ROADMAP CLIMATE GOALS FOR UKRAINE 2030

A PROPOSAL FROM THE UKRAINIAN CIVIL SOCIETY

Kyiv, 2020

ORGANIZATIONS THAT SUPPORT THE IMPLEMENTATION OF THE ROADMAP

Ecoaction, Clean Energy Lab, OPORA, Kharkiv Zero Waste (Center for Public and Media Initiatives), Ukrainian Nature Conservation Group, Center for Public Communications, CSO «Association of Small Cities of Ukraine», CSO «Plato», Network Of Ukrainian Sorting Initiatives, #ECODIIT Professional Community, Ukrainian Climate Network.


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CONTENT

LIST OF ABBREVIATIONS

CMU – Cabinet of Ministers of Ukraine

Condominium – an association of co-owners of apartment buildings

CoP – coefficient of performance

COP – Conference of the Parties, United Nations Climate Change Conference

DSO – distribution system operator

EBRD – European Bank for Reconstruction and Development

ENTSO-e – European Network of Transmission System Operators for Electricity

ESCO – energy service company

EU – European Union

FAO – Food and Agriculture Organization of the United Nations

FEC – final energy consumption

GDP – gross domestic product

GFEC – gross final energy consumption

GHG – greenhouse gases

GPP – geothermal power plant

HPP – hydropower plant

HW – household waste

IPCC – Intergovernmental Panel on Climate Change

IRENA – International Renewable Energy Agency

KhNPP – Khmelnitsky Nuclear Power Plant

LDN – Land Degradation Neutrality

LULUCF – Land use, land-use change, and forestry

MSW – municipal solid waste

NAASU – National Academy of Agrarian Sciences of Ukraine

NDC – Nationally determined contribution

NPEC – National Plan for Energy and Climate

NPP – nuclear power plant

NEURCU – National Energy and Utilities Regulatory Commission, Ukraine

OECD, OECP – Organisation for Economic Co-operation and Development

PPP – purchasing power parities

PSP – Pumped-storage plant

PWR – Pressurized water reactor

r. f. – Reference fuel

RES – renewable energy sources

RWMP – Regional Waste Management Plans

SIDA – Swedish International Development Cooperation Agency

SNF – Spent nuclear fuel

SPP – solar power plant

SSU – State standard of Ukraine

Toe – tonne of oil equivalent

TP – thermal plant

TPP – thermal power plant

UN – United Nations

UNCCD – UN Convention To Combat Desertification

UNFCCC – United Nations Framework Convention on Climate Change

VAT – value added tax

INTRODUCTION

The last decade was the hottest decade throughout the period of instrumental meteorological monitoring. The territory of Ukraine is no exception. The year 2019 was one of the warmest in recent history, with long-term heat waves over several weeks in June and July, anomalous droughts in Cherkasy region, which covered about 80% of its territory. The frequency of natural meteorological phenomena – heavy rain, wind, snow, fog, hail has increased; the seasons have changed their length. All this testifies to the urgency of tackling climate change. There are a number of factors that contribute to climate change such as emissions from extraction and combustion of fossil fuels, industrial and agricultural activities, low energy efficiency of buildings, lack of waste management, and reduction of carbon uptake by ecosystems.

The report of the Intergovernment al Panel on Climate Change on Global Warming of 1.5 °C, published in 2018, stated that an increase in temperature by even 1.5 °C would lead to irreversible changes in the environment[1]. According to scientists, to limit global warming, carbon dioxide (CO_2) emissions from human activities need to be reduced by 45–60% by 2030 compared to 2010. Furthermore, by 2050, a zero balance must be reached, in thatall anthropogenic CO_2 emissions are absorbed from the atmosphere.

Ukraine and approximately 200 other countries of the world have ratified the Paris Agreement, aimed to maintain a global temperature rise this century well below 2 °C and to pursue efforts to limit the temperature increase even further to 1.5 °C. In order to join the agreement, countries had to declare their plans to reduce their greenhouse gas emissions in Nationally Determined Contributions. Despite pledging support, Ukraine has made a very unambitious contribution that predicted a 40% increase in greenhouse gas emissions by 2030, compared to the current level. It was rated as “critically unsatisfactory” by international experts. If the NDCs approved by the countries at this point are implemented, it is likely that it will lead to an increase in the average temperature of the planet by 3–4 °C in the second half of the 21st century.

At the 24th Climate Conference in 2018, the Minister of Environment and Natural Resources of Ukraine announced the beginning of the development of a new NDP, which would take place in 2019–2020. In 2019, the Ministry announced the revision of the Energy Strategy 2035 and the beginning of elaboration of the National Plan for Energy and Climate for 2021–2030. The coordination of all these processes will help to avoid the creation of multiple, uncoordinated strategies and plans. It is equally important to prepare and submit an NDC to the Secretariat of the United Nations Framework Convention on Climate Change nine months before the 26th Climate Conference (scheduled for March 2020) so that the experts can investigate its potential.

In preparation for the 26th Climate Conference, the Ukrainian government is in the process of reviewing and developing its climate policy vision. To exert imperative pressure on the government that an appropriate, ambitious NDC needs to be developed, CSOs and independent experts in different fields have come together to propose goals that will help to reduce greenhouse gas emissions in all sectors.

The 2030 Climate Goal Roadmap includes quantitative targets for five sectors: energy, buildings, transport, waste and one subdivides sector, which includes agriculture, forestry and land use. Achieving these goals will help to reduce greenhouse gas emissions in each of these respective sectors. The goals have been developed on the basis of an analysis of the legal framework, international examples and best practice, and the experience of the public and experts, within these sectors.

We highly recommend that the government integrates this document into the national sectoral plans and strategies when developing and reviewing them. This will allow to develop an ambitious climate policy and involve the public, whose participation should be an integral part of drafting national documents.

[1] IPCC. “Global Warming of 1.5 ºC” https://www.ipcc.ch/sr15/

PRODUCTION AND CONSUMPTION OF ENERGY

Legislative framework, regulatory and institutional conditions that are to be implemented to achieve energy sector goals

In the framework of the European integration process, Ukraine has to adapt its national legislation to the EU directives. In June 2019, Ukraine updated an Annex 27 to the EU-Ukraine Association Agreement – On Energy. However, most of the directives mentioned in the updated document are part of the outdated EU Third Energy Package. The implementation of these norms is extremely important for the further sustainable development of the energy sector in Ukraine as they form the basis for liberalized open energy markets. However, the old grid systems are already facing new technological and socio-economic challenges. In order for the Ukrainian energy sector to keep up with the global development trends, it is of paramount importance to plan the implementation of the future stages.

Implementation of the provisions of the so-called Fourth Energy Package of EU Directives «Clean energy for all Europeans». In 2018–2019, the European Union approved a new set of directives aimed at updating policies and targets on climate and energy, energy markets and their regulation. This package of directives is titled «Clean energy for all Europeans».

As Ukraine continues to implement the norms of the previous, Third Energy Package, speculation about updating the legislation to meet the reality and be prepared for the challenges of today is necessary. The following are the main elements related to production and consumption of energy; they must be reflected in legislative documents as they are crucial for the sustainable development of the sector in the future.

Integration of RES on a market basis (Directive 2018/2001). It is the green generation that is capable of replacing traditional coal and nuclear power, creating competition for them and reducing the cost of electricity in the long run. However, the current model of support of RES in Ukraine foresees that all "green" electricity is to be bought by a state-owned enterprise, which does not allow for a positive systemic effect of increasing the proportion of RES. The price of energy from coal and nuclear generation is distorted in the Ukrainian market, which removes fair competition between energy sources. Currently, renewables demand state support for development and government-guaranteed purchase of electricity. In order to develop, renewables require support from the state and government-guaranteed purchase of electricity. This model eliminates most of the risks for the RES operators without encouraging them to integrate better into the system. Direct participation in the markets will stimulate green generation to improve the quality of production forecasting, increase the level of competition not only between traditional and renewable generation, but also between RES technologies. Support costs should also be tied to market prices in such a way as to encourage station operators and/or generating capacity owners to adapt to market signals on their own. Direct market participation will also stimulate the balanced development of related segments and technologies that provide flexibility for power systems.

While the support for the large-scale RES objects is to be determined via auctions, the issue of supporting small-scale generation capacities remains unresolved. The system of the feed-in tariff that remains available for small stations will no longer be attractive in the coming years – primarily because the validity period ends in 2030. In the current version of the law[2], the auctions to determine the amount of support to RES are focused

[2] Law of Ukraine "On Amendments to Certain Laws of Ukraine to Ensure Competitive Conditions for the Generation of Electricity from Alternative Energy Sources" https://zakon.rada.gov.ua/laws/show/2712–19

on large scale projects therefore it will be difficult for small stations to compete with larger projects. Therefore, in order to ensure further rapid development and involvement of all market participants in the use of distributed energy resources, Ukraine needs to adopt a new law that will radically change the approach to the development of small generation, distributed energy resources and demand management and allow their seamless integration into the energy markets. In addition, to further develop a support system, the small RES stations must also be integrated into the auction system. This may be implemented by introducing individual quotas and auctions for small stations with a maximum project size limit.

For the development of the energy market, it is important to enable more players to be integrated and to reduce entry barriers, as stipulated in EU Regulations 2019/943 (internal electricity markets), 2019/942 (state regulation of energy) and Directive 2019/944/EU. The latter requires initiatives that grant equal competition rights in the market and to determines the status of prosumers[3], energy cooperatives, energy communities, aggregators, virtual power plants, energy storage systems.

The flexibility of energy systems must become the backbone of development and regulation. In order to increase the share of RES in the network it is necessary to take a fundamentally new approach to its operation. The central concept of «base load» is a fragment of the past and should no longer be implemented. The rapid reduction in the cost of solar and wind-based generation technologies displays traditional generation, and poses new challenges for grid management and power system dispatching control.

Flexibility of energy systems can be achieved both from the generation side (for example, through the temporary use of upgraded gas turbines or gas piston stations or hydropower plants) and from the energy storage technologies. The rapid development of the latter requires a fundamentally new approach to integrating them into the grid, which should be envisaged by appropriate regulatory acts. However, the construction of a new peak load station or storage systems is not always the most optimal variant in terms of cost per unit of energy produced, although the cost of these technologies is drastically decreasing[4]. It is crucial to incorporate the consumers into the market through the provision of demand-side regulation services and this should become an integral part of the modern energy systems' arsenal of flexibility.

HISTORICAL TRENDS IN AVERAGE COST OF ELECTRICITY

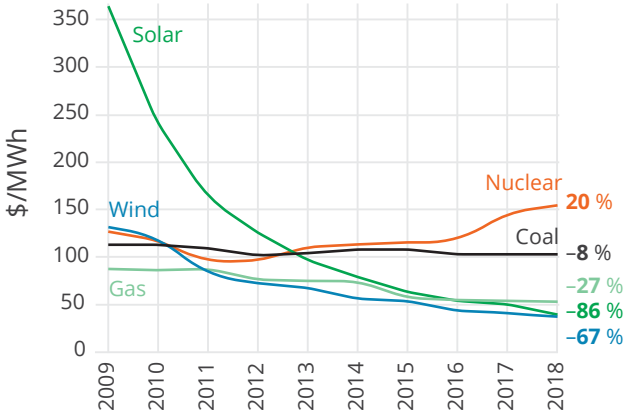


Figure 1. Historical trends in average cost of electricity (Lazard, 2018).

Grid flexibility can also be achieved through the development of infrastructure, that is, the network itself. The Regulator (NEURCU) should implement digitization of network control systems and improve the metering systems for all consumer groups (households and non-domestic customers). The regulator should also to introduce the up to date real-time dispatching system as part of 5-year development plans of distribution system operators and as part of 10-years plans of the transmission system operators.

In addition, the development of distributed electricity generation requires a fundamentally new approach to the work of the distribution system operators. This should be foreseen in the Transmission System Development Plan for 2020–2029: the transmission system must meet the needs of the electricity market and ensure the security of electricity supply. In order to upgrade outdated distribution networks in Ukraine, investment-based pricing for electricity must be stimulated. However, it is important to plan the next phase

[3] A prosumer is a person who consumes and produces a product (i.e. electricity).

[4] Lazard, 2018. Levelized cost of energy analysis – version 12.0: https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

when pricing for distribution system operators will be based on qualitative, not just quantitative, performance. Those indicators should be included in 5-year development plans.

