maintenance of the waste management registers is published	TBD
	1.4 The support of the development of inter-municipal cooperation	State and international funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	Most of the clusters covered by inter-municipal cooperation agreements	Percentage of clusters covered by inter-municipal cooperation agreements	UAH 10 million per year
2. Creation of economic and financial conditions for	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission	State budget	National Energy and Utilities Regulatory	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development in SCU	N/A

MBT with biogas and energy production (incl. electricity, heat and biomethane)			Commission of Ukraine					
	2.2 The creation of other technical and economic condition for MBT with biogas and energy production	State budget	Supreme Council of Ukraine, Ministry for Development of Economy, Trade and Agriculture	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development in SCU	TBD
3. Provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2021-2022	Unstable financial situation in the country	List of available funding sources	List of available funding sources	TBD
	3.2 Training in development of proposal for funding	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	The lack of funds and grant program	Number of trainees	Number of trainees	UAH 5 million per year
	3.3 The preparation of funding proposals to be submitted	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	The lack of funds and grant program	Presence of supported proposals	Number of supported proposals	UAH 3 million per project
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations	State and international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	-	Number of the platform active participants, number of supported NGOs	Number of the platform active participants, number of supported NGOs	UAH 10 million
	4.2 The exchange of information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)	State and international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	-	Number of the workshops and conferences	Number of the workshops and conferences	TBD

2.1.7 Action Plan for Technology W6: Mechanical-biological treatment of waste with alternative fuel (SRF) production for cement industry

2.1.7.1 Introduction

MBT is a common approach for all concepts that involves the treatment of waste with a combination of mechanical and biological methods. The main difference among different approaches is the order of the process stages and the purpose of biological treatment. Technological chain is oriented either by the concept of splitting or by the idea of stabilization.

When "stabilization" is the main goal, the waste is biologically processed without separation. It is done by the convective or diffusion biological drying and maximal hygienisation of waste before the next mechanical separation of non-combustible components. The remaining material can be used as alternative fuel (RDF/SRF) with energy production at appropriate facility. Thus, the production of fuel from solid waste is the basic possibility of MBT application. In the simplest case, it may consist in preliminary sorting, the removal of certain components from mixed waste and shredding the residue for:

- the use of RDF/SRF in specialized incinerators for the electric and/or thermal energy production;
- The transfer/sale of RDF/SRF to the nearest cement plant for energy and material recovery and fossil fuel substitution.

The use of RDF/SRF in the cement industry allows to utilize not only fuel energy but also its mineral part in the process of clinker production.

The combustion of fuels from MSW in cement plants or in specialized boiler houses requires the fuel's classification. Ukraine has already a standard for solid recovered fuel (DSTU, 2018). This document was accepted by confirmation method and submitted in the original language (English) only. SRF (class 3) consists predominantly of biological waste. It is homogeneous dry raw material with the low content of undesirable impurities, suitable for storage. The calorific value for class 3 is 15 MJ/kg suitable for the most cement plants and/or CHP plants working on solid fuels. SRF of this type is characterized by low chlorine content (<1,0%), which is also permissible for cement production.

In Ukraine, there is an interest in implementing demonstration projects for the SRF's utilization in cement industry as a part of the of the waste management strategy (NWMS, 2017) implementation. However, this possibility requires an additional discussion and development.

In most cases, for the use of alternative fuels, cement plants need to be modernized. In addition, the feasibility for using SRF is determined by logistics, mainly the distance between SRF producer and cement plant. It should be mentioned that Ukrainian cement plants are located mainly in the west and south-east regions of the country.

The use of RDF as an alternative to fossil fuels for cement manufacture would result in the following environmental benefits:

- Fossil fuel substitution;
- Less GHG emissions;
- The elimination of health problems associated with open dumping of MSW.

2.1.7.2 Ambition for the TAP

The proposed level of MSW biological treatment diffusion including mechanical-biological treatment of waste should ensure 5% in 2030, 16% in 2040 and up to 20% in long term prospect till 2050. Such level of ambition corresponds to the implementation of Waste sector Target scenario S3G to achieve sectoral goal stated in the NDC2 as well as to the implementation of National Waste Management Strategy of Ukraine with ten-year postponement.

2.1.7.3 Actions and Activities selected for inclusion in the TAP

Summary of barriers

The summary of barriers presented below is based on the information provided in the Mitigation Technology Barrier Analysis and Enabling Framework report.

Financial and economic barriers for the mechanical-biological treatment of waste with alternative fuel production include low feasibility (low IRR, NPV, long payback period) of MBT projects due to low tariffs for waste treatment, low tariffs for waste landfilling, low population income, inadequate access to financial resources, and high cost of capital and finance.

Non-financial barriers include the low technical standards of waste management, the lack of information regarding waste content and amount, the lack of local suppliers, low number of cement plants and their unequal distribution on Ukrainian territory.

Regulation/legislation barriers includes the lack of comprehensive and strategic energy policy implementation, insufficient institutional framework, over-bureaucratic procedures, and the lack of control for unofficial landfilling and activities.

Actions selected for inclusion in the TAP and activities identified for the implementation of the selected actions

In order to achieve goals provided in Table 2.2, efforts should be made by central and local authorities, business, financial institutions, scientific and non-governmental organizations. The mission of the central and local authorities is to ensure the development of regional waste management plans on the basis of cluster structure, as soon as there is the creation of technical and economic condition for MBT development with energy and material's use component. In this regard, key actions to be implemented are:

- The creation of necessary infrastructure;
- The creation of economic and financial conditions for MBT with alternative fuel (RDF/SRF);
- The provision of long-term and low-interest loans or grants through state funds, private sources and international funds;
- The creation of the stakeholder and technical expert's networks for technology development and transfer.

The corresponding activities to be implemented to make these actions work includes:

- The development of regional waste management plans on the basis of cluster structure;
- The establishment of coordination council for research of waste reuse and processing;
- The creation of waste management registers and adoption of the decree of their maintenance;
- The support of the development of inter-municipal cooperation;
- The introduction of high gate fee/tax for waste disposal and CO₂ emission;
- The creation of technical and economic condition for MBT with alternative fuel production (price/conditions of RDF/SRF sale/transfer to cement plants);
- The preparation of funding proposals to be submitted;
- The creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations;
- The exchange of information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties).

The development of pilot project for one of the Ukrainian United territorial community is based on the facility for mechanical-biological treatment of waste with alternative fuel production.

2.1.7.4 Stakeholders and Timeline for implementation of TAP

The following Stakeholders will be involved to develop the composting of food and green residuals:

- The Ministry of Communities and Territories Development of Ukraine being responsible for formation and implementation of state policy including municipal service in order to create a comfortable, high quality and safe living space for population;
- The Ministry of Ecology and Natural Resources of Ukraine being responsible for the state control of environmental protection, rational use and protection of natural resources;
- The Ministry for the Development of Economy, Trade and Agriculture being responsible for technical regulation and trade development;
- The Ministry of Finance of Ukraine providing support for enabling legal framework;
- Association “Ukr cement” and cement plants
- Local authorities, municipal companies as entities control local budgets and man power;
- Technical and financial experts as key components of capacity building;
- NGOs for ensuring the connection among central and local governmental bodies and Ukrainian population.

Specific activities will be implemented mostly within the period 2022-2030 along with the program of the development and implementation for regional waste management plans.

2.1.7.5 The estimation of Resources Needed for Action and Activities

Capacity building is needed to carry out actions and activities including the creation of stakeholder and technical expert networks for technology development and transfer. That may be achieved by the creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations and exchange information and lessons learned by organizing of information campaigns, workshops and conferences.

In Ukraine, the project’s planned cost could be in the range of 100 to 150 €/t. Operational costs (OPEX) for MBT technology are primarily related to electricity consumption, repairs and maintenance costs, staff remuneration, and cost of residuals disposal. It is typically in the range from 8 to 12% of capital expenditures.

The final cost of MSW processing is determined by CAPEX and OPEX as well as the terms of project financing. If the project’s specific capital cost amounts 150 €/t, the final cost of MSW treatment is 30-40 €/t depending on the conditions and share of involved bank capital.

2.1.7.6 Management Planning

The main risk of the technology is associated with the lack of local initiative, low activity in legislation development, relatively high cost, unstable financial situation in cement industry, and the lack of funds.

The introduction of face-out stimulating tariffs for waste disposal may support to raise the level of separate collection to minimise the amount of landfilled waste. However, the tariff for waste disposal could often be limited by political reason in Ukraine. In order to avoid that, the independent verification has to be carried out for the introduced tariffs for waste disposal.

The immediate requirements to implement the development of MBT technology along with waste disposal site closure are the following:

- a) enacting the new Laws for the Waste and Landfilling of Municipal Solid Waste;
- b) the update and revision of National Waste Management Strategy till 2030 and National Waste Management Plan till 2030;
- c) the development of portfolio for technology transfer, technical and financial support projects requested with the purpose to disseminate mechanical-biological treatment of waste in Ukraine.

2.1.7.7 TAP overview table

TAP overview table								
Sector: Waste								
Sub-sector: Municipal Solid Waste								
Technology: Mechanical-biological treatment of waste with alternative fuel (SRF) production for cement industry								
Ambition: MBT level – 2% in 2020 and 6% in 2040								
Benefits: GHG emission reduction, reduction of biodegradable waste landfilling, replacement of chemical fertilizers, fossil fuel substitution								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for Monitoring of implementation	Budget per activity
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans based on cluster structure	State, regional, and local budgets, environmental funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	All clusters covered by regional waste management plans	Percentage of clusters covered by regional waste management plans	UAH 5 million per oblast
	1.2. The establishment of coordination council for research on waste reuse and processing	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	Key experts and decision makers are not actively involved	Coordination council is established	Decree for the establishment of coordination council is published	N/A
	1.3. The creation of waste management registers and adoption of the decree of their maintenance	State budget, environmental funds	The ministry of Ecology and Natural Resources of Ukraine	2022-2023	-	Decree for the maintenance of the waste management registers is adopted by the CMU	Adopted decree for the maintenance of the waste management registers is published	TBD
	1.4 The support of the development of inter-municipal cooperation	State and international funds	The ministry of Communities and Territories Development of Ukraine	2021-2028	The lack of local initiative, the lack of funds in local budgets	Most of the clusters covered by inter-municipal cooperation agreements	Percentage of clusters covered by inter-municipal cooperation agreements	UAH 10 million per year
2. The creation of economic and financial	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission	State budget	National Energy and Utilities Regulatory	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation	N/A

conditions for MBT with alternative fuel production			Commission of Ukraine				development in SCU	
	2.2 The creation of other technical and economic condition for MBT with alternative fuel production	State budget	Supreme Council of Ukraine, Ministry for Development of Economy, Trade and Agriculture	2022-2024	Low legislation development	Legislation act accepted	Stages of legislation development in SCU	TBD
3. The provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2021-2022	Unstable financial situation in the country	List of available funding sources	List of available funding sources	TBD
	3.2 Training in development of proposal for funding	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	The lack of funds and grant program	Number of trainees	Number of trainees	UAH 5 million per year
	3.3 Preparation of funding proposals to be submitted	State funds, private sources, international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	The lack of funds and grant program	Presence of supported proposals	Number of supported proposals	UAH 1.0-3.0 million per project
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations	State and international funds	The ministry of Communities and Territories Development of Ukraine	2022-2024	-	Number of the platform active participants, number of supported NGOs	Number of the platform active participants, number of supported NGOs	UAH 10 million
	4.2 Exchange information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)	State and international funds	The ministry of Communities and Territories Development of Ukraine	2024-2030	-	Number of the workshops and conferences	Number of the workshops and conferences	TBD

2.2 Project Ideas for Waste Sector

2.2.1 Brief summary of the Project Ideas for Waste Sector

All together three project ideas are proposed for Waste Sector. These project ideas are presented below in sections A, B and C in the tabular format, being as follows:

- The creation of Ukrainian Circular Economy Platform covering mainly sorting of valuable components of MSW with subsequent treatment of waste residual by other technologies;
- The development of pilot project for one of the Ukrainian United territorial community is based on the facility for composting of food and green residuals by windrow method with production of compost for forest and agriculture;
- The development of pilot project for one of the Ukrainian cluster/set of united territorial communities is based on the facility for mechanical-biological anaerobic treatment of food/green waste with biogas and energy production.