The integration of the Ukrainian grid into the European ENTSO-E is and should remain a priority. Working side-by-side with the European energy system will not only stimulate the competition due to the increased energy export-import opportunities, it will also increase the flexibility of the Ukrainian grid thus, contributing to its stability.

A new approach to integrated strategy that would combine energy and climate goals (Directive 2018/1999 / EC). Elaboration of the Energy Strategy of Ukraine 2035 was the first stage in this process. However, the goals stated in the document are formulated on the basis of expert opinions only, without complex modeling involved. The document needs to be revised in order to integrate environmental and climate goals. The new strategy should be based on the principles of the Energy Union, cross-sectoral modeling, have more ambitious goals in all sectors, and cover the timeline until 2050. The new Strategy should also pay greater attention to energy security and recognize the important role of renewable energy and emerging technologies in achieving Ukraine's energy independence.

Ultimate withdrawal of subsidies for fossil fuel based energy production and consumption, which distort markets and impede their development. This applies to both regulated «social» tariffs for energy and energy sources, and the various forms of subsidies provided to the coal industry of Ukraine. According to the OECD (2018)[5], in 2014, the energy subsidies reached UAH 202.8 billion (USD17 billion). In the future, the amount of state support will decline due to cancelling certain forms of subsidies and reform of the energy sector. It is important to completely cease the support for fossil fuels and non-market approaches to setting tariffs for the households in order to accelerate Ukraine's transition to renewable energy. In addition, the internalisation of all costs (i.e. taxation that is sufficient to offset the environmental and human health impacts) in the cost of energy will reflect the true cost of energy from fossil fuels. This in turn, will highlight the cost effectiveness of the existing RES technologies, reduce the costs of supporting clean energy development and accelerate the energy transition.

At the moment, the share of energy from renewable sources in Ukraine is mainly increasing due to large generation. The gradual withdrawal of cross-subsidies for certain consumer groups will also stimulate the rapid introduction of state-of-the-art distributed generation technologies by households and small businesses. This will accelerate the energy transition, stimulating households to consume their own «green» energy, which will also attract many more players to increase the proportion of RES.

Updating the greenhouse gas taxation system and monitoring system. At the end of 2019, Verkhovna Rada of Ukraine adopted the law «On the Basics of Monitoring, Reporting and Verification of Greenhouse Gas Emissions». The law provides for development and adoption of a single mandatory emission monitoring methodology that will give rise to representative data on emissions from installations. The law will also strengthen the control over the calculation of reported emissions and the verification of the data, from which CO2 tax is calculated. Its implementation will be one of the first integral steps in establishing a unified system and further stimulating emission reductions from installations.

Revision the tax on emissions of greenhouse gases. At present, Ukraine has the lowest emission tax in the world, which is 10 UAH per one ton, which is 2.5 times lower than in Poland and 315 times lower than in Denmark. The High-Level Commission on Carbon Prices recommended to set the emission price at USD40–80 per 1 ton by 2020 and USD50–100 per one ton by 2030. This recommendation aimed at reaching the Paris Agreement goal of maintaining a global temperature rise this century well below 2 °C and to pursue efforts to limit the temperature increase even further to 1.5 °C.

[5] OECD, 2018. Inventory of Energy Subsidies in the EU's Eastern Partnership Countries: https://www.oecd.org/environment/outreach/Energy%20subsidies%20in%20EaP%20PH_ENG%20web-1.pdf

GOAL 1 Increase the proportion of renewable energy sources in the energy balance of Ukraine

	Baseline	Target for 2030
Electricity	8,6%	58%
Heating and cooling	7,6%	24%
Final energy supply	6,6%	30%

Units: The proportion of RES in final energy supply, as well as in total annual electricity and heat production.

Baseline: 8.6% – the proportion of RES in electricity, 7.6% – in heating and cooling and 6.6% – in final energy supply[6] (2017).

Target for 2030[7]: The proportion of renewable energy is increased: up to 58% in electricity, up to 24% in heat, up to 30% in final energy use compared to 2012.

RATIONALE

Use of renewable energy instead of fossil fuels is critical for preventing the worst effects of climate change. Supported by the Heinrich Boell Foundation Regional Office in Ukraine, the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine published the «Transition of Ukraine to Renewable Energy by 2050». This study outlines the precursors for Ukraine's energy transition to renewable energy by 2050, namely, the development and cost reduction of modern energy efficient technologies and renewable energy and the significant potential of renewable energy sources in Ukraine.

According to the revolutionary scenario described in the study, the proportion of renewables in the structure of final energy consumption may reach 91% in 2050. Simultaneously,, this scenario envisages a 42% reduction in energy consumption in 2050 compared to the conservative (baseline)8 scenario of 2012. The corresponding intermediate targets for 2030 are approximately 30%, 58% and 24% RES proportion in final energy consumption, electricity and heat generation, respectively.. As outlined in the revolutionary scenario, the target structure for electricity production in 2030,, as 58% for RES, 15% for NPP, 22% using gas thermal power plants, thermal power plants (upgraded) and new peak load gas-piston power stations (combined) and 5% used by coal thermal power plants. This scenario assumes a moderate annual increase in electricity consumption of 2.5% on average over the period 2020–2030 and a total annual production of 214 GWh in 20309.

In accordance with the Energy Strategy of Ukraine, an introduction of mechanisms for attracting investments for the implementation of the capacity replacement program is vital. These mechanisms need to be decommissioned (primarily coal-fired TPPs and NPPs) with the new energy infrastructure.

[6] Report on the results of stimulation and use of energy produced from renewable sources in Ukraine for the period 2016–2017: https://saee.gov.ua/sites/default/files/2016–2017.pdf

[7] The lower boundary of the targets corresponds to the results of the revolutionary scenario 2030 of the research of Heinrich Boell Foundation (Dyachuk et al., 2017). The upper boundary of the targets is calculated on the basis of the revolutionary scenario with conditionalities such as coal phase-out or cancelling of the construction of new coal thermal power plants.

[8] In the study "Transition of Ukraine to Renewable Energy by 2050" (Dyachuk et al., 2017) the baseline (conservative) scenario is a hypothetical scenario in which the characteristics of most technologies remain the same until 2050, that is, as they were in 2012.

[9] "Transition of Ukraine to Renewable Energy by 2050" (Dyachuk et al., 2017) p. 81, table. D.6.3.11 "Electricity generation under the revolutionary scenario", figures consistent with the revolutionary study scenario.

A recent study has highlighted that development of new RES capacities is (far) more efficient than traditional strategies., This is primarily due to the fact that true cost of traditional strategies such as XXXX do not account for the the cost of overcoming environmental impacts and harming human health[10].

The LCOE calculator[11] for Ukraine confirms that the average cost of electricity from new RES facilities approaches the cost of electricity from existing thermal power plants and is lower than the cost of electricity from new TPPs and NPPs, taking into account for externalities such as aCO_2 tax, taxation of toxic emissions, recultivation of ash-disposal areas, deductions for radioactive waste management and safe decommissioning. The increase of share of power plants using renewable energy sources reduces the average cost for a functioning market[12]. Thus, the average LCOE for onshore wind farms with a current CO_2 tax and a price of capital of 10% will be lower than for nuclear plants; and the solar power plants will, in similar terms, have a lower or equal cost compared to coal-fired power plants. In addition, in Ukraine, the CO_2 emission tax is only 10 UAH/t[13], although in other countries this figure can reach up to 124 EUR/t[14]. Increasing the carbon dioxide tax will further increase the competitiveness of green energy and reduce its cost compared to traditional electricity generation, which will increase proportionately.

According to a study by Carbon Tracker (2018)[15], the cost of energy from new coal plants will be higher than the cost of energy from renewable sources as early as 2020, even without externalities. Given this data, and assuming that energy demand can be met by increasing generation capacity from renewable sources instead of building new coal and nuclear power plants, the RES index in final energy consumption by 2030 has the potential to reach 40.1% and up to 70% in electricity.

With the increasing proportion of renewable energy sources, in particular variable solar and wind capacities, it is crucially important to increase the flexibility of the grid. y Intensifying the cross-border flows (in particular with EU countries), enforcing the demand management measures, and utilising distributed energy sources and energy storage capacities are all plausible means of doing so. According to the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine[16], use of modern systems of accurate forecasting of RES base generation, combined with the modern peak load reduction technologies, will allow Ukraine to meet the electricity demand. This in turn, will reduce the investment costs by Euro 11.5 billion between 2020 and 2050 (due to less construction of power generation facilities) and reduce the total operating cost of the grid by 0.5%.

[10] Ecoaction. Renewable energy for Ukrainians: what policy makers can do: https://ecoaction.org.ua/vde-dlya-ua.html

[11] Levelised cost of electricity calculator https://cel.com.ua/tools/lcoecalculator/

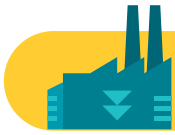
[12] According to IRENA, LCOE Calculator Lecture Presentation, October 2, 2019: https://www.facebook.com/cleanenergylab/videos/2407378709475067

[13] Tax Code of Ukraine

[14] Institute for Climate Economics. Global Carbon Account 2019: https://www.i4ce.org/download/global-carbon-account-2019/

[15] Powering down coal. Navigating the economic and financial risks in the last years of coal power: https://www.carbontracker.org/wp-content/uploads/2018/12/CTI_Powering_Down_Coal_Report_Nov_2018_4–4.pdf

[16] Long-term energy modeling and forecasting in Ukraine: scenarios for the Energy Strategy of Ukraine 2035, Institute of Economics and Forecasting NAS of Ukraine. (Dyachuk et al., 2017)



GOAL 2 Reduction coal generated electricity

Proportion of coal generation in total electricity production

Target for 2030 5%

Baseline 31%

No more than 11 billion kWh, CO_2 emissions from coal-fired power plants reduced to 12–13 million tonnes

Units: Proportion of coal generation in total electricity production,%.

Baseline: Proportion of coal generation in total electricity production – 31% (2018)[17].

Target for 2030: A 5% maximum of coal in annual electricity generation, in absolute terms – no more than 11 billion kWh, CO2 emissions from coal-fired power plants reduced to 12–13 million tonnes[18].

Sub-target 1: Total emissions from coal are reduced by 90% from the 2018 level.

Sub-target 2: Plans for construction of new coal-fired TPPs are abandoned.

Sub-target 3: The date of the final phase out of the coal in the energy sector is set.

RATIONALE

Given the urgency of actions to contain global warming below 1.5–2 °C, in line with the objectives of the Paris Agreement at the international level, a larger number of countries support a moratorium for the construction of new coal-fired power plants, advocating the cessation of use of coal in electricity and mobilizing financial flows for developing RES measures and increasing energy efficiency. As of 2018, the amount of direct emissions from combustion of coal at power plants constituted 57.8 million tons of CO_2 equivalent[19] (excluding coalbed methane in mining, as well as associated CO_2 emissions from concentration and transportation processes).

In Ukraine, the majority of coal-fired TPPs were built in the 1960s. Most of the coal-fired TPPs now operate far beyond their design lifetime and have some of the lowest technical, economic and environmental performance in the world[20]. Furthermore, in 2018, Ukraine had the highest in the world cost of electricity from thermal generation – USD70 per 1 MWh. Even in Europe, with high CO_2 taxes and stringent requirements for fire gas purification systems, the cost of producing 1 MW of electricity is on average less by USD10, according to the "Powering down coal" report by Carbon Tracker[21]. Monopolization, large-scale corruption schemes, the environmental crisis and the energy security crisis are the main features of the current state of coal energy in Ukraine[22].

According to official data of the Ministry of Energy and Coal Industry of Ukraine (today – the Ministry of Energy and Environmental Protection of Ukraine), in 2018, the average consumption of coal by Ukrainian thermal power plants was 399 g/kWh[23], with some of the most worn-out

[17] Statistics of the Ministry of Energy and Coal Industry «Electricity generation by energy companies and power plants of Ukraine for 12 months of 2018: http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245337827&cat_id=245183225

[18] Share of renewable energy sources in electricity generation.

[19] A carbon dioxide equivalent or CO_2 equivalent, abbreviated as CO_2-eq is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

[20] Ukraine's coal power plants need a planned phase out, not CCS https://energypost.eu/ukraines-coal-power-plants-need-planned-phase-ccs/

[21] Powering down coal. Navigating the economic and financial risks in the last years of coal power: https://www.carbontracker.org/wp-content/uploads/2018/12/CTI_Powering_Down_Coal_Report_Nov_2018_4–4.pdf

[22] Towards the end of the coal age in Ukraine?!: https://ua.boell.org/en/2015/11/15/towards-end-coal-age-ukraine

[23] Statistics of the Ministry of Energy and Coal Industry «Electricity generation by energy companies and power plants of Ukraine for 12 months of 2018: http://mpe.kmu.gov.ua/minugol/control/uk/publish/article?art_id=245337827&cat_id=245183225

units used up to 450 g/kWh. Meanwhile, in Europe, coal power plants consume 320–340 g of coal per 1 kWh of electricity. Due to the low efficiency and high specific fuel consumption at Ukrainian TPPs, the specific emissions of greenhouse gas CO^2 per 1 kWh are 20–25% higher than in the EU countries. Coal thermal power generation in 2018 amounted to 47.8 billion kWh, or 31% of total energy from all energy sources.

Given the large gap in the performance and environmental standards of TPPs, Ukraine's integration into the EU electricity market (envisaged by the Association Agreement with the EU and the Energy Community Treaty) may be difficult, and opportunities for unimpeded electricity trade may be restricted. This is due to both fiscal and regulatory constraints imposed by the European Commission r to prevent the carbon leakage effect[24,25].

In June 2017, Ukraine signed an agreement with the Association of ENTSO-e Network Operators on the conditions for the future unification of Ukraine's and Moldova's grid systems with that of Continental Europe. The further implementation of EU-oriented reforms in the electricity sector, including the coal phase out, should ensure the enhancement of Ukraine's energy security and full integration into the European energy market, which has embarked on a complete decarbonisation and rapid reduction of greenhouse gas emissions in line with the Paris climate targets.

Ukraine should follow then example of Great Britain and Germany, the historical industrial leaders of Europe, whose electricity industries are now moving to a new stage of development. Between 2012 and 2018, the proportion of coal power generation in Great Britain fell from 39.3 to 5%, in absolute numbers from 143 to 17 billion kWh[26]. In Germany, in 2018, RES produced more electricity than all thermal and nuclear power capacities. Despite the fact that coal generation remains in second place after RES and produces significant amounts of electricity (207 billion kWh, of which domestically extracted lignite – 131.3 billion kWh, imported coal – 75.7 billion kWh), all German coal thermal power plants will be closed by 2038 at the latest[27]. A number of countries plan to phase out coal much earlier. For example, in Finland, all coal power plants will be closed by 2029, and the use of coal in the energy sector will be completely banned[28].

At the global level, in 2018, the cost of renewable energy has fallen to a level where new RES (notably, wind and solar) beat coal power plants in competition over the price of a kilowatt-hour, even without additional government support. This is stated in the latest report on the cost of renewable energy technologies, published on May 29 2019 by the International Renewable Energy Agency (IRENA)[29]. This has also been confirmed by previously published data by the analytical firms Lazard and Bloomberg New Energy Finance[30,31].

Between 2020 and 2030, the replacement of decommissioned coal power facilities with new RES facilities will allow Ukraine to attract significant investments and lay the foundation for the overall economic revival of the country. Ukraine should take into account the experience of the EU countries in the transformation of the electricity sector and, using these lessons, optimize the operation of the grid in economic and environmental terms, namely, to reduce the cost of electricity production and the specific emissions of CO_2. Thus, over the next ten years, the proportion of coal energy should decline by 2.5–3% per year, with the total coal industry phase out in the 2030s.

[24] Carbon leakage refers to the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laser emission constraints. This could lead to an increase in their total emissions.

[25] European Commission: https://ec.europa.eu/clima/policies/ets/allowances/leakage_en

[26] Carbon Brief. Analysis: UK electricity generation in 2018 falls to lowest level since 1994: https://www.carbonbrief.org/analysis-uk-electricity-generation-2018-falls-to-lowest-since-1994

[27] Fraunhofer ISE. Net Public Electricity Generation in Germany in 2018: https://www.ise.fraunhofer.de/content/dam/ise/en/documents/News/Stromerzeugung_2018_2_en.pdf

[28] Reuters. Finland approves ban on coal for energy use from 2029: https://www.reuters.com/article/finland-energy-coal/finland-approves-ban-on-coal-for-energy-use-from-2029-idUKL5N20N6QV

[29] IRENA. Renewable Power Generation Costs in 2018: https://www.irena.org/publications/2019/May/Renewable-power-generation-costs-in-2018

[30] Lazard. Levelized Cost of Energy and Levelized Cost of Storage 2018: https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/

[31] Bloomberg New Energy Finance blog. Battery Power's Latest Plunge in Costs Threatens Coal, Gas: https://about.bnef.com/blog/battery-powers-latest-plunge-costs-threatens-coal-gas/#_ftn1

Significant reductions in CO_2 emissions from thermal energy can be achieved in the short term by reducing the operating hours of coal-fired units (switching to a seasonal schedule or reserve mood), decommissioning the most worn-out and inefficient units, and replacing coal with gas at more efficient units. Energy security remains equally important for Ukraine at this stage: in 2018, the total volume of coal imports for energy and industry constituted 21.4 million tons, the proportion of Russian coal constituted 70.2%[32].

GOAL 3 Minimize coal extraction

Baseline
69 mines (2018)

Target for 2030
Coal is only produced in mines that provide fuel for the residual/reserve TPPs for the transition period after 2030; all other state and private mines are closed.

Units: Total number of private and public coal mines.

Baseline: 69 (2018)[33].

The number of state coal mines in 2018 is 33 (47% of the total). The number of unprofitable state coal mines in 2018 is 29 (88% of the total)[34]. The total coal production at the state mines in 2018 is 4.14 million tons (12.4% of the total)[35]. The number of employees at state mines in 2018 is 42 thousand (37.8% of the total)[36].

Target for 2030: Coal is only produced in mines that provide fuel for the residual/reserve TPPs for the transition period after 2030; all other state and private mines are closed.

Sub-target 1: The programs of economic diversification of the mining regions, that foresee socially responsible restructuring of the industry, have been approved and implemented.

Sub-target 2: Subsidies for the construction and operation of state-owned mines and any indirect support (such as tax holidays, debt relief for coal mines) have been cancelled from 2020.

Sub-target 3: The date for the ultimate cessation of coal production has been determined by the end of 2021 in Ukraine.

Sub-target 4: In 2020 a priority list of mines for closure according to their profitability has been set; the mines have been decommissioned by 2030.

RATIONALE

The process of the domestic coal industry phase out began three decades ago and is yet to be completed. This slow progress can be attributed to a range of factors, including the socio-economic decline of the mining regions. The industry is currently in a state of complete disintegration, which, in the absence of a strategic state approach to restructuring, poses significant environmental, social and economic threats to the country. In Ukraine, 29 out of 33 state-owned mines are not profitable at all. The domestic coal industry is completely dependent on the annual multi-billion state subsidies from the budget, and control over the use of these funds is, at best, fragmented.

[32] Economichna pravda. How much coal was imported by Ukraine from the Russian Federation in 2018

[33] Summary Report of the Coal Industry Supervision Department's on the State of Occupational Safety at Coal Enterprises for 2017: http://dsp.gov.ua/wp-content/uploads/2018/03/uzahalnenyj-zvit-za-2017-rik.doc

[34] Government portal. Head of Government: At the mines, we should hear the sound of machinery working, not the knock of hard hats because of payroll debts: https://www.kmu.gov.ua/ua/news/glava-uryadu-na-shahtah-maye-buti-shum-virobnictva-ne-stuk-kasok-cherez-borgi-po-zarplati

[35] Ministry of Energy and Coal Industry. Statistics 'Coal Production in Ukraine December 2018': http://mpe.kmu.gov.ua/minugol/control/en/publish/article?art_id=245334620&cat_id=245183238

[36] Ministry of Energy and Coal Industry. Statistics, response to the official inquiry of Center for Environmental Initiatives 'Ecoaction' # 139, June 14, 2018.

In 2013, Ukraine spent more than UAH 15 billion[37] on the restructuring of the coal industry, partial reimbursement for coal producing cost, modernization of mines and other items of state support for the coal sector. Due to the occupation of certain regions of Lugansk and Donetsk regions, expenditures from 2015 have decreased to UAH 2–3 billion annually[38]. The state budget for 2019 plans to support the state coal mines with t UAH 3 billion. This is, UAH 1 billion more public funding than that used to support household energy-efficient measures countrywide.

According to the Ministry of Energy and Coal Industry of Ukraine, since 2004, 68 state-owned mining companies have been liquidated in Ukraine, 19 state-owned mines have begun the process of closure or are in preparation for closure as of 2018[39]. According to information provided by the Ministry of Energy and Coal Industry, the total coal production decreased from 164 million tons in 1990 to 33 million tons in 2018. Between 1991 and 2013, the number of employees involved in the industry decreased by almost 90%. In 2013, there were approximately 120,000 people working in the industry. The trend of job cuts continues today, which was greatly influenced by the outbreak of war in Donetsk and Luhansk regions. As of 2018, approximately 42,000 people are employed at state mines[40].

Energy strategy of Ukraine until 2035 «Safety, Energy Efficiency, Competitiveness" envisages the closure of all unprofitable state-owned enterprises in the sector by 2025[41]. The Strategy also provides for the adoption of a social and environmental impact mitigation plan for each enterprise. However, there are no specific plans or clear lists of enterprises as of 2019. Furthermore, the existing experience of closing down coal mines in Ukraine shows that it was conducted without an adequate program of social reconversion of the territory, which not only led to negative socio-economic but also environmental consequences. In most cases, the former mono-industry towns underwent economic decline with the population migrating to other settlements and regions.

In view of the Government's course set out in the Energy Strategy of Ukraine for the restructuring of the coal industry and the closure of unprofitable coal mines, only a comprehensive approach can ensure a fair transformation. Establishing a constructive dialogue between state authorities, local self-government bodies and the local population is a prerequisite for addressing the socio-economic challenges of the mining regions. These include the employment and retraining of laid-off workers, the issue of reconversion of coal territories, and attracting investment to support new economic activities that will replace the fossil fuels based industry.

[37] OECP, 2018. Inventory of Energy Subsidies in the EU›s Eastern Partnership Countries: Ukraine https://www.oecd.org/environment/outreach/Energy%20subsidies%20in%20Ukraine_final_UA_3.02.2019.pdf

[38] State Treasury Service of Ukraine, 2019. Annual reports on implementation of the State Budget of Ukraine for 2015, 2016, 2017 and 2018 and monthly report on implementation of the State Budget of Ukraine for January-August 2019: https://www.treasury.gov.ua/ua/file-storage/misyachnij-zvit-pro-vikonannya-derzhavnogo-byudzhetu-ukrayini-za-sichen-serpen-2019-roku

[39] Ministry of Energy and Coal Industry. Statistics, response to the official inquiry of Center for Environmental Initiatives 'Ecoaction' # 139, June 14, 2018.

[40] Ministry of Energy and Coal Industry. Statistics, response to the official inquiry of Center for Environmental Initiatives 'Ecoaction' # 139, June 14, 2018.

[41] Cabinet of Ministers of Ukraine. Order "On approval of the Energy Strategy of Ukraine until 2035" Safety, Energy Efficiency, Competitiveness" of August 18, 2017 # 605-p.

GOAL 4 Reduction the proportion of electricity production at nuclear power plants

	Target for 2030	Baseline
Nuclear power (GW)	5	13,8

Units: Installed power (GW) of operating nuclear units.

Baseline: 13.8 GW of nuclear power capacities (15 active reactors).

Target for 2030: 5 GW of nuclear power, no new reactors erected.

Sub-target 1: The nuclear power plants (NPPs) that expire the design lifetime have been decommissioned.

Sub-target 2: Construction of new nuclear power plants has beencancelled.

RATIONALE

To date there are 15 nuclear reactors operating in Ukraine at four plants (Rivne, Khmelnitsky, South-Ukraine and Zaporizhzhya), which produce up to 55% of the country's total electricity. Such heavy dependence on a single energy source undermines Ukraine's energy security, as failure of one of the plants can have critical consequences for the energy supply. Ten of the 15 operating reactors of the Ukrainian NPPs have already exhausted their 30-year project resource and continue to work beyond the design lifetime. However, such operation mode implies additional risk of accidents and the accumulation of hazardous radioactive waste, including spent nuclear fuel. The risks associated with the operation of the NPPs will increase as a result of the aging of the reactors, as modernization does not imply the replacement of key equipment such as reactor vessels. The Ukrainian reactors were built mainly in the 1980s and do not fully comply with current international safety standards for new nuclear power plants.