2.2.2 Specific Project Ideas for Waste Sector

A. Creation of Ukrainian Circular Economy Platform

Introduction/Background	<p>“Ukrainian Circular Economy Platform” is a special platform for all interested market players and other stakeholders. It is planned to be a knowledge hub and e-commerce platform (Ukrainian Materials Marketplace), universal tool offering training, financial opportunities, and consultancy services for companies that are truly looking to accelerate their transition to circular economy. Platform will facilitate MSW recycling practice as well as active and transparent cooperation among secondary material market players. Ukrainian Circular Economy Platform will ensure market-based conditions for the supply and demand of recycled MSW components and awareness of stakeholders, which will lead to increasing of MSW recycling level and reduction of Ukrainian MSW disposal practice respectively. Similar platforms have been successfully created and implemented in other countries with the support of international financial institutions as, for example, in Turkey.¹⁰ During the project idea preparation, consultations were held with experts from Turkey Circular Economy platform. Moreover, these experts have expressed their readiness¹¹ to share their experience for the implementation of similar project in practice, in case Ukrainian Circular Economy Platform activity would be launched.</p> <p>Furthermore, the project implementation will contribute to gender equality by creating new environment friendly market’s niches and high qualified jobs in logistics, science, monitoring services and related areas. These jobs demand modern gender-neutral skills in software, logistics and secondary raw material market conditions unlike existing bulky MSW disposal practice. Moreover, the successful functioning of Ukrainian Circular Economy Platform would need excellent negotiation skills of the employees that creates great opportunity for gender equal working environment.</p>
Objectives	<p>Ukrainian Circular Economy Platform can be considered as a platform for promoting circular economy principles which would be climate friendly and market based. Thus, the main objective of the Circular Economy Platform (at least at the initial phase of its functioning) is to increase the share of MSW,</p>

¹⁰ Turkey Circular Economy Platform. See details at: Turkey Circular Economy Platform - Ana Sayfa (donguseleekonomiplatformu.com)

¹¹ Such a support should be budgeted as a consultancy

	which would be recycled and further sold by market price as raw material for industry, desirably domestic industry.
What are the outputs and are they measurable?	<p>The main result of the project is to provide for the significant amount of MSW secondary raw material's sales at prices, which would be formed in competitive and transparent conditions. Other benefits include the development of causal relationship to increase the share of recycling. These benefits are in raising the awareness of stakeholders, their active interaction, ensuring reliable supply and demand for MSW secondary raw materials and active international cooperation. The list of measurable outputs but not limited to, is as follows:</p> <ol style="list-style-type: none"> the amount of MSW secondary raw materials (and other waste types) sales through the Ukraine Materials Marketplace; the variability of waste material types (as an example, paper and cardboard, sludge, organics, glass etc.) available for the transactions; the price of the MSW secondary raw materials; the number of active participants and sponsors as well as their status; the number of transactions and their profitability signed due to interaction at Ukrainian Circular Economy Platform.
Relationship to the country's sustainable development priorities	<p>Ukraine needs to reach 10 % of MSW recycling in 2030; 34 % - in 2040; and 40 % - in 2050 to ensure the implementation of Ukraine's NDC2 in the waste sector and implementation of National Waste Management Strategy of Ukraine till 2030 with ten-year postponement (see Table 2.2). Ukrainian Circular Economy Platform will facilitate dissemination of MSW recycling practice, thus, contributing to achieve goals defined in Ukraine's NDC2 for Waste sector as well as goals defined in National Waste Management Strategy of Ukraine till 2030.</p>
Project deliverables e.g. value/benefits/messages	<ul style="list-style-type: none"> Created platform for cooperation among all interested parties and stakeholders in Ukrainian MSW management sector. The increased amount of recycled MSW secondary raw material. Ensured transparent and competitive prices on MSW secondary raw material. Ensured reliable supply and demand for MSW secondary raw materials. Achieving of GHG emission reduction.
Project scope and possible implementation	<p>The creation of successful platform for cooperation among all interested parties and stakeholders in Ukrainian MSW management sector, which could be further developed without any external financial support after the project finalization.</p>
Project activities	<p>Project activities include: the development of concept for Ukrainian Circular Economy Platform, which would specify its mission, objectives in detail, applicability, stakeholders, etc; ensuring the support from central and local authority; the creation and promotion of Ukrainian Circular Economy Platform, the involvement of stakeholders in active participation. The project implementation should cover the time until Ukrainian Circular Economy Platform would become self-sustaining. Until that time, Ukrainian Circular Economy Platform should have the status of non-profit organization.</p>
Timelines	<p>The total duration of the project is five years. First year is mainly to make a strong team, to finalize the concept, creation and testing of practical tools for the Ukrainian Circular Economy Platform. Second year will be focused on the adjustment of work in accordance with country-specific circumstances. The last three years should be focused on promotion of Ukrainian Circular</p>

	Economy Platform, as well as involvement of stakeholders in active participation.
Budget/resource requirements	The budget could be evaluated as 250,000 EUR per year, which is 1,250,000 EUR in total
Measurement/evaluation	The main indicator is the amount of annual MSW secondary raw materials sales through the Ukraine Materials Marketplace, in physical units (tones) and in overall value of sales (EUR).
Possible complications/challenges	The willingness of big MSW secondary raw material market players to participate in transparent and predictable market environment is a crucial challenge. Another important challenge is to ensure that market players will continue to deal with their partners through the Ukraine Circular Economy Platform in the future after project is over.
Responsibilities and Coordination	Local NGOs and professional associations.

B. *The aerobic composting of food and green residuals by windrow method*

Introduction/Background	<p>Transition from dominating MSW disposal practice to other modern MSW treatment methods is an integral part for the sustainable MSW management system in Ukraine. Accordingly, the modernization of Ukraine's MSW management system should imply the widespread use of biological treatment methods including composting at household and industry/community level.</p> <p>The implementation of large-scale composting project will contribute to gender equality by creating new environment friendly market niches and high qualified jobs in logistics, science, agriculture sector, monitoring services and related areas. These jobs demand modern skills in monitoring software, logistics and fertilizer market's conditions unlike existing bulky MSW disposal practice. In addition, it will benefit to improve the comfort at home (food processing, kitchen waste processing, gardening) in private sector. This issue is especially important for women, since they are most often engaged in maintaining home comfort at single family houses in Ukraine.</p>
Objectives	The development of demonstration project at the level of united territorial community with following dissemination purpose. Processing of green and food waste by biological aerobic method in mid- or big scale. The use of final material after composting in the garden and parks as well as for landscape construction or for agriculture purpose as fertilizer and soil improver.
What are the outputs and are they measurable?	The main result of the project is the implementation and demonstration operation of new waste treatment facility for proving the affordability and financial sustainability for local community. The output of the project is composted materials that can be measured in the amount of treated waste (t/an), alternatively in the amount of produced and utilized compost (t/an), or in reduction of the waste amount to be landfilled (%).
Relationship to the country's sustainable development priorities	By National Waste Management Strategy of Ukraine, the level of MSW biological treatment development including composting should be 5% in 2030, 16% in 2040 and up to 20% in long term prospect till 2050. The 5% share correspond approx. 500,000 tons of composted food and green waste. Composting of 500,000 tons of MSW will result in approx. 0.3 Mt CO ₂ -eq. of GHG emission's reduction.
Project deliverables e.g. value/benefits/messages	<ul style="list-style-type: none"> • New waste treatment facility for green and food waste. • The minimization of landfilling needs, prolongation of existing landfill operation

	<ul style="list-style-type: none"> • GHG emission's reduction • New jobs for local community
Project scope and possible implementation	Project scope includes the search for local community willing and able to implement the waste treatment facility for green and food waste, feasibility study, the development of project design documents, equipment's purchase and construction, start up and demonstration operation within at least one year (four seasons of the year).
Project activities	Project activities include: communication with potential project holders, pre-feasibility and feasibility studies, search of finances, development project design documents and their approvals, negotiations with equipment suppliers and tender procedures, construction, start up and operation, monitoring and capacity building activities.
Timelines	The total duration of the project could at least two years. First year is mainly for project development and second year for demonstration operation, dissemination and capacity building.
Budget/resource requirements	Project budget is the function of project scale. It is expected that for capacity of 10,000 t/ann of green and food waste annual treatment the cost of the facility will be at the level of 1.5 M€. In that case, the total cost of the project including all preparation and follow-up activities will be 1.75 M€.
Measurement/evaluation	The main indicator for evaluation is the amount of treated waste, amount of utilized compost, and on the long-run up to 2030 the number and total capacity of implemented compost facilities in Ukraine.
Possible complications/challenges	The successful expansion of inter-municipal cooperation and ability/readiness of local communities for joining their efforts may play an important role. Financial sustainability is also main challenge for the project that mostly depend on the level of tariff for waste treatment and disposal.
Responsibilities and Coordination	<p>Local authorities are responsible for the development the plans of regional waste management on the basis of cluster structure and introduction of high gate fee/tax for waste disposal preventing waste landfilling and sufficient tariff for waste treatment.</p> <p>The introduction of inter-municipal cooperation as legal mechanism should be supported by the Government within development of institutional and organizational capacity. The government is also responsible for the creation of technical and economic condition for the use of compost as fertilizer and soil improver.</p>

C. The mechanical-biological treatment of municipal solid waste with biogas production

Introduction/Background	<p>Transition from dominating MSW disposal practice to other modern MSW treatment methods is an integral part for the sustainable MSW management system in Ukraine. Accordingly, the modernization of Ukraine's MSW management system should imply the widespread use of biological treatment methods including the mechanical-biological treatment of municipal solid waste or source separated organic waste (SSOW) with biogas production at industry/community level.</p> <p>The project implementation will contribute to gender equality by creating new environment friendly market niches and high qualified jobs in energy, logistics, public utility sector, monitoring services and related areas. These jobs demand modern skills in public utility infrastructure, monitoring software, logistics and energy market conditions unlike existing bulky MSW disposal practice.</p>
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Objectives	The development of demonstration project at the level of territorial cluster (several united territorial communities) with following dissemination purpose. Processing of green and food waste by biological anaerobic method in mid- or big scale. The use of biogas for energy production and digestate after anaerobic process in the garden and parks as well as for landscape construction or for agriculture purpose as fertilizer and soil improver.
What are the outputs and are they measurable?	The main result of the project is the implementation and demonstration operation of new waste treatment facility for proving the affordability and financial sustainability for local community. The output of the project is biogas that can be measured in the produced volume (m ³ /an), alternatively in the amount of produced energy (kWh in row biogas, or electricity and heat produced), or in reduction of the waste amount to be landfilled (%).
Relationship to the country's sustainable development priorities	By National Waste Management Strategy of Ukraine, the level of MSW biological treatment development including mechanical-biological treatment of municipal solid waste with biogas production should be 5% in 2030, 16% in 2040 and up to 20% in long term prospect till 2050. The 5% share correspond approx. 500,000 tons of treated food and green waste. Anaerobic treatment of 500,000 tons of MSW will result in approx. 0.4 Mt CO ₂ -eq. of GHG emission's reduction.
Project deliverables e.g. value/benefits/messages	<ul style="list-style-type: none"> • New waste treatment facility for green and food waste. • The minimisation of landfilling needs, prolongation of existing landfill operation • GHG emission's reduction • New jobs for local community
Project scope and possible implementation	Project scope includes the search for local community willing and able to implement waste treatment facility for green and food waste, feasibility study, the development of project design documents, equipment's purchase and construction, start up and demonstration operation within at least one year (four seasons of the year).
Project activities	Project activities include: communication with potential project holders, pre-feasibility and feasibility studies, search of finances, development project design documents and their approvals, negotiations with equipment suppliers and tender procedures, construction, start up and operation, monitoring and capacity building activities.
Timelines	The total duration of the project could at least three years. Two years are mainly for project development and last year for demonstration operation, dissemination and capacity building.
Budget/resource requirements	Project budget is function of project scale. It is expected that for capacity of 20,000 t/an of green and food waste annual treatment the cost of the facility will be at the level of 4.5 M€. In that case the total cost of the project including all preparation and follow-up activities will be 5.0 M€.
Measurement/evaluation	The main indicator for evaluation is the amount of treated waste, amount of produced biogas/energy, and on the long-run up to 2030 the number and total capacity of implemented MBT facilities in Ukraine.
Possible complications/challenges	The successful expansion of inter-municipal cooperation and ability/readiness of local communities with their efforts may play important role. Financial sustainability is also main challenge for the project that mostly depend on the level of tariff for waste treatment and disposal.
Responsibilities and Coordination	Local authorities are responsible for the development of regional waste management plans on the basis of cluster structure and introduction of high

	<p>gate fee/tax for waste disposal preventing waste landfilling and sufficient tariff for waste treatment. The introduction of inter-municipal cooperation as legal mechanism should be supported by the Government within the development of institutional and organizational capacity. The government is also responsible for the creation of technical and economic condition for use of biogas as energy carrier.</p>
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Chapter 3 Cross-cutting Issues

Further dissemination of climate technologies in agriculture will lead to GHGs emission reduction not only in agriculture sector but also in energy sector due to replacement of fossil fuel with renewable energy sources, in the transport sector due to the increased efficiency of diesel fuel's use by agricultural machinery and potential biomethane use in transport, as well and LULUCF sector.

Some of measures proposed for the support of climate technologies in agriculture will also support the implementation of climate technologies in the waste sector, in particular:

- The improvement of incentives for energy generation and consumption using biogas (power, heat energy, transportation),
- Reforming carbon taxation mechanisms,
- The development of renewable heat energy incentive mechanism for district heating systems.

The diffusion of modern MSW treatment technologies will benefit not only to the GHG emission reduction in the corresponding type of economy activity, as well as to the implementation of sound solutions for economy. It will also lead to GHG emission reduction and economic benefits in all other IPCC sectors: industry – by reducing the need in primary raw material for manufacturing; energy – by combusting alternative fuels; agriculture and forestry – by the prevention of crucial industrial impact on land, as well as the use of organic fertilizers manufactured from organic waste fraction as an alternative to mineral fertilizer's use to the certain extent. Moreover, different MSW treatment technologies shouldn't be considered as simple alternatives, on the contrary they are complimentary to each other, wherein the scale of each technology diffusion depends on country and regional circumstances, such as MSW composition, the density of the inhabitants and their welfare and culture etc. At the project level, it means that all the above mentioned circumstances should be taken into account, when implementing specific design solutions.

The vision about how the waste treatment system is expected to be developed by 2050 is illustrated in Annex I.

The diffusion of modern MSW treatment technologies and climate technologies in agriculture will also benefit to gender equality in Ukraine, in particular, contributing to decreasing of difference between the average salary for men and women, as well as to increasing the share of women in the management staff.

Conclusions

The report presents recommendations about actions and specific activities that aim at fostering the dissemination of climate mitigation technologies in Agriculture and Waste sectors of Ukraine. Recommendations were developed on the basis of the outcomes of previous stages of the TNA project that were focused on the prioritization of climate technologies, barrier analysis and identification of measures in order to create enabling framework for the broader application of prioritized technologies.

For each prioritized technology in the Agriculture and Waste sectors, a Technology Action Plan (TAP) was prepared, which includes the following information:

- the level of ambition;
- actions and activities to be implemented;
- information about stakeholders to be involved and timeframe of activity implementation;
- the estimation of resources needed for actions and activities;
- management planning;
- generalized table, specifying the key milestones for technology TAP implementation.

Agriculture sector:

Activities included in the TAPs have the potential to support climate technologies dissemination and trigger significant GHGs emission reduction in Agriculture sector.

Level of ambition for agriculture sector in Ukraine

Technology	Level of ambition for 2030		
	GHGs emission reduction, Mt of CO ₂ -eq. per year	Land area coverage, million ha	Other parameters
The use of information and telecommunication technologies for GHG emission reductions in agriculture	2	10	-
Conservative tillage technologies	7	10	-
Biogas production from animal waste	2	-	0.34 billion m ³ of natural gas 250 MW of electric capacity
Organic agriculture	3.5	3.5	-
The production and use of solid biofuels from agricultural residues	3.8	-	3.6 Mtoe of solid agricultural residues

The dissemination of proposed climate technologies will also result in additional benefits with the help of the increased operational efficiency and material efficiency of agricultural production, development of rural areas, reduced soil erosion and runoff pollution of water resources, improved soil quality and fertility, as well as adaptation co-benefits.

The proposed project idea “Enabling GHGs emission reductions and carbon sequestration in agriculture in Ukraine” was developed to support the implementation of the following three technologies:

- The use of information and telecommunication technologies for GHG emission reductions in agriculture,
- Conservative tillage,
- Organic agriculture.

All three technologies relate to crop production and have the potential to both reduce greenhouse gases emissions from agricultural operations and increase carbon sequestration. ICT increases the operational efficiency of farm operation and could serve as an enabler for the introduction of conservative tillage and organic agriculture.

Waste sector:

Detailed intermediate and target indicators were formulated and presented for the development of waste management system in Ukraine by 2050. The set of indicators is quite ambitious, however by local opinions it is realistic and could be fully achieved. The proposed set of target indicators is presented in the table below. This trend corresponds to the target scenario of Waste sector development for 2030 and 2050 in 2nd NDC, and the full implementation of acting National Waste Management Strategy by 2040, that means it's postponement by 10 years.

The Level of ambition for waste management sector development in Ukraine up to 2050

Indicator for MSW	Base value, 2020	Target		Long-term vision
		2030	2040	2050
Reuse	4.6	8	10	10
Recycling		10	34	40
Biological treatment		5	16	20
Incineration	1.7	7	10	25
Disposal/landfilling	93.7	70	30	5
Total (estimated)	100	100	100	100

Project ideas were prepared for the most popular technologies among stakeholders:

- The creation of Ukraine Circular Economy Platform (Waste sorting).
- The aerobic composting of food and green residuals by windrow method.
- The mechanical-biological treatment of municipal solid waste with biogas production.

Important gender equality issues are addressed in the light of implementation of mitigation actions in the waste and agriculture economy sectors of Ukraine:

- each project idea includes the benefits for gender equality from its implementation;
- the cross-cutting sections include information about gender equality's opportunities from waste management sector development.

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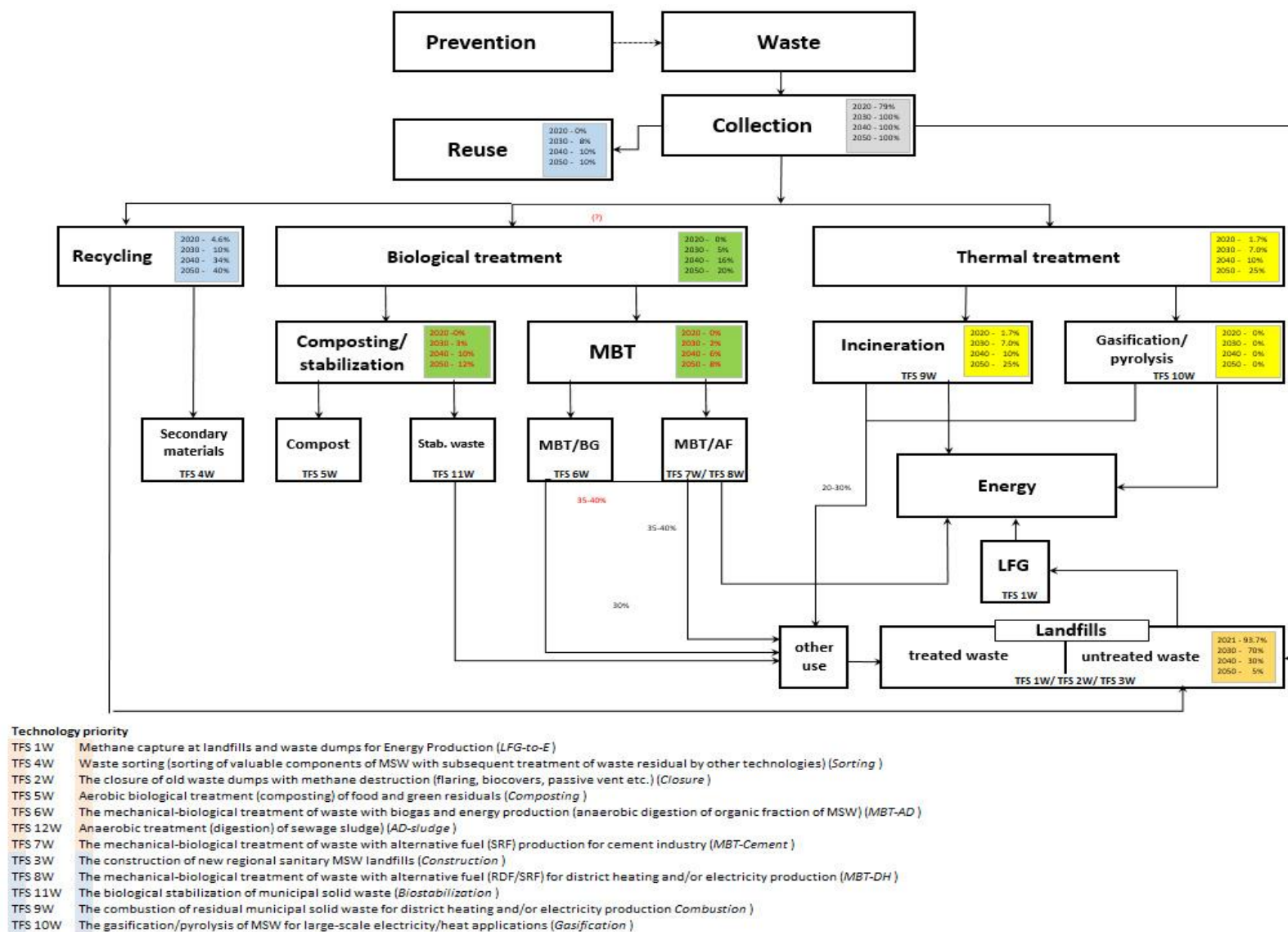
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Annex I. Waste management diagram with prioritized technologies



Annex II. List of stakeholders involved

Table II. – Institutions involved in stakeholder consultation process

Institution	Website	Representative
Public Administration Bodies		
Ministry of Environmental Protection and Natural Resources of Ukraine	https://mepr.gov.ua/	Simkova Yevheniia
Ministry of Healthcare of Ukraine, the Directorate of Public Health and Disease Prevention	http://www.moz.gov.ua/	Iryna Rudenko
Ministry of Healthcare of Ukraine, expert group on NCD prevention and health promotion of the Directorate of Public Health and Disease Prevention	http://www.moz.gov.ua/	Tetyana Skapa
The Committee on Energy and Housing and Communal Services	https://itd.rada.gov.ua/mps/info/page/21100	Oleh Seminskyy
Ministry of Education and Science of Ukraine	https://mon.gov.ua/	Olena Kharina
Ministry of communities and territories development of Ukraine	www.minregion.gov.ua	Oksana Anoprikova
Ministry of communities and territories development of Ukraine	www.minregion.gov.ua	Diana Novikova
Ministry of communities and territories development of Ukraine	www.minregion.gov.ua	Tatiana Horbatiuk
Ministry for Development of Economy, Trade and Agriculture of Ukraine, Directorate of Agro-Industrial Development	https://www.me.gov.ua/	Vedmid Larysa
Ministry for Development of Economy, Trade and Agriculture of Ukraine, Directorate of Agro-Industrial Development	https://www.me.gov.ua/	Mishchenko Liubov
Ministry for Development of Economy, Trade and Agriculture of Ukraine, Directorate of Pricing Policy and Development of the Real Sector of the Economy	https://www.me.gov.ua/	Viktoria Kovalenko
Ministry for Development of Economy, Trade and Agriculture of Ukraine Directorate of Pricing Policy and Development of the Real Sector of the Economy	https://www.me.gov.ua/	Olena Khomych
State Agency of Fisheries of Ukraine	https://darg.gov.ua/	Polina Ivashchenko
National Security and Defence Council of Ukraine, Department of Environmental and Energy Security of the Staff	https://www.rmbo.gov.ua/	Oleksandr Semenets
Ministry of Justice of Ukraine, Section of the civil protection, nuclear energy using and environmental protection of the Division of land, agrarian, environmental and nuclear law of the, Department of private law	http://www.minjust.gov.ua/	Vita Romanenko
Ministry of Justice of Ukraine, Section of the civil protection, nuclear energy using and environmental protection of the Division of land, agrarian, environmental and nuclear law of the, Department of private law	http://www.minjust.gov.ua/	Svitlana Ralchenko
The State Agency for Energy Efficiency and Energy Saving of Ukraine	https://saee.gov.ua/	Tamara Burenko
The State Agency for Energy Efficiency and Energy Saving of Ukraine	https://saee.gov.ua/	Olena Lenska
The State Agency for Energy Efficiency and Energy Saving of Ukraine	https://saee.gov.ua/	Yuliya Kryvsha
The State Agency for Energy Efficiency and Energy Saving of Ukraine	https://saee.gov.ua/	Viktor Bilko
The State Agency for Energy Efficiency and Energy Saving of Ukraine	https://saee.gov.ua/	Bohdan Radchenko
National Commission for State Regulation of Energy and Utilities, Division for the Strategic Development of Energy Markets and Public Utilities Sphere Department for Strategic Development and International Coordination	https://www.nerc.gov.ua/	Anna Potravka
The State Service of Ukraine for Geodesy, Cartography and Cadastre (StateGeoCadastre)	https://land.gov.ua/	Olha Savchuk
The State Statistics Service of Ukraine, Department of ecological accounts and environmental statistics division of agriculture and environmental statistics	www.ukrstat.gov.ua	Oksana Yuriivna Boretska
The State Statistics Service of Ukraine, Department of ecological accounts and environmental statistics division of agriculture and environmental statistics	www.ukrstat.gov.ua	Oleksandr Mykolayovych Sokolenko
Committee of the Public Council		
The Member of parliament, Chairman of the Subcommittee on Household Waste Management		Oleksandr Yurchenko
The Office of the President of Ukraine, Impact Assessment Division of the Main Directorate of Expert and Analytical Support of the Directorate for Economic Policy Issues	https://www.president.gov.ua/news/administration	Svitlana Yarova
Reforms Delivery Office of the CMU		Denysiuk Maryna
Budget institution "National Center For GHG emission inventory" (BI "NCT")		Iuliia Zakharchuk
Regional Authorities		
Chernivtsi Regional State Administration, Department of Ecology and Natural Resources	https://bukoda.gov.ua/	Mykola Bilokon