Nuclear power plants also require fuel, which is 100% imported in Ukraine and consists of uranium ore, hence is fossil by natureit. If all stages of the NPP energy production cycle are taken into account, nuclear power is not carbon-free. These stages include the uranium extraction, ore milling, fuel production, construction of plants, transportation of fuel and waste, high-level radioactive waste management and disposal. With this in mind, nuclear energy produces on average 6 times more CO_2 emissions than wind and 2–3 times more than various types of solar generation technologies[42].

By 2030, only two reactors of operating NPPs (with a total capacity of about 5 GW) will operate within the design lifetime. In order to reduce the risks of nuclear accidents, dependency on a single energy source and reduce the accumulation of hazardous radioactive waste, it is necessary to provide for the gradual shutdown and decommissioning of old nuclear power plants during the period from 2025 to 2030.

It is not economically feasible to construct new reactors. No new reactor has been commissioned in the EU and the US in the last ten years. At present, nuclear reactors are one of the most expensive sources of electricity (ceding first place to peak load gas stations only)[43]. There is an upward trend in the cost per kilowatt of installed NPP capacity, reaching as much as Euro 7,200 per 1 kW (Olkiluoto NPP, Finland) or even USD9,400 per 1 kW (Plant Vogtle, USA)[44], and long delays in terms of construction. While modeling calculations for Ukraine's energy development by 2050 in the study "Transition of Ukraine to the Renewable Energy by 2050», the authors took into account that, according to SE NNEGC Energoatom, the cost of construction of a new reactor constitutes about EURO 6,500 per 1 kW of installed capacity of the NPP. Even with such an estimate of the cost of construction of new reactors, model calculations indicate that it is not

[42] Sovacool, 2008. Valuing the greenhouse gas emissions from nuclear power: A critical survey: https://www.sciencedirect.com/science/article/pii/S0301421508001997

[43] When comparing LCOE according to Lazard's Levelized Cost of Energy Analysis 2018.

[44] Weekly report. High-priced and dangerous: nuclear power is not an option for the climate-friendly energy mix: https://www.diw.de/documents/publikationen/73/diw_01.c.670581.de/dwr-19–30–1.pdf

feasible from an economical point of view to build new nuclear power plants in Ukraine.

Project of construction of units 3 and 4 at Khmelnitsky NPP. At first glance, an inexpensive (UAH 72.4 billion) project, promoted by Energoatom, poses risks for the energy and environmental security of Ukrainians. Only Russian-owned companies can construct WWER-1000 type reactors. The claimed construction period of 7 years is obviously unrealistic, given the early stage of design (only the feasibility study has been completed), the lack of secured funding and failures to meet deadlines of construction of nuclear facilities even in countries with extensive experience in such construction (France, Finland). The low budgeted costs for KhNPP power units 3 and 4 project is explained partially by the intention of NNEGC Energoatom to use the old building structures (left from 1980s) in the construction process, and by the choice of obsolete VVER-1000 type reactor (developed in 1970s). This in turn, poses significant security uncertainties and risks. In the process of transboundary environmental impact assessment, Austrian experts[45] emphasized, the following risks of this project:

1. The selected reactor type (VVER-1000/B-320) does not comply with modern safety standards.
2. The project does not fully comply with modern NPP design principles.
3. The risk of external extreme events (tornadoes, floods, etc) is underestimated.
4. The protection against terrorist attacks and sabotage is not sufficient.
5. There is a lack of uptodate information on the status of existing buildings and structures.
6. The analysis of possible scenarios of severe accidents is not sufficient.
7. The specific plan for management of radioactive waste and spent nuclear fuel is missing.

The construction of new nuclear units only exacerbates the unresolved problems of nuclear power and impedes investment in RES and energy efficiency. Such containment is due to the scarcity of resources in general and the need to adapt networks to large generating capacities instead of adapting to distributed generation and increasing efficiency in energy consumption. Moreover, it takes a long period of time to construct new reactors, therefore they have limited ability to quickly reduce greenhouse gas emissions.

Even today, the effects of global climate change are affecting the reliability of nuclear power plants, and over time the risks will only increase. Sea level rise, frequency and magnitude of extraordinary natural phenomena (hurricanes, tsunamis, tornadoes, fires), risk of critical reduction of water level in NPP cooler ponds due to lack of precipitation, increase of water temperature in reservoirs and other consequences of climate change increase the probability of occurrence accidents at the NPPs. Therefore, we must stop supporting the industry that does not contribute to fight against climate change and focus on the development of clean and secure renewable energy, which should be a major solution to the global climate crisis[46].

[45] Becker, Mraz, 2019. EIA NPP Khmelnitsky 3&4. Procedure 2019. Final Expert Statement (Consultation report): https://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0699.pdf

[46] New time. Why nuclear does not save us from climate change: https://nv.ua/ukr/amp/chomu-atomna-energetika-ne-vryatuye-nas-vid-zmini-klimatu-50054433.html?fbclid=IwAR3SYg54aeueLNYUGqn2BjOPUhFZ8ZN-zx8w6oRcDVSWMpl-T8EfDm21ipo

GOAL 5 Reduction energy and carbon intensity of the economy

	Target for 2030	Baseline
Primary energy consumption (toe/USD1000 2010 GDP (PPP))	0,15-0,16	0,29–0,29
Final energy consumption (toe/USD1000 2010 GDP (PPP))	0,09	0,15
Carbon intensity (т CO_2equivalent /USD1000 2010 GDP (PPP))	0,4	0,82

Units: Primary energy consumption – toe/USD1000 2010 GDP (PPP)[47] (2015), final energy consumption – toe/USD1000 2010 GDP (PPP), carbon intensity – т CO_2equivalent /USD1000 2010 GDP (PPP)

Baseline:

- primary energy consumption – 0.29[48] (2015), 0.27[49] (2017)
- final energy consumption – 0.15 (2015)
- carbon intensity – 0.82 (2015)

Target for 2030:

- primary energy consumption – no more than 0.15–0.16[50]
- final energy consumption – no more than 0.09
- carbon intensity – no more than 0.4[51]

RATIONALE

The proposed energy and carbon targets for the economy of Ukraine are based on the results of the revolutionary energy development scenario for 2050, modelled in the framework of «Transition of Ukraine to the Renewable Energy by 2050» study (by Heinrich Boell Foundation) and the Energy Strategy of Ukraine 2035. The study envisages meeting final consumption needs only through RES with full nuclear energy shutdown by 2050. The corresponding targets for 2030 are presented in the table above. Achieving these targets will help to reduce greenhouse gas emissions by up to 227 million tons of CO_2 equivalent by 2030, which is about 28% of 1990 levels. The implementation of the revolutionary scenario in Ukraine will bring the level of energy intensity of the economy in Ukraine to the level of 0.16 toe/USD1000 2010 GDP (PPP) by 2030 (see Figure 2).

The current Energy Strategy sets even more ambitious goals than the simulated indicators of the revolutionary scenario. Indeed, it provides for a reduction in energy consumption of up to 0.15 toe/USD1000 2010 GDP (PPP) by 2030 and 0.13 toe/USD1000 2010 GDP (PPP) by 2035. The 2030 targets proposed in this document represent only the upper limit for energy and carbon footprint of Ukraine, which it is vital to achieve. It is noteworthy that the reduction of energy intensity of the economy is moving faster than predicted within the most

[47] toe/USD1000 2010 GDP (PPP) – tons of oil equivalent by purchasing power parity (in 2010 prices).

[48] IEA, 2017. Key World Energy Statistics: https://www.iea.org/publications/freepublications/publication/KeyWorld2017.pdf

[49] IEA, 2017. Key World Energy Statistics: https://webstore.iea.org/key-world-energy-statistics-2019

[50] Cabinet of Ministers of Ukraine. Order "On approval of the Energy Strategy of Ukraine for the period up to 2035" Security, energy efficiency, competitiveness "of August 18, 2017 No. 605-p: https://zakon.rada.gov.ua/laws/show/605–2017-%D1%80

[51] "Transition of Ukraine to the Renewable Energy by 2050" (Dyachuk et al., 2017)

PRIMARY ENERGY INTENSITY OF GDP UNDER THE REVOLUTIONARY SCENARIO

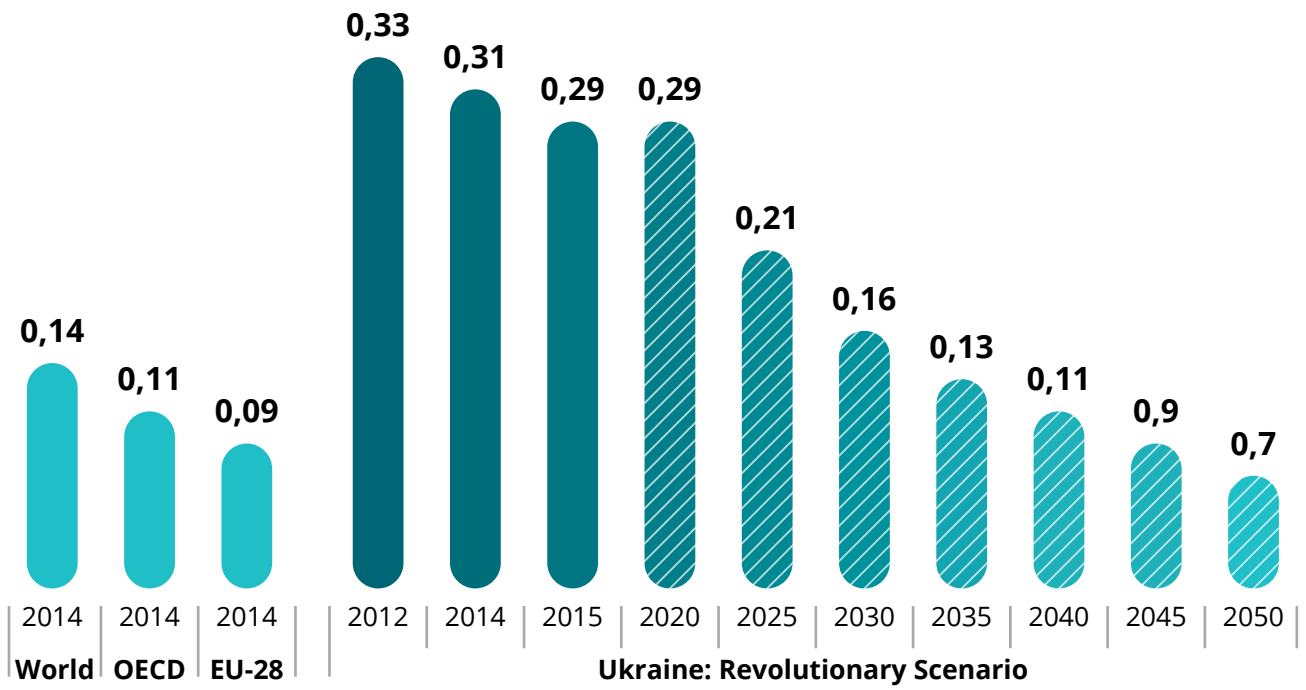


Figure 2. Primary energy intensity of GDP under the revolutionary scenario (Dyachuk et al., 2017)

ambitious revolutionary scenario of energy development modeled for today. Thus, according to the International Energy Agency, the primary energy intensity of the Ukrainian economy is reduced to 0.27 toe/USD1000 2010 GDP (PPP) as of 2017, although simulation results should have only been reached after 2020. Accordingly, it is quite possible to achieve a more rapid reduction in the energy intensity of the economy of Ukraine, provided that an effective energy and climate policy is implemented.

In addition, Ukraine is one of the countries characterized by the so-called «decapitation», i.e. the delineation of trends of economic growth from resource consumption and environmental impact. Thus, according to the World Resources Institute[52] estimates, CO_2 emissions in Ukraine decreased by 29% (99 million tons) from 2000 to 2014, while real GDP grew by 49% over the same period. Various factors predetermine the phenomenon of decapitation. In Denmark, for example, a rapid reduction in emissions is associated with a significant increase of the role of RES in energy production, whereas in Ukraine it is likely to be connected with a reduction of energy-intensive industrial production by 10%. Therefore, it is important that the reduction of energy and carbon intensity occur is not only due to structural changes in the economy (reduction of energy-intensive sectors and growth of the service sector), but primarily due to the introduction of energy-efficient and energy-saving technologies. The industry of Ukraine has enormous potential for increase of energy-efficiency[53], as does the building sector, which needs to be fully realized in order to reduce the energy and carbon intensity of Ukrainian economy more rapidly.