Institution	Website	Representative
Chernihiv Regional State Administration, the Department of Ecology and Natural Resources	vodacpk.com.ua	Tetiana Nebrat
Poltava Regional State Administration, the Department of Ecology and Natural Resources	http://eko.adm-pl.gov.ua/	Julia Rozum
Poltava regional state administration, the Department of ecology and natural resources	http://eko.adm-pl.gov.ua/	Ludmyla Herinsh
Poltava regional state administration, the Department of ecology and natural resources	http://eko.adm-pl.gov.ua/	Larysa Budaievska
Poltava regional state administration, the Department of ecology and natural resources	http://eko.adm-pl.gov.ua/	Inna Moseichuk
Department of North-Crimea Channel	https://upkk.davr.gov.ua	Olena Gridasova
Kyiv Regional State Administration, the Department of Ecology and Natural Resources	http://ecology-kievoblast.com.ua/	Anna Tkalich
Zakarpattia regional state administration, the Department of regulation of emissions into the atmosphere, use of water resources and waste management of the department of ecology and natural resources	www.carpathia.gov.ua	Lyubov Bedo
Zakarpattia regional state administration, the Department of animal husbandry of the department of agro-industrial development	www.carpathia.gov.ua	Nina Kish
Zakarpattia regional state administration, the Department of ecology and natural resources	www.carpathia.gov.ua	Vitaliy Kovach
Zakarpattia regional state administration, the Department of agro-industrial development	www.carpathia.gov.ua	Snizhana Pavlyk
Zakarpattia regional state administration, the Department of agro-industrial development	www.carpathia.gov.ua	Victor Terelia
Zakarpattia regional state administration, the Department of ecology and natural resources	www.carpathia.gov.ua	Yuriy Shpontak
Kirovohrad regional state administration, the Department of ecology, natural resources and fuel – energetic complex	www.kr-admin.gov.ua	Hanna Oleksandrivna Homeniuk
Ternopil regional state administration, the Department of ecological safety of the department of ecology and natural resources	http://www.oda.te.gov.ua	Nadiya Voitovych
Luhansk Regional State Administration, the Department of Food and Agrarian Market of the Department of Agro-Industrial Development	http://loga.gov.ua	Yulia Semenivna Lazebnyk
Luhansk Regional State Administration, the Department of Crop Production, Engineering and Technical Policy and Land Relations of the Department of Agro-Industrial Development	http://loga.gov.ua/	Iryna Hennadiivna Kordyukova
Luhansk Regional State Administration, the Department of communal property, land, property relations, ecology and natural resources	http://loga.gov.ua/	Larisa Morozova
Khmelnytsky Regional State Administration, the Department of Environmental Impact Assessment, Environmental Management and Monitoring	https://www.adm-km.gov.ua/	Valentyna Shybetka
Khmelnytsky Regional State Administration, the Department of Environmental Impact Assessment, Strategic Environmental Assessment and Monitoring	https://www.adm-km.gov.ua/	Anna Lokazyuk
Khmelnytsky Regional State Administration, the Department of Environmental Impact Assessment, Strategic Environmental Assessment and Monitoring	https://www.adm-km.gov.ua/	Oksana Khamula
Khmelnytsky Regional State Administration, the Department of Nature Management, Atmospheric Air, Subsoil, Water and Land Resources and Waste Management	https://www.adm-km.gov.ua/	Victoria Jakobchuk
Khmelnytsky Regional State Administration, the Department of Nature Reserve Development, Environmental Economics, Environmental Programs and Public Relations	https://www.adm-km.gov.ua/	Kristina Pavlova
Volyn Regional State Administration, the Department of AgroIndustrial Complex	http://agrovolyn.gov.ua/	Iurii Iurchenko
Volyn Regional State Administration, Division for Nature Management Economics and Environmental Programs of the Department of Ecology and Natural Resources	https://voladm.gov.ua/	Viktorina Tymoshchuk
Volyn Regional State Administration, Division for Nature Management Regulation, Coordination Activities and Environmental Monitoring of the Department of Ecology and Natural Resources	https://voladm.gov.ua/	Olga Grytsai
Volyn Regional State Administration, the Department of infrastructure management and technogenic and environmental safety	https://voladm.gov.ua/	Mykhailo Kozak
Lviv Regional State Administration, the Department of Sustainable Development of Agricultural Production, Infrastructure and Land Relations	http://www.loda.gov.ua/	Igor Vus
Rivne regional state administration, the Department of ecology and natural resources	https://www.rv.gov.ua/	Anatolii Shavurskyi
Donetsk regional state administration, the Department of Ecology and Natural Resources	www.ecology.donoda.gov.ua	Sergey Petrovich Natrus

Institution	Website	Representative
Donetsk regional state administration, the Department of Economics and investments of the Department of Land Relations, Water Resources, Economics and Investments of the Department of Agricultural Development and Land Relations	www.ecology.donoda.gov.ua	Anatoly Vladimirovich Gorbachev
Zhytomyr Regional State Administration, the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Mykola Mykolayovych Semenyuk
Zhytomyr Regional State Administration, the Department of Atmospheric Air and Waste Management of the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Marina Yaroslavivna Sulzhenko
Zhytomyr Regional State Administration, the Department of Atmospheric Air and Waste Management of the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Nadiya Mykhailivna Mudrenok
Zhytomyr Regional State Administration, the Department of Atmospheric Air and Waste Management of the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Tetyana Mykolayivna Pylypchuk
Zhytomyr Regional State Administration, the Department of Atmospheric Air and Waste Management of the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Oleg Petrovich Popov
Zhytomyr Regional State Administration, the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Tetiana Adamivna Rasputna
Zhytomyr Regional State Administration, the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Natalia Olexandrivna Steglyuk
Zhytomyr Regional State Administration, the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Svitlana Viktorivna Targonska
Zhytomyr Regional State Administration, the Department of Ecology and Natural Resources	http://www.ecology.zt.gov.ua/	Sergey Sergiyovych Leonov
Sumy Regional State Administration, the Department of environment protection and energy	www.sm.gov.ua	Iryna Kashpur
Sumy Regional State Administration, the Department of atmospheric air standardization, water resources, waste management and atmospheric air quality management Department of environment protection and energy	www.sm.gov.ua	Uliya Loboda
Sumy Regional State Administration, the Department of atmospheric air standardization, water resources, waste management and atmospheric air quality management Department of environment protection and energy	www.sm.gov.ua	Yana Korotchenko
Sumy Regional State Administration, the Department of atmospheric air standardization, water resources, waste management and atmospheric air quality management of the Department of environment protection and energy	www.sm.gov.ua	Olesia Radchenko
Sumy Regional State Administration, the Department of atmospheric air standardization, water resources, waste management and atmospheric air quality management of the Department of environment protection and energy	www.sm.gov.ua	Yana Tukina
Sumy Regional State Administration, the Department of atmospheric air standardization, water resources, waste management and atmospheric air quality management of the Department of environment protection and energy	www.sm.gov.ua	Vita Matvienko
Sumy Regional State Administration, the Department of ecological assessment, monitoring and economics of nature management of the Department of environment protection and energy	www.sm.gov.ua	Inna Shkrobot
Sumy Regional State Administration, the Department of ecological assessment, monitoring and economics of nature management of the Department of environment protection and energy	www.sm.gov.ua	Galyna Kryvtsova
Sumy Regional State Administration, the Department of ecological assessment, monitoring and economics of nature management of the Department of environment protection and energy	www.sm.gov.ua	Olena Yatsenko
Sumy Regional State Administration the Department of ecological assessment, monitoring and economics of nature management of the Department of environment protection and energy	www.sm.gov.ua	Nataliya Yurchenko
Sumy Regional State Administration, the Department of ecological assessment, monitoring and economics of nature management of the Department of environment protection and energy	www.sm.gov.ua	Anastasiia Berezhna
Sumy Regional State Administration, Section of Inclusive Education, Extracurricular and Educational Work of the Department of Education and Science	www.sm.gov.ua	Svitlana Mykhailychenko
Zaporizhzhya regional state administration, the Waste management sector of the division of rational use of natural resources and environmental programs of the department of environmental protection	https://www.zoda.gov.ua/	Yevhenii Yeltsov
Zaporizhzhya regional state administration, the Waste management sector of the division of rational use of natural resources and environmental programs of the department of environmental protection	https://www.zoda.gov.ua/	Inessa Kiiashko
Zaporizhzhya regional state administration, the Division of crop and rural development of agricultural development department	https://www.zoda.gov.ua/	Oleksandr Yasynetskyi
Zaporizhzhya regional state administration, the Subdivision of organization of livestock production of the livestock production and food industry division	https://www.zoda.gov.ua/	Viktor Plechun

Institution	Website	Representative
Odessa regional state administration	https://oda.odessa.gov.ua/	Yliya Bevz
Odessa regional state administration	https://oda.odessa.gov.ua/	Iryna Chefarlicheva
Odessa regional state administration	https://oda.odessa.gov.ua/	Iryna Dalechenko
Lviv Regional State Administration, the Department of Standardization of Permitting Activity and Monitoring of the Department of Ecology and Natural Resources	https://deplv.gov.ua/	Ihor Kravets
Lviv Regional State Administration, Department for Regulation of Water and Subsoil Use of the Department of Ecology and Natural Resources	https://deplv.gov.ua/	Roman Tutsykyi
Lviv city council Office of Ecology and Natural Resources Department of Urban Planning	https://city-adm.lviv.ua/	Oleksandra Sladkova
Regional office of water resources in Dnipropetrovsk region, the laboratory for monitoring water and soil	dovr.gov.ua	Oksana Shiyanova
Communal company "Poltavaplocomunenergo"	http://te.pl.ua/	Татьяна Поливода
Communal entity " the Institute of research of city social and economic development"		Redkina Nadiya
Sosnitsa village council		Кустенко Наталія
Academic/Research Institutions		
Ivan Franko National University of Lviv	https://lnu.edu.ua/	Anatoliy Smaliychuk
The Center of Advanced Training for Water Management Personnel (CATWM)		Olha Lysiuk
Zaporizhzhia Polytechnic National University	https://zp.edu.ua/	Alexey Nazarenko
Public Institution «Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine»	http://ecos.kiev.ua/	Oksana Sakal
Public Institution «Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine»	http://ecos.kiev.ua/	Tetiana Omelianenko
Public Institution «Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine»	http://ecos.kiev.ua/	Yuliia Makovetska
Public Institution «Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine»	http://ecos.kiev.ua/	Irina Denisenko
Budgetary Institution "Methodological and Technological Center for Aquaculture"	https://darg.gov.ua/	Olena Poplavska
Kyiv academic university NASU	https://kau.org.ua/	Volodymyr Nochvai
Igor Sikorsky Kyiv Polytechnic Institute	https://kpi.ua/	Yurii Veremiichuk
Taras Shevchenko National University of Kyiv	http://www.univ.kiev.ua/en/	Valeriy Michaylenko
Odessa State Environmental University	https://odeku.edu.ua/	Valeriya Ovcharuk
IC "ECOENGINEERING"		Serhii Sydorenko
Institute of Engineering Thermophysics NASU	http://itf.kiev.ua/	Nonna Pawliuk
Ukrainian order "sign of honour" research institute of forestry and forest melioration named after G. M. Vysotsky	https://urifm.org.ua/	Vysotska Natalia
Institute of Agroecology and Environmental management of National Academy of Agrarian Sciences of Ukraine	https://agroeco.org.ua/	Anna Schavinska
State organization "Institute of Economic and Legal Research of National Academy of Sciences of Ukraine"	https://www.iepd.kiev.ua/?cat=1	Smyon Yatsenko
National University of Kyiv-Mohyla Academy	https://www.ukma.edu.ua/	Олена Маслюківська
NGOs		
NGO "GWP-Ukraine"	https://www.gwp.org/	Anna Tsvietkova
International Charity Organisation "Green Dossier"	https://www.dossier.org.ua/en/	Kateryna Shor
Organic Ukraine	https://organicukraine.org.ua/	Olena Korogod
International Charity Organisation "Green Dossier"	https://www.dossier.org.ua/en/	Tamara Malkova
Center for Environmental Initiatives Ecoaction	https://ecoaction.org.ua/	Mariia Diachuk
Center for Environmental Initiatives Ecoaction	https://ecoaction.org.ua/	Amosov Mykhailo
Center for Environmental Initiatives Ecoaction	https://ecoaction.org.ua/	Anna Danyliak
International Charity Organisation "Green Dossier"	https://www.dossier.org.ua/en/	Olga Ignatenko
International Charity Organisation "Green Dossier"	https://www.dossier.org.ua/en/	Nadia Shevchenko
UNDP in Ukraine	https://www.ua.undp.org/	Nataliya Strnadko
The Club of economists	https://www.economists.org.ua/	Oleksandra Pravdyva
The Resource Efficient and Cleaner Production Centre	http://www.recpc.org/	Valeriy Pavshuk
LLC OCI		Kozbur Nataliia
Bioenergy Association of Ukraine	https://uabio.org/	Georgiy Geletukha
"UKRNPICIVILBUD"		Pelovina Julia