[52] World Resources Institute, 2016. The Roads to Decoupling: 21 Countries Are Reducing Carbon Emissions While Growing GDP: https://www.wri.org/blog/2016/04/roads-decoupling-21-countries-are-reducing-carbon-emissions-while-growing-gdp

[53] DIW Econ, 2014. Final report of the project «Capacity Building for Low Carbon Growth in Ukraine».

HOUSING SECTOR

Legislative framework, regulatory and institutional conditions for achieving housing sector goals

Today, the construction and operation of buildings under the current level of energy consumption accounts for approximately 40% of global carbon dioxide emissions. According to prognosis the building stock will double by 2060[54].

The most cost-effective way to reduce greenhouse gas emissions[55] and improving people's living conditions is to improve energy efficiency in buildings.

According to the EU-Ukraine Association Agreement and the Energy Community Treaty, the national policy of Ukraine on the energy performance of buildings must comply with the Directives 2010/31/EC on the energy performance of buildings and 2012/27/EC on energy efficiency.

In accordance with European requirements, the law "On Energy Efficiency of Buildings" is in force in Ukraine, which regulates energy performance of buildings, energy certification of buildings, a system for ensuring the qualification of energy auditors and other principles of promoting energy efficiency. In addition, there is a gradual progress in the implementation of full commercial accounting of various energy resources, and the Energy Efficiency Fund is in operation, which promotes energy efficiency improvements. Furthermore, the current law "On Introduction of New Investment Opportunities, Guaranteeing the Rights and Legal Interests of Entrepreneurs for Large-Scale Energy Modernization" allows for the initiation of energy efficiency improvements in state and communal property by attracting private investment through an energy service mechanism.

In order to achieve a carbon-neutral economy by 2050, Ukraine needs to ensure conditions for the construction and longer operation of nearly zero-energy buildings, with institutional and legal support provided in the National Plan. The minimal energy efficiency requirements for already constructed and new buildings should be gradually modified so that starting from 2030 more than half of the energy needs of buildings are covered by renewable energy sources. A National Plan to increase the proportion of buildings with nearly zero-energy consumption should be adopted.

It is necessary to make an inventory of buildings according to their energy consumption, starting with those maintained at the state or local budget, adding all other buildings at a later date, including residential ones. This requires the introduction of energy management systems at the level of state executive bodies (national and local levels) and local governments, which will help to create and maintain a database of energy consumption, including energy use in buildings. As a result, a database of buildings with information on energy performance and energy consumption should be established; it will be regularly analyzed and will serve as a basis for planning the modernization of buildings in order to achieve national energy saving goals.

According to the provisions of Directive 2012/27/EC, Ukraine must set a goal which will enable annual reduction of final energy consumption by at least 0.7%[56], thus, ensuring energy efficiency in supply or final consumption.

[54] Energy Efficiency 2018. Analysis and outlooks to 2040: https://www.iea.org/efficiency2018/

[55] McKinsey Quarterly, February 2007. A cost curve for greenhouse gas reduction.

[56] The requirements of Art. 7 of Directive 2012/27/EC according to the obligations of Ukraine under the Energy Community Treaty.

Based on the analysis of housing data and on the basis of the national energy conservation target, a target for reducing energy consumption and improving the energy efficiency of buildings should be set. In order to achieve national energy conservation goals and increase the level of energy efficiency in Ukraine, a strategy for thermal modernization of buildings should be adopted. It should include an assessment of the amount of energy savings and the possibility of attracting finance through the Energy Efficiency Fund, the mechanism of energy service contracts and other new financing programs.

Central government offices and public buildings should be examples of best energy efficiency practices; at least 1% of their total floor area should be thermo-modernized. An energy management system must be in place for such buildings.

In order to encourage thermo-modernization of buildings, use of energy from renewable sources and implementation of energy efficiency measures the cost of energy in the country should be market-based and include losses from negative externalities, such as charges for pollution from fossil fuel energy consumption and the like.

The key to achieving energy efficiency in housing is people's conscious attitude to energy use. Therefore, the state should provide systematic informational support to the goals of the state and the role of the public in achieving them through the use of available tools and measures.

GOAL 1 Reduction residential energy consumption

Specific energy consumption
(kWh/m²)

Target for 2030 120

Baseline 194

Units: Proportion of energy use in buildings,% and primary energy consumption, kWh/m².

Baseline: Specific energy use in buildings in Ukraine – 194 kWh/m² [57].

Target for 2030: Energy use in buildings will be reduced by 25% and 70%[58] from the baseline by 2013 and 2015, respectively. Primary energy consumption:

- 120 kWh/m² => 2030;
- 50 kWh/m² => 2050.

RATIONALE

In order to fulfill the obligations under the Paris Agreement, it is necessary to reduce greenhouse gas emissions, primarily by reducing fossil fuel combustion. Buildings should play a significant role in reducing energy consumption, since this is the most energy intensive sector, and energy in Ukraine is produced mainly from fossil sources. Therefore, by 2050 the buildings in Ukraine should comply with the nearly zero-energy buildings standards. The nearly zero-energy buildings standards are to be introduced into the legal framework of Ukraine.

Available energy efficiency measures have the potential to reduce energy consumption by 42%[59]. More than half of the energy demand in housing should be covered from renewable energy sources.The primary goal by 2030 should be to reduce the specific energy use in building by 25%[60] via the optimization of management systems, the introduction of economically feasible measures and the insulation of walls in most buildings, that do not meet the minimum energy efficiency requirements.

In most cases, nowadays, new buildings equipped with energy efficient technologies in accordance with current norms and standards do not succeed because:

- Owners of apartments lack understanding of the principles of efficient heating and quality control of materials (in particular, in majority of cases the windows do not meet the standards), as a result, the buildings are commissioned with non-compliance with energy efficiency requirements;
- Engineering equipment is poorly maintained, which leads to significant energy overruns.

On top of that, the State Architectural and Construction Inspectorate does not perform its function to ensure compliance with state standards in buildings. In many cases, this causes excessive energy use and shortens the life of energy efficient measures (for instance partial wall insulation). Therefore, state oversight in this area should be thoroughly reformed, and controlling officials should carry personal responsibility for decisions taken until the lifetime of buildings or parts of buildings is over.

[57] Author's own calculations according to the data of State Statistics Service of Ukraine on the national dwelling stock and on the basis of energy balance, for the household sector (2017, excluding data from temporarily occupied territories).

[58] "Transition of Ukraine to Renewable Energy by 2050" (Dyachuk et al., 2017). Based on the assumption that it is necessary to reduce the energy use in buildings by 42% in order to ensure the conditions for the 100% RES scenario.

[59] "Transition of Ukraine to Renewable Energy by 2050" (Dyachuk et al., 2017), p.. 81, table. D.6.3.11 "Generation of electricity under the revolutionary scenario".

[60] The goal is set by discussing with the experts involved in developing the Roadmap. The goal set by the Law of Ukraine "On the Energy Efficiency Fund" (Verkhovna Rada Bulletin, 2017, No. 32, p. 344) constitues 20%, but members of the public believe that it should be more ambitious.

GOAL 2 Improving the energy efficiency of buildings

	Baseline	Target for 2030
Funds aimed at improving the energy efficiency of buildings (billion UAH)	2	40
Proportion of thermo-modernized buildings (%)	20%	30%

Units: Funds aimed at improving the energy efficiency of buildings, UAH and the proportion of thermo-modernized buildings,%.

Baseline:

- 2018 – UAH 2.1 billion, of which UAH 500 million is the state program «warm credits» and UAH 1.6 billion – the Energy Efficiency Fund (not used);
- According to the National Energy Efficiency Action Plan for the period up to 2020[61], 25% of apartment buildings and 20% of public buildings are to be thermo-modernized by 2020. There is no actual information on the proportion of thermo-modernized buildings.

Target for 2030:

- Total investment in improving the energy efficiency of buildings from the state and local budgets – at least UAH 40 billion annually (prices are set according to the 2019 exchange rate);
- 30% of buildings in the country have energy efficiency classes not lower than «B» (by 2019 standards).

RATIONALE

As of the beginning of 2020, residential and non-residential buildings (over 30 years in operation) are in poor physical condition and do not meet the current requirements of energy efficiency regulations, which leads to significant expenditures on energy. According to the Ministry of Communities and Territories Development more than 40,000 apartment buildings require energy efficiency modernization. More than 18,000 buildings constructed between 1971 and 1980 and more than 22,000 buildings constructed between 1981 and 1990[62] require immediate thermal modernization. However, due to the lack of comprehensive statistics on housing and non-housing facilities, it is difficult for the responsible executive bodies at the central level (Ministry of Regional Development, State Statistics Service) to accurately analyze the existing outdated housing stock and its technical condition. Therefore, the primary task for the central government is to collect data on the ownership of buildings, their physical and technical condition.

The next step is to ensure the effective operation of the State Energy Efficiency Fund. The fund should finance the insulation of condominium buildings in the planned amounts. State and local budgets must co-finance energy-efficient activities in public institutions.

[61] Decree of the Cabinet of Ministers of Ukraine of November 25, 2015 No. 1228-p.

[62] Research on modern thermal insulation systems and development of basic construction and technical solutions of thermal reconstruction of facades of residential buildings constructed in 1960–1995.

BUDGET EXPENDITURES FOR ENERGY EFFICIENCY MEASURES UNDER THE WARM CREDIT PROGRAM AND THE ENERGY EFFICIENCY FUND

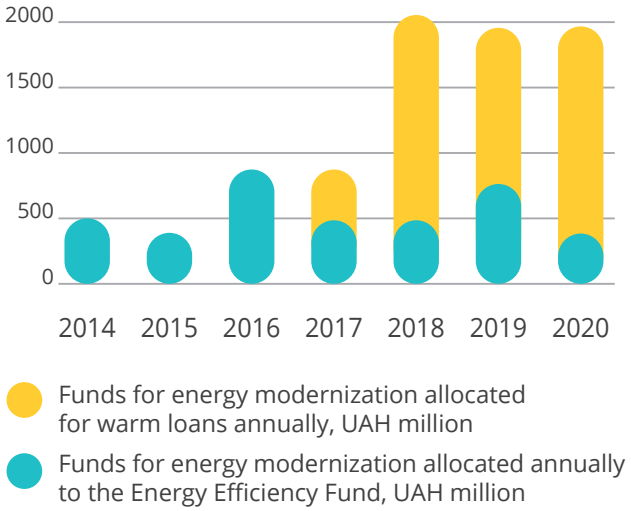


Figure 3. Budget expenditures for energy efficiency measures under the Warm Credit Program and the Energy Efficiency Fund (based on official data).

However, the dynamics of current expenditures of the state budget for energy efficiency measures in buildings indicate an insufficient level of support. The state's annual expenditures for energy efficiency measure constitute UAH 2.1 billion, which does not exceed 0.2% of the total state budget housing and utilities services receive 10–35 times more in form of subsidies and privileges[63]. Rough estimates show the thermo-modernization of all housing in Ukraine requires about Euro 100 billion[64]. Assuming that: 1) the proportion of the state and local budgets will constitute 30% of all investments; and 2) it is planned to insulate all housing by 2050, we can conclude that the total expenditures from local and state budgets for these purposes should be at least UAH 40 billion per year. This amount will allow the thermal modernization of 30% of buildings.

In addition, the Energy Strategy 2035 envisages the introduction of sustainable mechanisms of state support for condominiums on the principles of co-financing for thermal modernization of buildings, as well as the creation of instruments of state financial and technical support (including the involvement of foreign partners) to implement energy efficiency measures in apartment buildings. However, there are no provisions for introducing mandatory energy efficiency measures in buildings, which is one of the obstacles to the rapid thermo-modernization of an outdated dwelling stock. The situation is similar for public buildings, where there is no strategy for large-scale thermo-modernization.

Therefore, in order to achieve the goal the following measures and steps are to be taken:

- State executive bodies (national and local levels) as well as local self-government bodies in a compulsory manner should introduce energy management systems
- A register of dwelling and non-residential property objects must be kept year of construction, technical condition, form of ownership, etc.;
- The functioning of mechanisms and instruments for large-scale thermo-modernization of dwellings and non-residential buildings must be ensured;
- There should be established legislative «rules of the game» to attract funds from local and foreign, private investors for thermal modernization of buildings of all types and forms of ownership;
- The financing of various housing modernization instruments ("warm loans" programs, Energy Efficiency Fund) should be continued;
- State Architectural and Construction Inspectorate should be reformed in order to be able to ensure compliance of objects with state building standards.

[63] Provision of "warm credits" does not solve the goal of the State Energy Efficiency Program https://rp.gov.ua/News/?id=79.

[64] By 2025, 10% of residential buildings in the Ukraine can be modernized with the help of the Energy Efficiency Fund. http://uacrisis.org/ua/73269-energy-efficiency-and-energy-poverty.

GOAL 3 Introduction efficient heat supply systems

	Target for 2030	Baseline
Energy losses in heat supply (%)	5,6%	18%
Specific primary energy consumption per unit of energy delivered (kWh/Gcal)	0,08	0,16

Units:

- Energy losses in heat supply,%;
- Specific primary energy consumption per unit of energy delivered, kWh/Gcal.

Baseline:

- Normalized losses in heat supply – 18%, actual energy losses in heat supply – over 26% (2016)[65];
- Specific cost of heat production for heat supply – 0.16 t r.f./Gcal (at 89% of the efficiency factor of the power plant) (2016)66.

Target for 2030:

- Less than 5.6% of heat has be loss –;
- The specific rate of primary energy consumption for the production of heat for heat supply is 0.08 t r.f./Gcal.

RATIONALE

Heating and hot water supply account for about 40% of total energy consumption, with households as the main consumer. In Ukraine, heat is produced mainly from fossil fuels. Annual consumption of heat constitutes 210–240 million Gcal[67]. In Ukraine, heating of approximately 60% of buildings and approximately 40% of households is provided by district heating systems, and the rest by autonomous heating and individual heating systems of various types[68].

The system of heat supply in Ukraine is extremely inefficient both in the production and transportation due to the wear and tear of the equipment. In 2016 the reference fuel consumption for heat supply constituted 0.16 t r.f./Gcal. The degree of wear of backbone and distribution networks reaches 70% of their total length. Standard losses in the transportation of thermal energy pose 18%, although the NEURCU spot checks estimated the losses at the level of 36%.

It is difficult to determine the amount of energy consumption and transportation losses in the absence of meters in almost 30% of consumers[69] and the incomplete accounting of energy supply.

In order to phase out fossil fuels by 2050, it is necessary to reduce energy consumption by 30% by improving the energy efficiency of both energy use and heat supply systems by developing efficient district heating systems. By 2030, district heating

[65] National Energy and Utilities Regulatory Commission. Report on NRURCU activities in 2017.

[66] NEURCU, 2016. Presentation "A step towards meeting the transparency and accessibility of tariffs for heat: production, transportation and supply."

[67] Directive 2012/27/EC requires a 1.5% reduction in energy consumption from fossil fuels annually, which can also be applied to heat losses.

[68] SE NEC Ukrenergo, 2016. Foreign experience of development of systems of centralized and autonomous heat and power supply: https://ua.energy/wp-content/uploads/2018/01/5.-TSentralizovane-ta-avtonomne-teplozabezpechennya.pdf

[69] State Energy Efficiency, 2019. The rate of installment of commercial heat meters, hot and drinking water meters in buildings as of December 19, 2019: http://saee.gov.ua/en/content/commercial-accounting

and grid operators are expected to provide annual savings of 0.7–1.5% of final energy consumption in accordance with Directive 2012/27/EC. At the same time, the demand of heat supply systems must be covered by 50% of renewable energy or waste heat, or by 75% of heat from cogeneration or by 50% of their combination.

In this manner, the consumption of primary fossil fuels for the heat production should be twice as low (0.08 t/Gcal) as the current level by 2030.

In order to fulfill the obligations under the Directive on heat supply, it is necessary to encourage the use of biomass and biofuels, solar energy, geothermal energy, and to promote the use of cogeneration and low-potential waste heat from industrial processes. A comprehensive assessment of the heat supply potential of high-efficiency cogeneration and the provision of heat using renewable energy and waste heat should be carried out.

It will be more difficult to comply with the requirements of Directive 2012/27/EC if cities continue to abandon the system of central heating. Individual boilers are less efficient than central heating and are much more difficult to convert to RES. However, local authorities and residents have a negative perception of central heating and tend to refuse it for a variety of reasons:

- Poor quality of service due to the lack of regular maintenance of networks and homes in the past;
- Non-transparency of activity of district heating companies;
- Low tariffs for heat and hot water supply;
- Lack of technical possibility to control the heat supply of a separate apartment.

Public policy should foresee informing people about the true state of affairs in district heating and explaining ongoing reforms. Such information should form an objective view and a justifiably positive image of district heating. The policy should also be based on the following approaches:

- The tariffs for heat and hot water supply should be set at level that cover all necessary maintenance work and depreciation;
- The heat supply standards are met if only the meters are installed.

The development of heat supply systems should take into account the tendency of decreasing consumer demand and the need to regulate the heat supply relative to the outside air temperature, while ensuring the use of low-potential waste heat and energy from renewable sources. The prerequisite for the development of an efficient heat supply system is the introduction of investment attraction mechanisms, in particular through raising of tariff.

TRANSPORT

Legislative framework, regulatory and institutional conditions for achieving transport sector goals.

In 2017, 11.3% of Ukraine's greenhouse gases were produced in transport sector (35.0 million tons of CO_2 equivalent)[70]. This is 6.4% more than in the previous year.

Although emissions in the transport sector reportedly decreased(68.7% less than in 1990, see Figure 4), it is worth taking into account the fact that in 1990 the level of emissions from obsolete equipment, trains, aviation and cars was extremely high. The economic downturn of the 1990s and 2000s, as well as the improvement of the EU fuel standards, led to a reduction in greenhouse gas emissions, but this was not the result of political decisions. Therefore, in 2019, the public requires the Verkhovna Rada of Ukraine and the Government to continue their course on reducing emissions from transport by 80–100% from the 1990 level. The EU countries are trying to reach such a reduction by 2050[71].

In recent years, Ukrainian legislation has become more loyal to car owners. As of January 1, 2015, both the first vehicle registration-[72] and environmental tax on emissions from cars[73] have been abolished. The car ownership tax, introduced in 2015, is not an environmental tax, but a luxury tax, because it is paid only for cars with a price over 375 minimum wages[74] and up to 5 years of age[75]. Such an approach contradicts the principle of environmental taxation, since it is older cars that produce more emissions. In fact, today greenhouse gas emissions from transport in Ukraine are not taxed at all. A law on the taxation of greenhouse gas and pollutant air emissions (environmental taxes for mobile sources of pollution) needs to be developed and adopted. Taxes should be collected on a regular basis (for example, annually) depending on the engine size and the age of the car, as well as on every purchase of a liter of fossil fuel (gasoline, diesel, gas).

Starting in 2018, there are tax benefits in place for owners of old European cars. In 2019, the Verkhovna Rada of Ukraine extended the privileges for them again[76]. This situation poses a threat not only in view of the increase of greenhouse gas emissions, but also of the deterioration of the air quality in the cities of Ukraine, road safety and reduction of budget revenues. One of the important steps in reducing greenhouse gas emissions is cancellation of privileges for old cars from Europe whose owners have not performed customs clearing.

The 2017 amendments to the Tax Code of Ukraine abolished most taxes on the import of electric

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[70] UNFCCC. Ukraine. 2019 National Inventory Report (NIR): https://unfccc.int/documents/195605

[71] EU Publications – Going Climate-Neutral by 2050: https://op.europa.eu/en/publication-detail/-/publication/92f6d5bc-76bc-11e9–9f05–01aa75ed71a1

[72] Currently, when registering the car the owner only pays tax to the Pension Fund of Ukraine (differentiated on the principle of "luxury tax" – the higher the cost of the car, the higher the tax) and value added tax, as well as import duty and excise tax in case of buying a car abroad – Tax Code of Ukraine

[73] Law of Ukraine "On Amendments to the Tax Code of Ukraine and Certain Legislative Acts of Ukraine on Tax Reform" of December 28, 2014 No. 71-VIII.

[74] In 2019 this amounts to UAH 4,173 x 375 = UAH 1.564,875.

[75] Tax Code of Ukraine, Art. 267: https://zakon.rada.gov.ua/laws/main/2755–17

[76] RBC. Customs clearance is cheaper and the fines are canceled: new privileges are being prepared for Euroblyakhi: https://www.rbc.ua/eng/styler/rastamozhka-deshevle-i-otmena-shtrafov-evroblyaheram-1574077975.html

GREENHOUSE GAS EMISSIONS IN THE TRANSPORT SECTOR IN UKRAINE

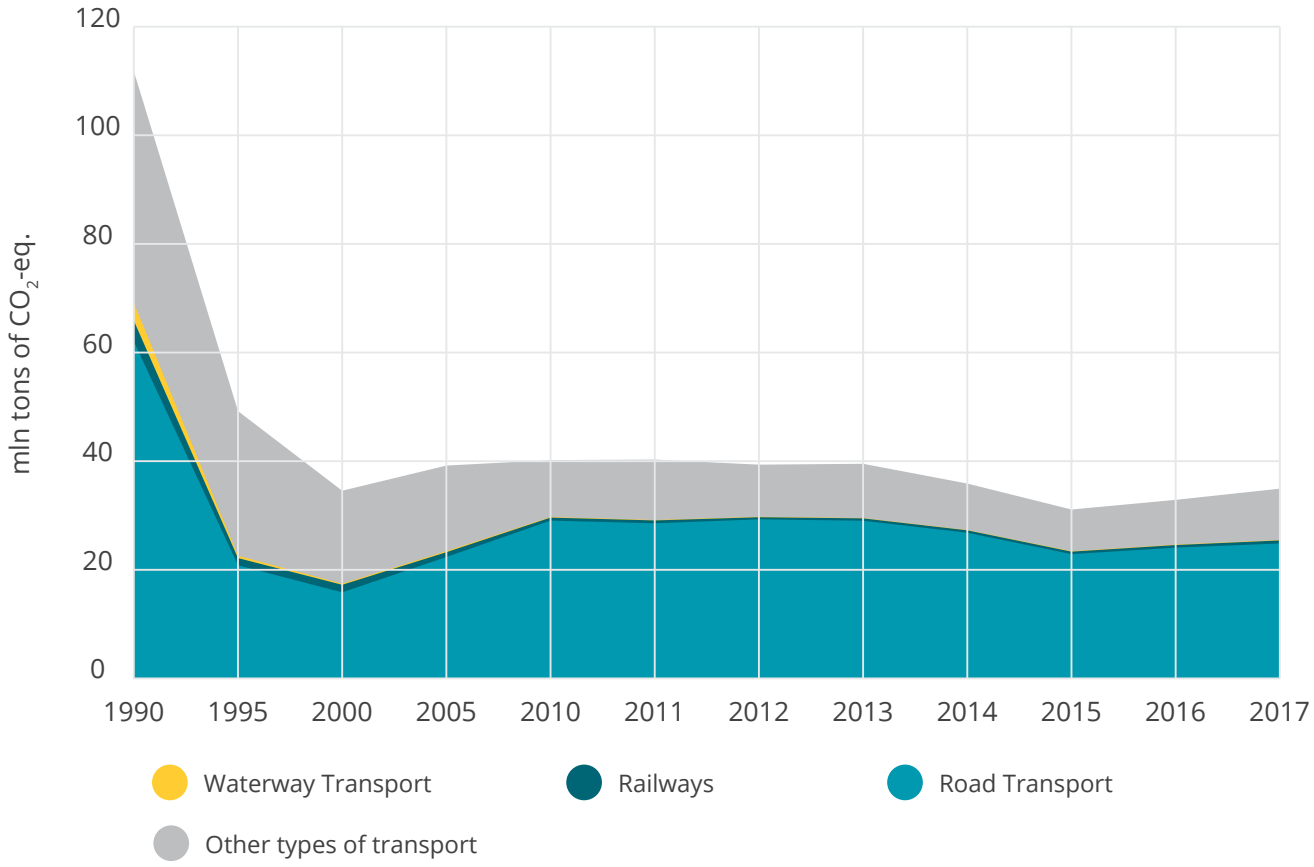

Figure 4. Greenhouse gas emissions in the transport sector in Ukraine (National Greenhouse Gas Inventory, 2019).

vehicles to Ukraine (electric motorists pay only tax to the Pension Fund of Ukraine)[77]. This stimulation of the purchase of electric vehicles is a positive factor for increasing the competitiveness of electric vehicles and reducing the number of petrol or diesel cars. However, electric mobility alone is not enough to solve the problem of greenhouse gas emissions and pollutants – it is necessary to limit the use of diesel and gasoline vehicles via fiscal and regulatory methods. The development of electric mobility in Ukraine faces other threats as well: insufficient charging stations for electric vehicles, especially between cities, as well as the attempts of some suppliers to monopolize the charging network.