Institution	Website	Representative
GCCM		Christina Rudnytska
Arnika		Maksym Soroka
ACTED	https://www.acted.org/en/countries/ukraine/	Liliia Yurkiv
NGO Svit Osvit		Olha Lavryk
NGO "Ecology club "Kray"		Галина Проців
NGO "European initiative - Euroin"		Svetlana Rozsochach
Organic Ukraine	https://organicukraine.org.ua/en/home/	Olena Korogod
AgTech Ukraine Association		Yuriy Petruk
National Association of Agricultural Advisory Services of Ukraine	https://dorada.org.ua/	Roman Korinets
Ukrainian Agribusiness Club	https://ucab.ua/en/	Roman Slaston
Ukrainian Agribusiness Club	https://ucab.ua/en/	Alla Kravchenko
Ukrainian Agribusiness Club	https://ucab.ua/en/	Oleg Nesterov
Private Sector		
The Association of Cement Producers of Ukraine "Ukrcement"	www.ukrcement.com.ua	Pavlo Bondarev
Resource Efficient and Cleaner Production Centre (RECPC NGO)	http://www.recpc.org/	Kostyantyn Tadya
Private Joint Stock Company "Ukrhydroenergo"	https://uhe.gov.ua/	Oksana Hulciaieva
The Ukrainian Chamber of Commerce and Industry, Department for investments promotion and project management	http://www.ucci.org.ua/	Yevhen Kuruelnko
SMARTWELL	https://smartwell.com.ua/	Oleksandr Baranovskyi
Data Agro	https://dataagro.com.ua/	Andriy Slavnyy
PJSC Intercorn	http://soles.ua/	Olena Hutsol
Egis International	https://www.egis-group.com/	Alex Gittelson
TIC LLC		Франжолі Діана
Ecotec - rational engineering - KG	https://www.sapsan.de/	Sergej Sokol
Newspaper Day	https://day.kyiv.ua/	Inna Lykhovyd
PPV Knowledge Networks	https://www.ppv.net.ua/	Olha Melnyk
Environmental consultant, Oleksandr Kislitsyn		Oleksandr Kislitsyn
Interoil Service LLC		Verbytska Valentyna
Green Offset	https://greenoffset.co.uk/	Anatoli Smirnov
LLC Envitec	envitec.com.ua	Mykhailovska Marina
AgroCares		Viktorii Sakun
PC Ecosolum LLC		Kostyantyn Solyanyk
Softengi	https://softengi.com/	Maryna Berezhnyska
Kray	https://kray.technology/	Дмитро Сурду
Ukrainian Business & Trade Association	https://ubta.com.ua/	Зоя Павленко
Teplotehnika		Oleksandr Skorokhod
MHP		Oleksandr Semenets
Organic Standard	https://organicstandard.ua/ua	Олена Манзюк
LLC "Envitek"	https://envitec.com.ua/kontakty	Marina Mikhailovskaya
KT-Energy LLC	https://kt-energy.com.ua/	Kyryl Tomliak
AgroBiogas LLC	https://agrobiogas.com.ua/	Olha Sydorchuk
Accord Ltd	https://bio-gas.com.ua/	Yuriy Epshtein
Arnika Organic	https://arnika.organic/	Anastasiia Bilych
Gals-Agro	https://gals-agro.com/	Oleg Riabov
Drone.ua	https://drone.ua/	Valerii Iakovenko
BM Engineering / Pellet Association of Ukraine	http://www.bm-biomass.com/	Volodymyr Bunetskyi
Ecosolum Group	http://www.ecosolum.com/	Kostyantyn Solyanyk
International organisations/projects		
Swiss-Ukrainian Decentralization Support Project DESPRO	https://despro.org.ua/despro/	Dmitry Laznenko
"Climate Change and Energy Policy" Program, Coordinator at the Heinrich Boell Foundation, Kyiv - Ukraine Office	www.ua.boell.org	Oksana Aliieva
"Integrated Natural Resources Management in Degraded Landscapes in the Forest-Steppe and Steppe Zones of Ukraine" Project		Oksana Davis

Institution	Website	Representative
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Climate Finance Specialist ECA Agri-Finance, Program Financial Institutions Group	www.ifc.org	Sergii Nevmyvanyy
Agriculture Insurance and Agriculture Finance Expert, IFC - International Finance Corporation (World Bank Group)	www.ifc.org	Andriy Zaripov
European Union to Ukraine, Sector Manager	http://eeas.europa.eu/delegations/ukraine	Vitaliya Mudruk
European Union to Ukraine, Sector Manager, Environment of Delegation	http://eeas.europa.eu/delegations/ukraine	Olga Simak
European Union to Ukraine, Sector Manager, Agriculture of Delegation	http://eeas.europa.eu/delegations/ukraine	Ben Hell
European Union to Ukraine Adviser on Green Deal and Digital of Delegation	http://eeas.europa.eu/delegations/ukraine	Gregory Tsouris
The United Nations Children's Fund (UNICEF)	https://www.unicef.org/	Nataliya Koliyets
IUCNAEL		Svitlana Romanko
European Business Association	https://eba.com.ua/	Irina Dushnik
European Business Association	https://eba.com.ua/	Mariia Kobiz
UNDP Ukraine	https://www.ua.undp.org/	Olga Syutikova
FAO SEC	http://www.fao.org/	Yuriy Nesterov
FAO UN	http://www.fao.org/	Oleksandr Kodak
FAO UN	http://www.fao.org/	Mikhail Malkov
Green Climate Fund	https://www.greenclimate.fund/	Galyna Uvarova
British Embassy Kyiv	https://www.gov.uk/	Olena Balbekova
Climate action network	https://climatenetwork.org/	Julia Pashkovska
GIZ, Project "Support for the Establishment of an Emissions Trading Scheme (ETS) in Ukraine"	https://www.giz.de/en/worldwide/32413.html	Vladyslav Zhezherin
IMPACT Initiatives	https://www.impact-initiatives.org/	Tetyana Kuchma
EBRD	https://www.ebrd.com/	Oleg Bulanyi
EBRD	https://www.ebrd.com/	Kyryl Tomliak
National Bank of Ukraine	https://bank.gov.ua/en/	Oleksandr Snizhko
USAID Energy Security Project	https://energysecurityua.org/ua/	Iuliia Pylnova
Project "Carbon stocks of Ukrainian Chornozems as a function of Land Use and Climate change and their significance for GHG-mitigation"		Larysa Shedei
Project "Carbon stocks of Ukrainian Chornozems as a function of Land Use and Climate change and their significance for GHG-mitigation"		Anatoliy Smaliychuk

Annex III. Results of a stakeholder survey on support mechanisms for the introduction of new technologies in Waste sector

Question W1. Please, assess the importance of implementing the following general economic and financial measures to effectively promote the widespread introduction of modern MSW management technologies in Ukraine?

Table III.1. – Proposed options and results, question W1 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The introduction of tariffs for waste management sufficient to cover associated expenses for project life time	4.42
2	The implementation of “Pay as you throw” principle	4.42
3	The implementation of “Extended producer responsibility” principle	4.83
4	The introduction of economic incentives for the production of domestic equipment for the dissemination of recycling practice	4.50
5	Temporary VAT exemption for reuse services	3.58
6	Temporary VAT exemption for recyclable materials and products	3.83
Average		4.26

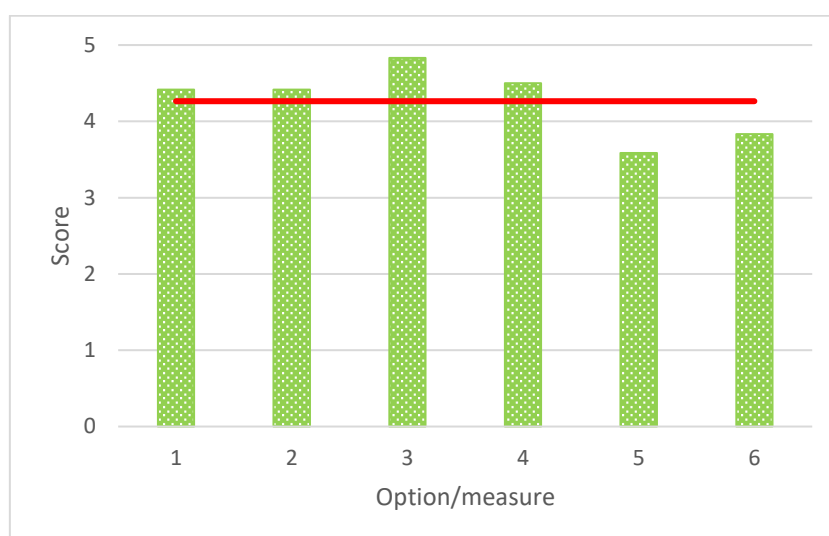


Figure III.1. – Scoring of measures for question W1

Question W2. Please, assess the importance of implementing the following general non-financial measures to effectively promote the widespread introduction of modern MSW management technologies in Ukraine?

Table III.2. – Proposed options and results, question W2 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The creation of general conditions for modern regional landfill construction program and old waste dumps closure	4.42
2	The creation of general conditions for modern waste treatment technology development	4.58
3	The creation of a new central authority responsible for waste management state policy implementation in Ukraine	2.92
4	The implementation of national waste list (classification) on the basis of European practice	4.25
5	The introduction of inter-municipal cooperation as a legal mechanism supported by the Government	3.92
6	Levelling an influence of informal sector	3.08
7	The creation of an interagency coordination board for waste reuse, processing and utilisation	3.00
8	Support for new jobs in waste management sector	3.83
9	Support for new specialties on sustainable waste management at the universities	3.92
10	The creation of guidelines in modern waste management opportunities for the municipalities	3.75
11	The creation of working platforms on dissemination best practices in Ukraine	4.17
12	Carrying out of national awareness campaign on sustainable waste management	4.42
Average		3.85

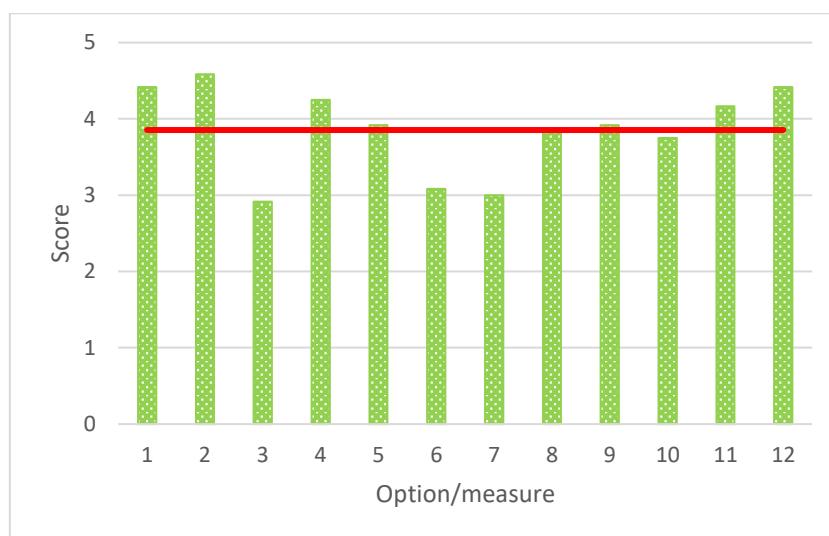


Figure III.2. – Scoring of measures for question W2

Question W3. Please, assess the importance of implementing the following measures for development of “Methane capture at landfills and waste dumps for energy production” technology?

Table III.3. – Proposed options and results, question W3 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The creation of economic and financial conditions for modern regional landfill construction program	4.50
2	The creation economic and financial conditions for old waste dumps closure	4.83
3	The introduction of high gate fee/ tax for waste disposal	3.83
4	Incentives to foreign investment	3.83
5	The alignment of landfill operation procedures in Ukraine with the requirements of Directive 1999/31/ EC on the waste disposal (D. 1999/31/EC, 1999)	4.33
6	Increasing the responsibility of landfill operators for the post-operational period of landfills (closure and monitoring)	4.33
7	Levelling an influence of informal sector	3.50
8	The creation of alternative legal jobs for the poor people from communities, located nearby the landfills that are planned to be closed	3.50
9	National awareness company on sustainable waste management as an alternative to MSW disposal	4.42
Average		4.12

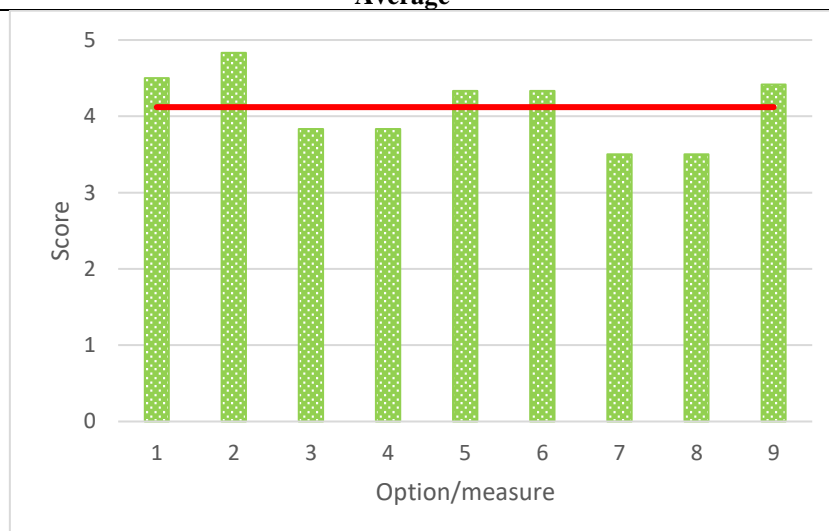


Figure III.3. – Scoring of measures for question W3

Question W4. Please, assess the importance of implementing the following measures for the development of “Waste sorting (sorting of valuable components of municipal solid waste with subsequent treatment of waste residual by other technologies)” technology?

Table III.4. – Proposed options and results, question W4 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The introduction of tariffs for waste management sufficient to cover associated expenses for project life time	4.17
2	The implementation of “Pay as you throw” principle	4.17
3	The implementation of “Extended producer responsibility” principle	4.58
4	The introduction of new law for Waste, which would be in line with EU legislation	4.58
5	The introduction of inter-municipal cooperation as a legal mechanism supported by the Government	4.25
6	Levelling an influence of informal sector	3.50
7	National awareness company for sustainable waste management as an alternative to MSW disposal	4.25
8	Product labelling	4.00
	Average	4.19

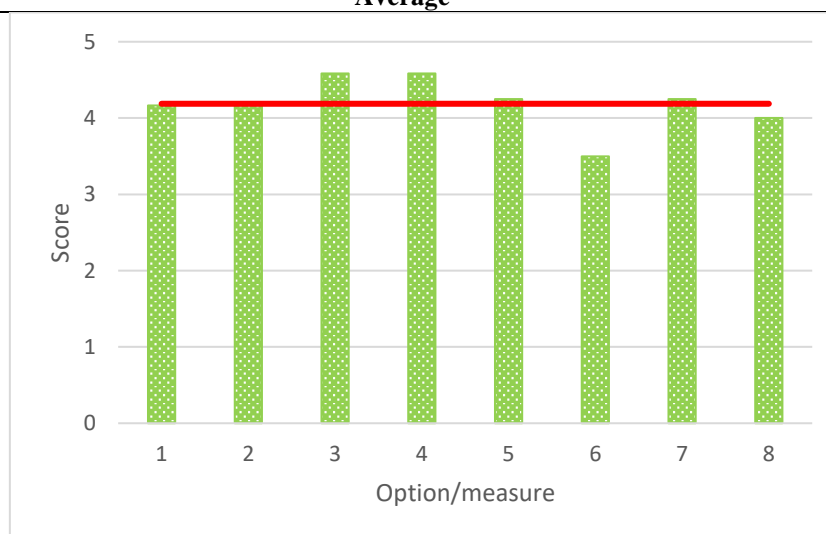


Figure III.4. – Scoring of measures for question W4

Question W5. Please, assess the importance of implementing the following measures for the development of “The aerobic biological treatment (composting) of food and green residuals” technology?

Table III.5. – Proposed options and results, question W5 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The increase of tariffs for waste disposal, which have to cover all expenditures including environmental and operational, as well as related to landfill closure	4.33
2	Increase in environmental tax for waste disposal	4.67
3	The significant introduction of penalties for violation of legislation in waste disposal issues	4.83
4	The alignment of landfill operation procedures in Ukraine with the requirements of Directive 1999/31/ EC on the waste disposal (D. 1999/31/EC, 1999)	4.50
5	The implementation of national waste list (classification) on the basis of European practice	4.17
6	The significant increase of responsibility for the violation of legislation in waste treatment system, especially waste disposal procedures	4.67
7	The responsibility of landfill operators for the post-operational period of landfills (closure and monitoring)	4.33
8	Ensuring the operation of new waste collection / reception centers, centers for the collection of solid waste components for reuse, sorting and reloading stations	4.08
	Average	4.45

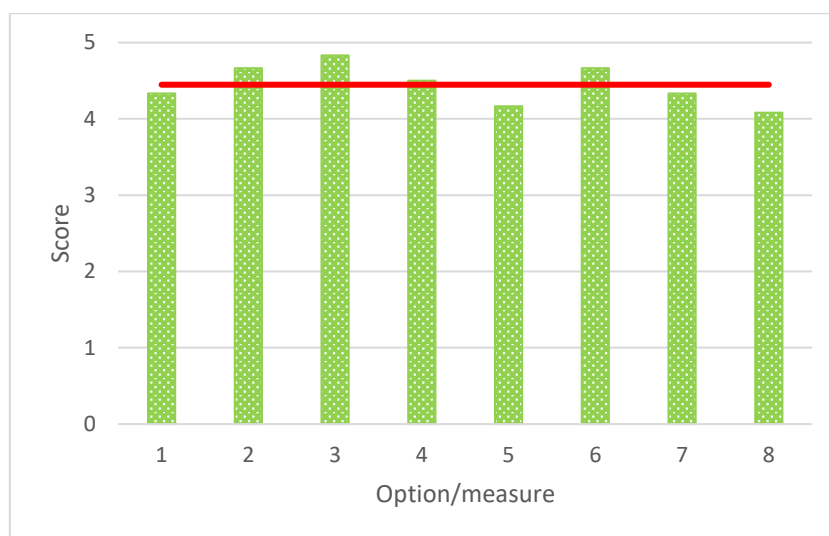


Figure III.5. – Scoring of measures for question W5

Question W6. Please, assess the importance of implementing the following measures for the development of “The aerobic biological treatment (composting) of food and green residuals” technology?

Table III.6. – Proposed options and results, question W6 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The creation of conditions for modern industry composting	4.33
2	The development of the program for compost use as soil improver and organic fertilizer	4.00
3	The introduction of economic incentives for the dissemination of environmentally friendly technologies and expansion of composting practice	4.08
4	The introduction of a mechanism for providing subsidies for the collection and transportation of green waste suitable for compost production	3.83
5	Ensuring that Waste Reception/Collection and Compost Centres in cities with a population above 20,000 are put into operation	4.17
6	Levelling an influence of informal sector, giving it an opportunity to work within the framework of acting legislation	3.25
7	Support of new specialties for sustainable waste management in universities	4.25
8	The creation of guidelines in modern waste management opportunities for the municipalities	3.75
9	The development of the program for home composting	3.83
10	The introduction of measures to populate waste separate collection and sorting	4.58
Average		4.01



Figure III.6. – Scoring of measures for question W6

Question W7. Please, assess the importance of implementing the following measures for the development of “The Mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of municipal solid waste)” technology?

Table III.7. – Proposed options and results, question W7 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The introduction of high gate fee/tax for waste disposal	4.08
2	The creation of conditions for MBT with biogas and energy production	4.33
3	The development of the program for MBT projects implementation	4.33
4	The introduction of economic incentives for the dissemination of environment friendly technologies and expansion of biological waste treatment practice	4.42
5	The introduction of a mechanism for providing subsidies for the collection and transportation of green waste suitable for biogas production	4.17
6	The introduction of inter-municipal cooperation	4.17
7	Ensuring the implementation of MBT Centres in territorial clusters with total population above 200,000 inhabitants	4.67
8	The introduction of measures to populate waste separate collection and sorting	4.58
	Average	4.34



Figure III.7. – Scoring of measures for question W7

Question W8. Please, assess the importance of implementing the following measures for the development of “The Mechanical biological treatment of waste with the alternative fuel production for cement industry” technology?

Table III.8. – Proposed options and results, question W8 (1-unlikely, 5 – excellent)

No.	Option/measure	Score
1	The introduction of high gate fee/ tax for waste disposal	4.25
2	The creation of conditions for MBT with SRF for cement industry production	4.25
3	To create a condition for the use of SRF as natural gas and other conventional fuels substitution	4.33
4	The development of the program for MBT project's implementation	4.33
5	The introduction of a mechanism for providing subsidies for the collection and transportation of waste suitable for SRF production	3.92
6	The introduction of inter-municipal cooperation	3.92
7	Ensuring the implementation of MBT Centres in territorial clusters with total population above 200,000 inhabitants	4.42
	Average	4.20

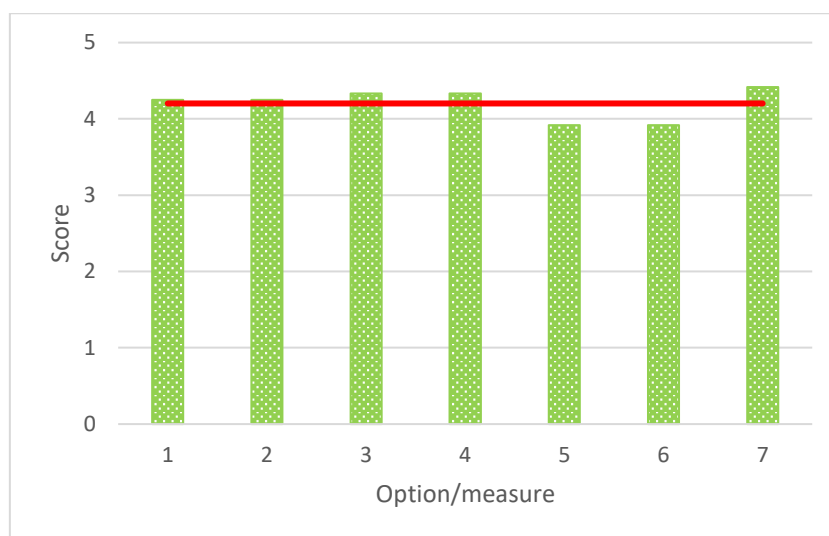


Figure III.8. – Scoring of measures for question W8

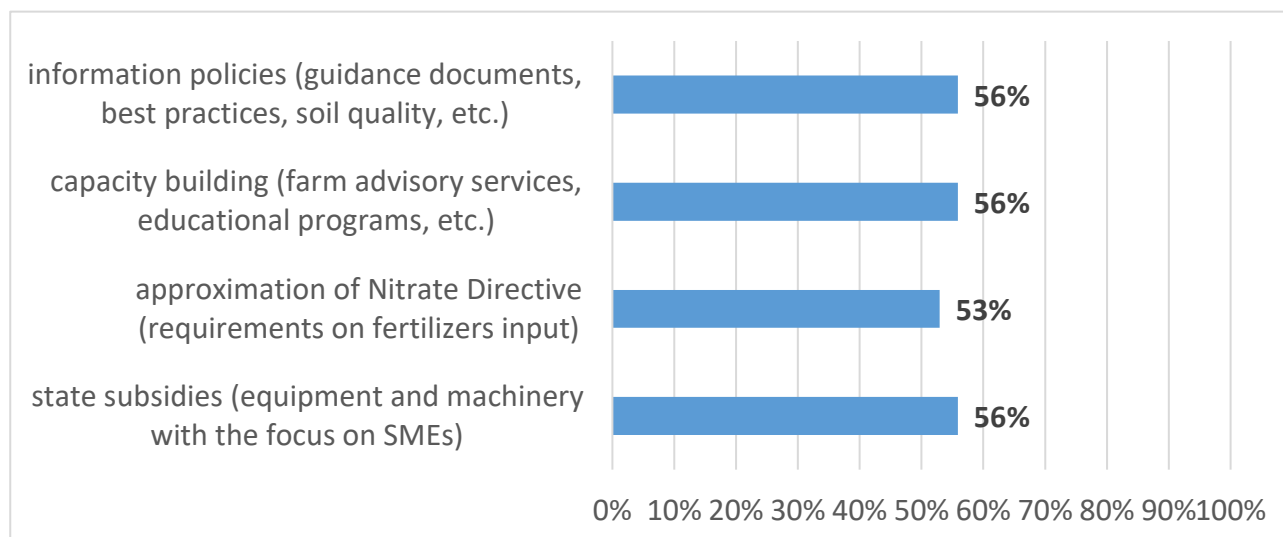
Additional waste management measures, proposed by stakeholders:

1. The introduction of a deposit system for containers (PET and glass bottles).
2. The prohibition of particularly problematic types of packaging (such as plastic bags and ABS kits).
3. Carrying seminars to demonstrate EU's best practices to stakeholders.
4. The organization of a pilot site for research about the generation and migration of landfill gas (Estonian experience).
5. The promotion of anaerobic composting technology. Putting it on a commercial basis.
6. The introduction of economic incentives for the implementation of public-private partnership projects in the field of waste management.

Annex IV. Results of a stakeholder survey on support mechanisms for climate technologies in Agriculture sector

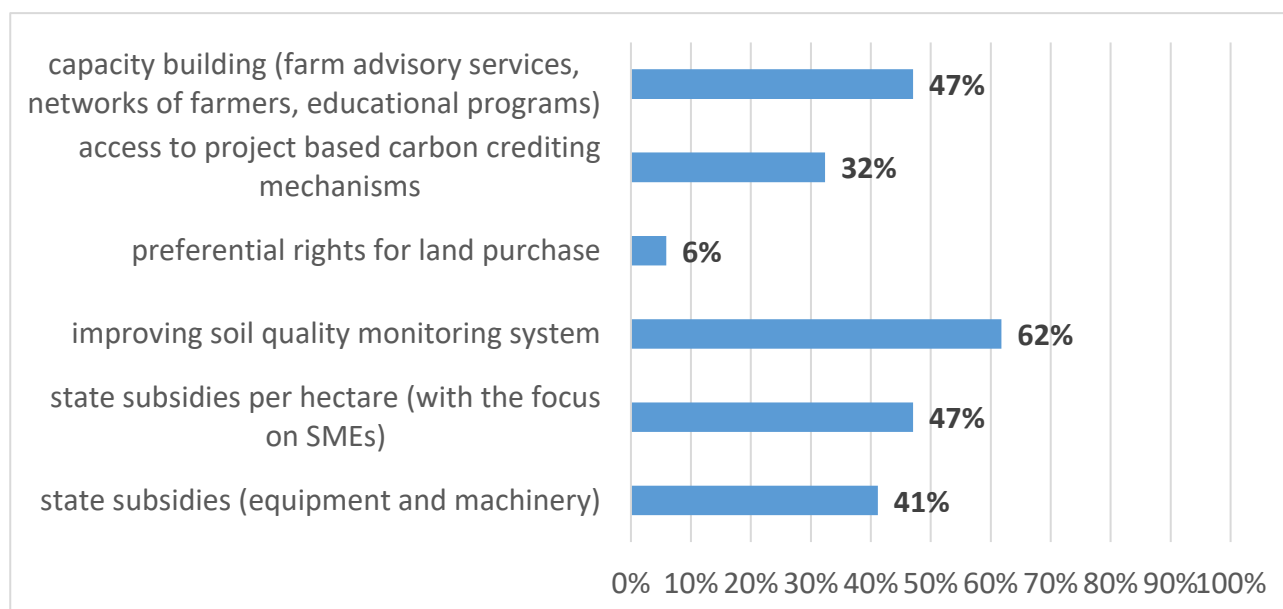
34 respondents from business organizations, state authorities, scientific institutions and NGOs participated in the online survey. Responses are summarized below.