Electric bikes and electric scooters are more environmentally friendly than electric cars. Like electric cars, they do not emit greenhouse gases and pollutants when traveling, but take up much less parking space and do not obstruct public transport. However, the import of electric bicycles to Ukraine is still taxed, which limits the growth of the electric bicycle market in Ukraine[78]. Terms defining micromobile transport[79] (for example, «electric scooter») are absent in the Ukrainian legislation, which removes these vehicles from the legal field, including during accidents – and this may deter people from using them. Taxes on the import of electric bicycles and electric scooters to Ukraine should be abolished, similar to the tax privileges for electric vehicles, and the concept of electric mobility

[77] In accordance with the amendments made to the Tax Code of Ukraine by the Law of Ukraine "On Amendments to the Tax Code of Ukraine and some other legislative acts of Ukraine on improving the administration and revision of the rates of individual taxes and fees" of November 23, 2018 No. 2628-VIII.

[78] Tax Code of Ukraine.

[79] Micromobility is a category of modes of transport that are provided by very light vehicles such as electric scooters, electric skateboards, shared bicycles and electric pedal assisted, pedelec, bicycles.

should be clarified in the legislation, in particular in the Traffic Code[80].

The National Transport Strategy of Ukraine until 2030 sets expectations and targets that should reduce the carbon footprint of transport in Ukraine[81]. We support the Strategy course on increasing the proportion of public and electric transport, electric buses and bicycles, introducing an economic incentive mechanism for their use; increase in the share of use of electric transport and electric vehicles, in particular. Likewise, bringing the share of electric transport in domestic traffic to 75% in 2030; increasing the use of alternative fuels and electricity by 50% by 2030, introducing economic incentives to use such fuels; developing mechanisms to compensate for the damage caused by transport to the environment, economically stimulating transport operators to reduce emissions of pollutants and greenhouse gases; introduction of a system of road tolls depending on the environmental class of the car; development of railway transport and introduction of economic stimulation for the transition of freight and passenger transportation to railway and water transportation modes.

At the same time, we consider it necessary to set more ambitious targets, in particular, to reduce greenhouse gas emissions from mobile sources by at least 80%[82] by 2030 compared to 1990 levels. At present, the Transport Strategy sets a target of 60% reduction from 1990, although in 2017 the reduction has already reached 69% – and therefore the Strategy provides an opportunity for increased emissions.

In Ukraine, it is advisable to develop a National Sustainable Mobility Plan[83] and to prepare Sustainable Urban Mobility Plans that take into account the safe and sustainable development of public transport, walking and micromobility[84,85]. It is necessary to give priority to the development of public transport and micromobility while developing socio-economic development programs for cities and regions (in action plans and budgets). At least 50% of all transport expenditures in local budgets should be spent on the development of public transport and at least 5% – on the development of bicycle transport and micromobility. It is recommended to revise and amend the Traffic Code[86], Construction Code[87]and State Standards on Marking[88] to ensure sustainable design and development of bicycle transport and micromobility.

[80] Road Traffic Regulations. Decree of the Cabinet of Ministers of Ukraine of October 10, 2001 No. 1306: https://zakon.rada.gov.ua/laws/main/1306–2001-%D0%BF

[81] National Transport Strategy of Ukraine until 2030.

[82] Following the example of the objectives of EU countries.

[83] National urban mobility policies and investment programmes (NUMPs): http://mobiliseyourcity.net/wp-content/uploads/sites/2/2018/08/08012018_NUMP_AC-.pdf

[84] Mobilise your city. National Level NUMPs: http://mobiliseyourcity.net/national-level-numps/

[85] Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan: https://www.eltis.org/mobility-plans/sump-guidelines, https://www.eltis.org/sites/default/files/sustainable_urban_logistics_planning_0.pdf

[86] Kyiv Cyclists' Association, 2018. Project of bicycle friendly changes to the Road Traffic Regulations: http://avk.org.ua/tag/zminy-do-pdr/

[87] Kyiv Cyclists' Association, 2018. Project of bicycle friendly changes to the State Building Norms: http://avk.org.ua/2018/06/stalo-vidomo-koly-nabudut-chynnosti-novi-dbn/

[88] U-Cycle, 2019.Proposals for SSTC2587: 201x Road marking: http://avk.org.ua/2019/06/ho-podaly-propozytsiji-do-proektu-dstu-pro-dorozhnyu-rozmitku/

GOAL 1 Increase the share of public transport and micromobility in cities

	Baseline	Target for 2030
The share of private motorized transport use	25%	10%
The share of public transport use	45%	45%
The share of bicycle use	1%	15%
Major roads in cities safe for cyclists	5%	70%

Units: Modal split; kilometers of bicycle lanes and paths.

Baseline:

- The share of private motorized transport use in cities with population over 500 thousand – 17–28%, in cities with population 250–500 thousand – 12–17%[89];
- The share of public transport use in cities with population over 500 thousand – 37–49%, in cities with population 250–500 thousand – 45–56%;
- Share of bicycle use – <1%[90];
- The proportion of major roads in cities safe for cyclists – <5%[91].

Target for 2030:

- The share of motorized vehicle use decreased compared to 2019, the goal is 10% in modal split;
- The share of public transport trips is maintained at the level of 2019 or increasing due to the decrease in the share of private car trips;
- The share of bicycle use reaches 10% in cities with population over 500 thousand, 15–20% – in large and medium-sized cities (250 thousand population);
- At least 70% of major streets in cities are safe and understandable[92] for cyclists.

RATIONALE

The major share of transport emissions in Ukraine is emitted by road transport (70.6% of emissions in the transport sector), which includes emissions from cars, trucks, buses and motorcycles[93]. This summates to approximately 8% of all greenhouse gas emissions in Ukraine. In countries with higher GDP per capita, the share of vehicle emissions is even higher[94], hence with increasing economic development, Ukraine can expect a further increase in road transport emissions. Given that the majority of Ukraine's population lives in cities (69.4%)[95], it is now important to develop attractive and environmentally friendly alternatives to motorized transport, namely, safe and comfortable public transport and micromobility. In order to reduce greenhouse gas emissions from transport, it is recommended to achieve the following proportion

[89] Hereafter: data for major cities (cities with population over 500 thousand inhabitants) – based on Kyiv (Kyiv Development Strategy until 2025, 2015) and Dnieper (A + C, 2019), for large cities (250–500 thousand inhabitants) – based on Vinnitsa, Zhytomyr, Poltava, Chernivtsi (GIZ, Mobility Research and Opinion Poll on Urban Mobility, 2019), Mariupol (A + C, 2018), Mykolaiv (Sustainable Mobility Development Plan, 2018).

[90] In Poltava in 2018–2%. GIZ, 2018. Mobility research and opinion polls on urban mobility.

[91] Based on the empirical assessment of cycling infrastructure mileage in major cities of Ukraine (Kyiv, Lviv, Vinnytsia, Odessa, Dnipro, Kharkiv) divided by kilometers of highways and arteries.

[92] By safe and understandable cycling, we understand the organization of traffic that ensures the zero mortality of cyclists and the absence of situations in which cyclists do not know how to pass a certain area. Safe and clear travel can be realized by bike lanes, bicycle lanes, counter-lanes, mixed traffic, speed limitation, etc. – see. Promoting Cycling for Everyone as a Daily Transport Mode (Presto): https://ec.europa.eu/transport/sites/transport/files/cycling-guidance/presto_policy_guide_cycling_infrastructure_en.pdf

[93] UNFCCC. Ukraine. 2019 National Inventory Report (NIR): https://unfccc.int/documents/195605

[94] In the EU2016, the share of road transport emissions constituted 27% – European Environment Agency (EEA), EEA greenhouse gas – data viewer, 6 June 2017.

[95] State Statistics Service of Ukraine. Population Table, 2019: http://www.ukrstat.gov.ua/

in transport use in Ukrainian cities by 2030: 35–55% – public transport, 10–20% – means of micromobility (including bicycles), 25–40% – walking, and only 10% – private cars[96,97].

To encourage the use of public transport and micromobility, it is necessary to:

- ensure the reliability and safety of public transport traffic,
- build intermodal transfer hubs and bus lanes, and optimize current routes,
- build bicycle infrastructure (lanes, parking lots),
- launch bikeshare systems,
- create car-free zones and low emission zones[98],
- increase safety for pedestrians at intersections via pedestrian islands and elevated medians,
- refuse to build motorways in an urban environment,
- and not increase the speed limit in the city.

While developing the public transport, priority should be given to electric transport, which include trams, trolleybuses, urban and suburban railways. It is advisable to include those elements to the sustainable mobility plans at local and national levels[99], as well as to the sectoral concepts of development of bicycle transport, micromobility, public electric transport, etc. Figure 5 highlights the benefits of using public electric transport and micromobility to reduce greenhouse gas emissions, compared to transport on fossil fuel.

GREENHOUSE GAS EMISSIONS PER PASSENGER-KILOMETER BY MODE OF TRANSPORT

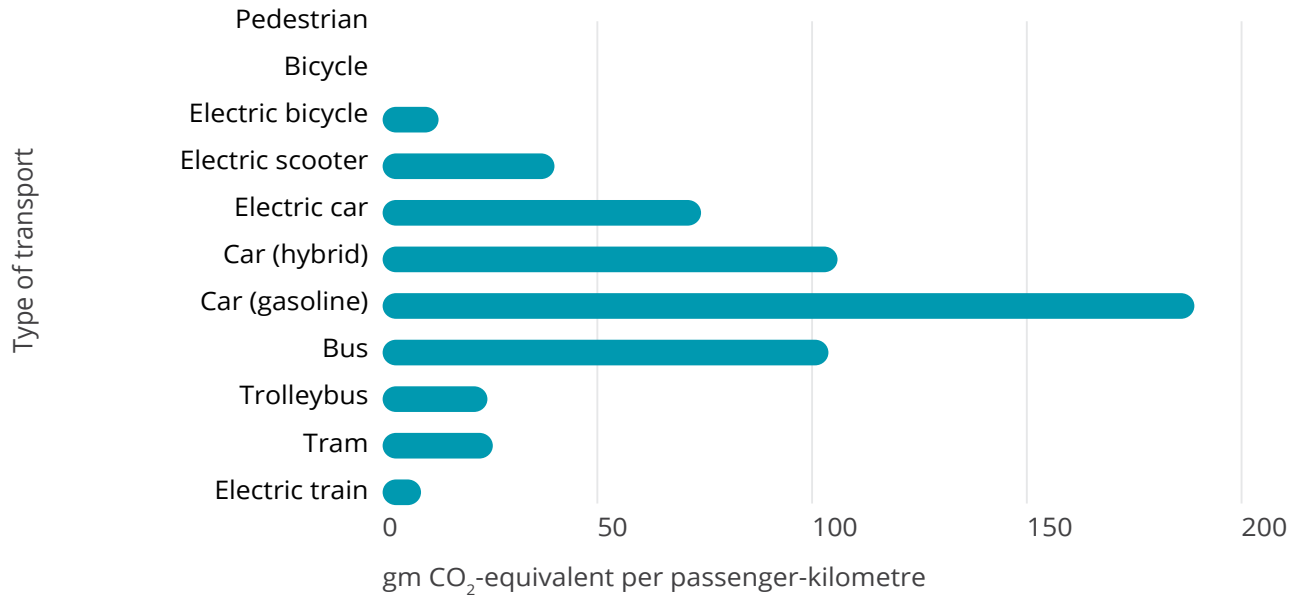

Figure 5. Greenhouse gas emissions per passenger-kilometer by mode of transport (Hoffmann, 2013; IPCC, 2018).

** Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 8 Transport; Hoffmann et al., 2013. E-Scooter – Sozial und naturwissenschaftliche Beiträge zur Förderung leichter Elektrofahrzeuge in der Schweiz. Electric greenhouse gas emissions for electricity are calculated based on the distribution of electricity production in Switzerland in 2013.*

[96] Jain AK, 2009. Urban Transport: Policy and Management – Recommendations on Public Transport, European Commission, Walking and Cyclist as Transport Modes – Analysis of Walking and Cycling: https://ec.europa.eu/transport/road_safety/specialist/ knowledge / pedestrians / pedestrians_and_cyclists_unprotected_road_users / walking_and_cycling_as_transport_modes_en

[97] The share proportion is individual and depends on the size of the city.