Question 1. What measures would be most effective to support the dissemination of the technology “The use of information and telecommunication technologies for GHG emission reductions in agriculture”?



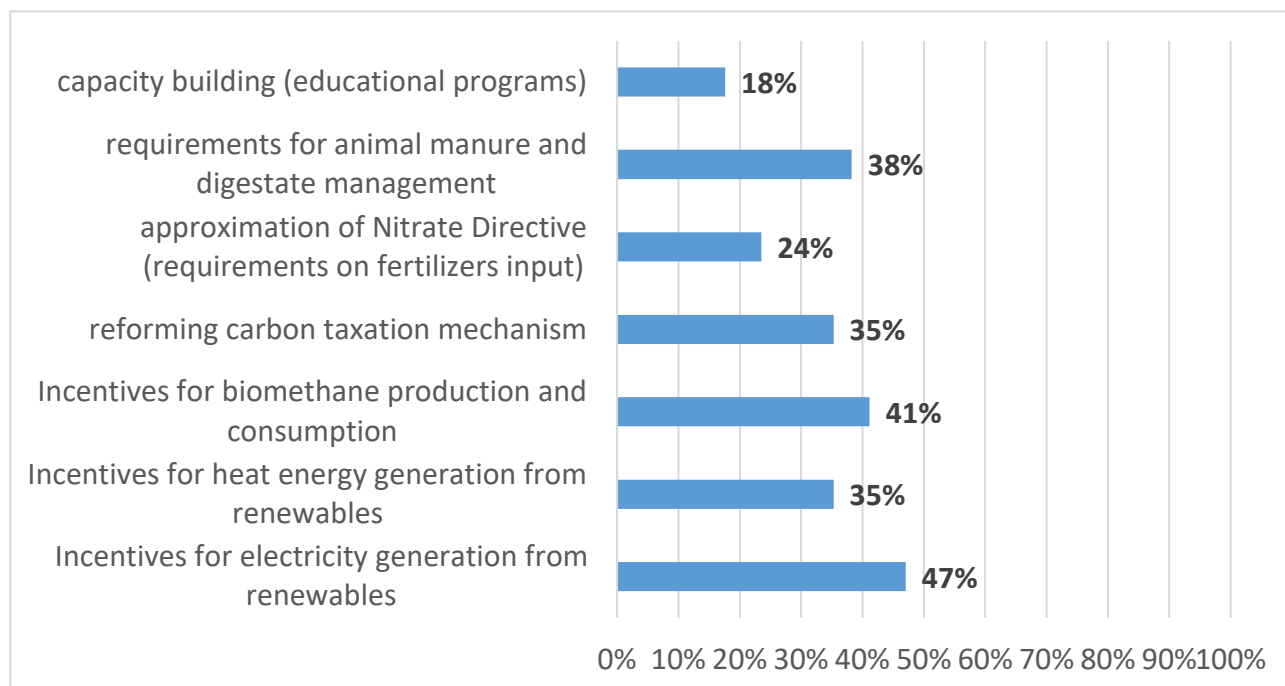
All suggested measures were supported by the majority of stakeholders participated in the survey.

Question 2. What measures would be the most effective to support the dissemination of conservation tillage technologies?



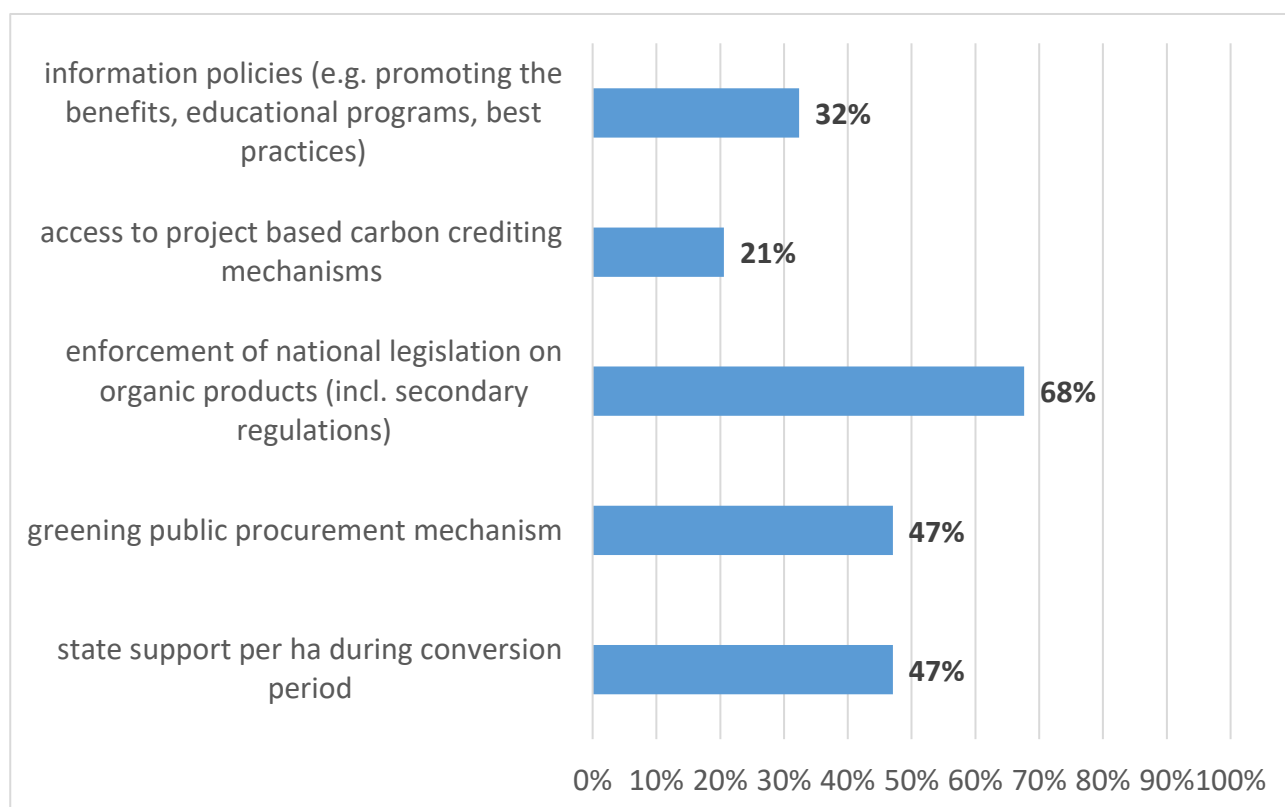
The highest level of support was provided to the improving soil quality monitoring system, while the majority of other proposed measures also received support (32%-47% of stakeholders). Only preferential rights for land purchase received limited support from stakeholders.

Question 3. What measures would be the most effective to support the dissemination of the technology “Biogas production from animal waste”?



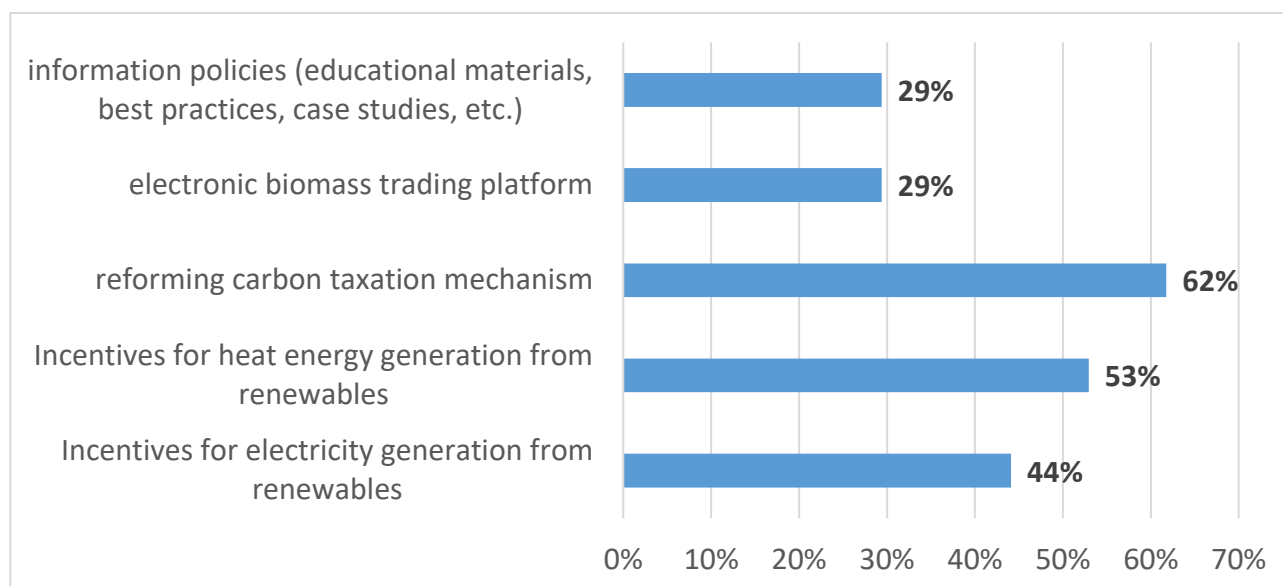
Most of the measures proposed received medium levels of support from consulted stakeholders.

Question 4. What measures would be the most effective to support the dissemination of the technology “Organic agriculture”?



The enforcement of national legislation on organic products, including all required secondary regulations, received the highest level of support from stakeholders. Most of other measures proposed received medium levels of support from consulted stakeholders.

Question 5. What measures would be the most effective to support the dissemination of the technology “The production and use of solid biofuels from agricultural residues”?



Reforming carbon taxation mechanism (e.g. exclusion of biomass from the tax base and increasing the tax rate for fossil fuels) and effective incentives for heat energy generation from renewable received the highest level of support. Other proposed measures also received medium level of support from the consulted stakeholders.

Additional measures and comments suggested by stakeholders:

- Focus on improving soil quality monitoring system to ensure their productivity and provision of ecosystem services;
- More broader involvement of stakeholders in the process of promoting climate mitigation technologies, including the involvement of scientific institutions, Ministry of Health, and general public;
- Developing support measures targeted at cooperatives, smallholders, and SMEs, including sectors providing services to agricultural enterprises (e.g. logistic, storage, etc.);
- The provision of support for organic farmers during all period of operation and without restrictions related to the conversion period;
- More detailed investigation of conditions suitable for the proposed climate technologies (soils, crops, climate, etc.) taking into account the impact on productivity and development of decision support tools with maps and other information for farmers (e.g. no till technology is feasible to be applied only for certain crops and under certain soil characteristics).

Annex V. Time tables for TAP implementation in Waste Sector

Table V.1. – Technology W1: Methane capture at landfills and waste dumps for energy production

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
1. The creation of necessary infrastructure	1.1. The creation of MSW disposal sites inventory												
	1.2. The development and adoption of list of MSW disposal sites with priorities for LFG systems implementation												
	1.3. The development of LFG (LFG-to-E) projects												
2. The creation of economic and financial conditions for regional landfill construction and old waste dumps closure	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission												
	2.2 The creation of economic and financial condition for the use of LFG not only for electricity, but also for heat and biomethane prod.												
3. The provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and int. agencies)												
	3.2 Training in development of proposal for funding												
	3.3 The preparation of funding proposals to be submitted												
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations												
	4.2 Exchange information and lessons learned (info campaigns, workshops and conferences)												

Table V.2. – Technology W2: Sorting

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. The creation of necessary infrastructure	1.1. The division of oblasts into “coverage areas” / clusters and their approval within the framework of regional waste management plans										
	1.2. The establishment of an interdepartmental coordination council for research about the reuse of natural resources and processing (recycling).										
	1.3. The creation of waste management registers and adoption of the decree of their maintenance										
2. Enabling framework for creation of market conditions	2.1. The development of national waste classifier based on EU legislation										
	2.2. The introduction of economic incentives for the introduction of environmentally friendly production technologies and expansion of processing (recycling)										
	2.3. Development and submission to the CMU draft act about the procedure for calculating the actual targets for MSW processing and recovery										
3. Raising motivation of population to ensure efficient	3.1. The development and dissemination of information materials dedicated to waste management issues and sustainable consumption										
	3.2. Organizing of conferences and workshops dedicated to waste management issues										
	3.3. The promotion of MSW separate collection practice in the media										

Table V.3. – Technology W3. The closure of old waste dumps with methane destruction

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2035	2040
1. The creation of necessary infrastructure	1.1. The creation of MSW disposal sites inventory												
	1.2. The development and adoption of list of MSW disposal sites, which operation has to be stopped												
	1.3. The development of projects for MSW disposal sites closures, which do not meet the established operational requirements												
2. The introduction of disposal face-out motivating financial mechanisms	2.1. The introduction of disposal face-out stimulating tariffs for waste disposal												
	2.2. The introduction of landfill operators' responsibility for MSW disposal for environmental damage and commitments to finance the restoration of environmental components that have been adversely affected by landfills												

Table V.4. – Technology W4: Aerobic biological treatment (composting) of food and green residuals

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans on the basis of cluster structure										
	1.2. The establishment of coordination council for research about waste reuse and processing (recycling).										
	1.3. The creation of waste management registers and adoption of the decree of their maintenance										
	1.4 The support of the development of inter-municipal cooperation										
2. The creation of economic and financial conditions for source separation and home and industry composting	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission										
	2.2 The creation of technical and economic condition for the use of compost as fertilizer and soil improver										
3. Provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)										
	3.2 Training in the development of proposal for funding										
	3.3 The preparation of funding proposals to be submitted										
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations										
	4.2 Exchange information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)										

Table V.5. – Technology W5: The Mechanical-biological treatment of waste with biogas and energy production (the anaerobic digestion of organic fraction of MSW)

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans on the basis of cluster structure										
	1.2. The establishment of coordination council for research on waste reuse and processing										
	1.3. Creation of waste management registers and adoption of the decree of their maintenance										
	1.4 The support of the development of inter-municipal cooperation										
2. Creation of economic and financial conditions for MBT with biogas and energy production (incl. electricity, heat and biomethane)	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission										
	2.2 The Creation of other technical and economic condition for MBT with biogas and energy production										
3. Provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)										
	3.2 Training in development of proposal for funding										
	3.3 The preparation of funding proposals to be submitted										
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders based on governed or non-government organizations										
	4.2 The exchange of information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)										

Table V.6. – Technology W6: Mechanical-biological treatment of waste with alternative fuel (SRF) production for cement industry

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. The creation of necessary infrastructure	1.1. The development of regional waste management plans based on cluster structure										
	1.2. The establishment of coordination council for research on waste reuse and processing										
	1.3. The creation of waste management registers and adoption of the decree of their maintenance										
	1.4 The support of the development of inter-municipal cooperation										
2. The creation of economic and financial conditions for MBT with alternative fuel production	2.1 The introduction of high gate fee/tax for waste disposal and CO2 emission										
	2.2 The Creation of other technical and economic condition for MBT with alternative fuel production										
3. The provision of long-term and low-interest loans or grants through state funds, private sources and international funds	3.1 Explore sources of funding (national and international agencies)										
	3.2 Training in development of proposal for funding										
	3.3 Preparation of funding proposals to be submitted										
4. The creation of the stakeholder and technical expert networks for technology development and transfer	4.1 The creation of the platform for national technical experts and stakeholders on the basis of government or non-government organizations										
	4.2 Exchange information and lessons learned (info campaigns for population, workshops and conferences for experts and other interested parties)										

Annex VI. Time tables for TAP implementation in Agriculture Sector

Table VI.1. – Technology A1: “The use of information and telecommunication technologies for GHG emission reductions in agriculture”

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. State subsidies	1.1 The amendment of paragraph 3 of the Order of the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with inclusion of ICT in the list of activities supported.										
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of ICT in agriculture (Order for the Provision of State Support for ICT in agriculture) with annual adjustment of the procedure										
	1.3 Gradual increase in the financing volume for the support of ICT in agriculture in the state program of agricultural support										
2. Regulatory Framework on Nutrients Management	2.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers.										
	2.2 The approval of the Code of Good Agricultural Practices										
	2.3 Setting up and implementation of a programme for promoting the application of the code of good agricultural practice, including the provision of training and information for farmers										
3. Capacity building policies.	3.1 The inclusion and promotion of climate technologies in agriculture in the activities of farm advisory services (including ICT in agriculture), involvement of private advisory service providers, and capacity building activities for the experts of farm advisory services in line with the Law of Ukraine On Agricultural Farm Advisory Services										
	3.2 Developing educational program for universities and vocational schools about climate technologies in agriculture (including ICT in agriculture)										
4. Information policies	4.1 The dissemination of information on nitrogen management and ICT in agriculture for reducing the emissions of greenhouse gases										
	4.2 Improving soil monitoring and provision of reliable soil quality data										

Table VI.2. – Technology A2 “Conservation tillage technologies (low-till, no-till, strip-till, etc.)”

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. State subsidies	1.1 The amendment of paragraph 3 of the Order for the Use of Funds Dedicated in the State Budget for Financial Support of Agricultural Producers (approved by the Decree of the Cabinet of Ministers of Ukraine #77 dated 08.02.2017) with the inclusion of conservative tillage technologies in the list of activities supported.										
	1.2 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Conservative Tillage (Order for the Provision of State Support for Conservative Tillage) with annual adjustment of the procedure										
	1.3 Gradual increase in the financing volume for conservative tillage support in the state program of agricultural support										
2. Soil quality monitoring system	2.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.										
	2.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.										
	2.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.										
	2.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by the National Research Foundation of Ukraine										
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions on notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon projects)										
	3.2 Developing guidance on monitoring, reporting and verification of GHGs emission reductions during agricultural activities.										

Table VI.3. – Technology A3 “Biogas production from animal waste”

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. The improvement of incentives for energy generation and consumption using biogas (power, heat energy, transportation).	1.1 The adoption of the Order of the Cabinet of Ministers of Ukraine On the Allocation of Annual Support Quota and the Schedule of Auctions for the Next Year and Indicative Forecasted Support Quotas for the Next Four Years with the inclusion of separate annual quotas for biomass and biogas-based power plants.										
	1.2 The development and introduction of tariff incentive for heat energy generation from renewable energy, incl. biomass and biogas (fixed tariffs or premiums) by amending the Law of Ukraine On Heat Supply										
	1.3 The amendment of the Law of Ukraine On Alternative Fuel Types with the introduction of the definition of biomethane (article 1), defining procedures for the access to natural gas grids and issuing certificates of origin										
	1.4. The development and approval of the Decree of the Cabinet of Ministers of Ukraine On Promoting Biomethane Use with the definition of a) quality requirements and quality control procedures for biomethane injection into natural gas grids; b) certification scheme for biomethane; c) financial incentives for certified biomethane.										
2. Reforming carbon taxation mechanisms	2.1. The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.										
	2.2. The adoption of the amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of carbon dioxide tax rates for fossil fuels.										
3. Regulatory framework on nutrients management and	3.1 The adoption of regulations on compulsory action plans for agricultural producers working in vulnerable zones defined using the Methodology for the Identification of Vulnerable Zones, in particular limitations related to the input of mineral and organic fertilizers										

animal manure management	3.2 The approval of the Code of Good Agricultural Practices (with incorporation of animal manure management requirements and organic fertilizers use requirements)										
	3.3 Setting up and implementation of a programme on promoting the application of the code of good agricultural practice, including the provision of training and information for farmers										
	3.4 The amendment of the Law of Ukraine On Animal By-products not Intended for Human Consumption and adoption of related secondary regulations (e.g. Orders of the Ministry of Agricultural Policy of Ukraine) taking into account the provisions of EU Fertilizing Products Regulation EU2019/1009, EU Regulation (EC) No 1069/2009 and Regulation (EU) No 142/2011 with the aim of a) introduction of the definition of digestate and categorization of digestate as animal by-product, b) requirements for animal manure and digestate storage and application (time before land application, storage systems, management practices, quality restrictions and quality control requirements); c) requirements for organic fertilizers (heavy metals and pathogens maximum limits, minimum requirements for primary nutrients and organic carbon content); and d) requirements for collection, transportation, processing, packing, labelling and use of animal by-products and relevant processing facilities, including biogas plants.										
	3.5 Changes to the Land Code of Ukraine (article 22) allowing construction of biogas production plants using animal waste on land plots designated for agricultural purposes.										
4. Capacity building	4.1 Introducing biogas related educational programs in the curriculum of educational institutions										
	4.2 Support the creation of demonstration programs and learning centers for biogas technology and animal manure management										
	4.3 The dissemination of information on the benefits and the best practices of biogas production from animal manure										

Table VI.4. – Technology A4 “Organic Agriculture”

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. State subsidies	1.1 The adoption of the Order of the Cabinet of Ministries of Ukraine On the Procedure of the Use of Funds Dedicated in the State Budget for the State Support of Agricultural Organic Goods Producers (Order for the Provision of State Support for Organic Agriculture) with annual adjustment of the procedure										
	1.2 Gradual increase in the financing volume for organic agriculture support in the state program of agricultural support										
2. Green procurement schemes	2.1 Developing guidance document for procurement specialists, central procurement organization and Prozorro Marketplace for the application of non-price criteria in public procurement of food products (state classification code 15890000-3) and catering services										
	2.2 Market analysis study with market engagement activities and the focus on potential matches between organic product supply and food products demand in public procurement schemes										
	2.3 Capacity building activities among procurement specialists on the development of tendering documentation using non-price criteria for food products and catering services and support the execution of pilot tenders										
	2.4 The development of a special module on organic products procurement for the electronic education course on green public procurement for Prozorro Infobox										
	2.5 To develop and approve the action plan for green public procurement and include the support of organic products procurement										
3. Supporting the development of project-based carbon crediting mechanism	3.1 The approval of the Decree of the Cabinet of Ministers of Ukraine on voluntary carbon emission reduction projects (with the provisions for the notification of designated national authority and procedure for receiving feedback, possibility to permanently cancel national carbon units in lieu of voluntary carbon projects)										

	3.2 Developing guidance for monitoring, reporting and verification of GHGs emission reductions during agricultural activities.										
4. Information policies	4.1 Awareness raising campaign about environmental, climate and health benefits of organic products										
	4.2 Information campaign about the best practices in organic farming, organic products manufacturers, and successful organic products procurement case studies										
	4.3 The support of scientific and research projects related to organic farming										
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.										
	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with the in the National Action Plan to Combat Land Degradation and Drought.										
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.										
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by National Research Foundation of Ukraine										

Table VI.5. – Technology A5 “The production and use of solid biofuels from agricultural residues”

Actions	Activities	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. Establishing biomass trading platform	1.1 Approving the Law of Ukraine On the Development of Solid Biofuel Market with the introduction of electronic biomass trading platform										
	1.2 Approving the rules of conducting electronic trading of biofuels (incl. selection of operator, eligibility conditions, reporting requirements, etc.)										
	1.3 Approving requirements for the quality of biofuel traded at the platform and quality control procedures										
2. The adoption of air emission requirements for small and medium size energy installation using biomass	2.1 Approve regulation with established maximum allowed air emission limits for the installation with different capacity.										
3. The development of renewable heat energy incentive mechanism for district heating systems	3.1 Adopt changes to the Law of Ukraine On Heat Supply with the introduction of renewable heat energy incentive mechanism for district heating systems defining the level and duration of support.										
	3.2 Define eligibility requirements for the subsidy scheme, including types of technologies, efficiency, air quality control and reporting.										
4. Reforming carbon taxation mechanisms	4.1 The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 242) with the exclusion of biomass, biogas and biomethane from the tax base of the carbon tax.										
	4.2. The adoption of amendments for the Tax Code of Ukraine (section 8 Environmental Taxes, article 243) foreseeing gradual increase of carbon dioxide tax rates for fossil fuels.										
5. Soil quality monitoring system	5.1 The approval of soil quality monitoring standards with synchronization of approaches and methods for soil sampling and soil analysis.										
	5.2 The development and approval of the Law of Ukraine On Soil Protection and Preservation of Fertility in line with										

	the in the National Action Plan to Combat Land Degradation and Drought.										
	5.3 The development of national soil quality database, including national soil organic content map, on the basis of soil quality studies and approved data sharing arrangements.										
	5.4 The incorporation of soil quality studies in the concept of state scientific and technical program in the area of climate change and projects supported by the National Research Foundation of Ukraine										
6. Information policies to promote crop residues use for energy purposes	6.1 The development and dissemination of guidance document describing the supply chain of crop residues (equipment, practices, cost, etc.) and management options (combustion, biochar production and use, pelleting, etc.).										
	6.2 The development and dissemination of guidance document describing environmental mitigation measures for biomass to energy projects (fuel quality control, optimization of combustion process, air quality control systems, monitoring, etc.), emission monitoring and reporting										
	6.3 Support scientific studies for the identification of sustainable removal rates for different regions, crops management systems and soil quality; impact of biochar application on soil and yields.										