[98] Urban Access Regulations in Europe: https://urbanaccessregulations.eu/low-emission-zones-main

[99] Poltava and Zhytomyr approved PSCM in 2019.

GOAL 2 Increase the share of electric transport

	Baseline	Target for 2030
The share of private electric transport	1%	75%
The share of urban public electric transport	54%	75%

Units:

- Share of electric transport in the total amount of trips,%;
- The share of public electric transport in cities in total passenger traffic.

Baseline:

- Share of private electric transport in the total amount of trips – <1%[100];
- Share of urban public electric transport in 2018 is 54% of the total passenger traffic[101].

Target for 2030:

- Share of electric transport constitutes 75% of in the total amount of trips[102];
- Share of passengers transported by public electric transport in cities (by trams, trolleybuses, subways, electric buses) is 75% of all passengers carried.

RATIONALE

Diesel and gasoline are one of the largest sources of greenhouse gas emissions in the transport sector. Electric transport does not generate local emissions from engine operation. If internal combustion engine cars are replaced with electric vehicles, it will significantly reduce not only greenhouse gas emissions but will also improve the air quality in cities. In combination with the use of renewable energy sources, the promotion of electric transport will reduce emissions from the transport sector as a whole. The proliferation of electric cars in taxi services and carsharing also helps to reduce emissions and reduce urban air pollution[103]. Electric cars in taxi and carsharing create alternatives to diesel and gasoline, which will reduce the number of trips by motorized individual transport within the cities.

Although electric cars do not directly emit greenhouse gases and pollutants into the atmosphere, they are still cars: they take up parking space, slow down public transport during peak hours, and cause fatal accidents. Electric cars are not a panacea, so it is advisable for cities to first develop public transport and micromobility, namely, bicycles, scooters, walking. The increase in share of electric transport in urban public transport will help to reduce greenhouse gas emissions. To do this, it is necessary to develop trolleybuses, trams and urban railways, where possible. At the same time, it makes sense to limit the use of minibuses that are not only harmful to the environment, but also do not increase budget revenues and are often dangerous to users. Figure 6 shows that the share of electric transport in the total number of passengers has increased since 2009, reaching 54% in 2018, which is a positive trend.

[100] According to the European Electromobility Association of Ukraine, by the end of 2019, about 19,000 electric cars were registered in Ukraine, which is 0.2% of the total number of cars. In the absence of other data, we can assume that drivers use electric vehicles with the same frequency as drivers of gasoline cars, and therefore the share of electric transport in 2019 equals 0.2%. The calculated value lays within the margin of error.

[101] State Statistics Service of Ukraine. Number of passengers carried by types of transport, 1995–2018.

[102] Transport Strategy of Ukraine until 2030. Expected results.

[103] Carsharing is a model of car rental where people rent cars for short periods of time, often by the hour.

SHARE OF PASSENGERS TRAVELLING BY DIFFERENT MODES OF TRANSPORT

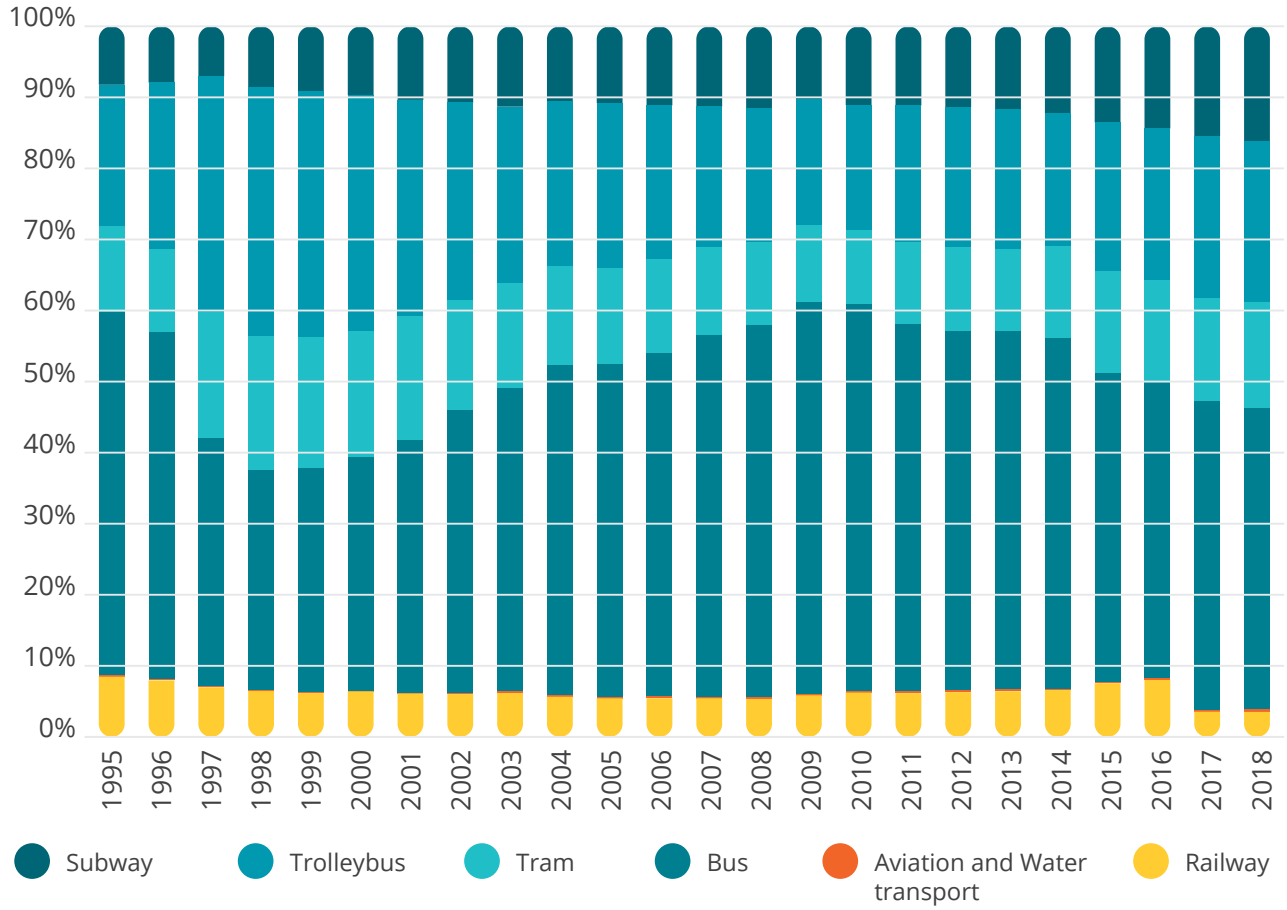

Figure 6. Share of passengers travelling by different modes of transport (State Statistics Service, 2019)*

** Aviation and water transport are combined to be more visible in the overall scheme. Data for 2014–2018 does not include data for the temporarily occupied territories of the Autonomous Republic of Crimea, Sevastopol and parts of the temporarily occupied territories of Donetsk and Luhansk regions. State Statistics Service of Ukraine. Tables "Transport – Number of passengers travelling by different modes of transport, 1995–2018": http://ukrstat.gov.ua/*

Electric micromobility (electric scooters, electric bicycles, etc.) can also contribute to reducing emissions by replacing shorter car trips, since it is much more energy efficient than cars, even electric-powered cars. Therefore, the creation of comfortable and safe conditions for micromobility (protected bicycle lanes, bike and scooter parking lots, electric bike- and scootersharing) is required to reduce CO_2 emissions.

The Transport Strategy of Ukraine expects to increase the share of electric transport up to 75% of inland traffic, which is achievable for public transport (although it is advisable to aim for a 100% transition to electricity). However, this is a rather ambitious goal for private motorized transport. Although challenging, gradually withdrawing gas and diesel vehicles and replacing them with electric vehicles, and reducing the usage of cars to 10% in overall distribution, reaching 75% of electric mobility by 2030 seems challenging, but possible.

GOAL 3 Increase the share of rail transportation

	Baseline	Target for 2030
The proportion of passenger traffic transported by rail	3,5%	15%
The proportion of freight transported by rail	51%	70%
Percentage of electrified railways	47,2%	70%

Units:

- The proportion of passenger traffic transported by rail;
- The proportion of freight transported by rail;
- Percentage of electrified railways.

Baseline:

- The proportion of rail passenger traffic out of total passenger traffic: 8% in 2016; 3.5% – 2017 and 2018[104];
- The proportion of freight transported by rail – 51.6% in 2018[105];
- The percentage of electrified railways – 47.2% in 2017[106].

Target for 2030:

- At least 15% of passengers are transported by rail;
- 70% of freight is transported by rail;
- 70% of railways have been electrified railways

RATIONALE

Greenhouse gas emissions from railway in Ukraine constitute approximates 500,000 tons of CO_2 equivalent per year, or 1.6% of all greenhouse gas emissions. However, annually, more than 500 million passengers, or about 6–8% of all passenger traffic[107], are able to be transported by rail. Reducing greenhouse gas emissions is one of the reasons why rail transport is advisable to develop, in particular by reducing investment in road transport.

European countries give priority to rail transport for long-distance and suburban connections. In 2011, they set out to complete an all-European rail high-speed network by 2050 so that most mid-range passenger journeys would be performed by rail[108]. Germany plans to invest around Euro 86 billion to expand and modernize the railways by 2030[109], and France aims to build 2,000 km of new railway tracks by 2020 and another 2,500 km after that[110].

It is advisable for Ukraine to develop rail services to reach at least 15% of the country's total passenger traffic by 2030, which is twice as much as in 2016. It is also important to modernize the systems for heating passenger train cars in order to stop heating them with coal. Rail services are not only an alternative to long-distance road transport, it can also discharge the number of people on suburban

[104] State Statistics Service of Ukraine. Statistical tables "Transport" for the period from 1995 to 2016: http://ukrstat.gov.ua/

[105] State Statistics Service of Ukraine, Volume of goods transported by modes of transport: http://ukrstat.gov.ua/. These data take into account freight transport by road, excluding transportation to serve the needs of own production and transport that is owned by individual entrepreneurs (IP). Together with IP and own production, in 2018 the share of freight transported by road constitued 73.4%, and by rail – only 19.6%.

[106] State Statistics Service of Ukraine. Operating Length of Public Roads, 2017.

[107] State Statistics Service of Ukraine. Transport statistics tables for the period from 1995 to 2016. In Ukraine during the period 2017–2018, the percentage of rail transportation fell to 3.5% (about 160 million passengers per year): http://ukrstat.gov.ua/

[108] European Commission, 2011. White Paper Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0144

[109] https://www.cleanenergywire.org/factsheets/germanys-2030-climate-action-package

[110] https://ec.europa.eu/environment/archives/networks/greenspider/doc/climate_change_campaigns/ccc_france.pdf

destinations, especially near heavily populated cities (Kyiv, Lviv, Dnipro, Kharkiv). Urban railways as an alternative to the subway and the light rail relevant in major cities (Kyiv, Kryvyi Rih, Dnipro).

Freight should also be transferred to the rail. According to the State Statistics Service of Ukraine, the share of rail freight transportation has fallen from 60 to 51.6% since 2010, while the road freight transportation has increased from 9.9 to 30%. The Transport Strategy of Ukraine notes the need for partial reorientation of freight to rail and water transport but does not set any measurable objective. By setting a target similar to that of the EU, which aims to transfer 30% of road freight by rail and water by 2030[111], Ukraine can achieve 60–70% of rail freight.

Less than half of Ukraine's railways are electrified (47.2% in 2017, according to the State Statistics Service of Ukraine). It is necessary to electrify the railroad tracks in order to reduce greenhouse gas emissions from the railway transportation, especially if passenger and freight traffic increases. Currently, over 60% of EU tracks are electrified and over 80% of passengers and freight are transported by electronically powered freight[112]. Although the Transport Strategy of Ukraine has not set a goal for track electrification, it is advisable to move up to 100% of electrified tracks by 2050 and 70% by 2030.

[111] European Commission, 2011. White Paper Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.

[112] European Commission, 2017. Electrification of the Transport System; International Energy Agency, 2019. The Future of Rail: https://www.iea.org/reports/the-future-of-rail

WASTE

Legislative framework, regulatory and institutional conditions for achieving the goals in the household waste management sector

An array of changes are required to reduce the impact of waste management policy on climate change. The prerequisites for these are the adoption of new legislative acts and the introduction of amendments to the current regulatory acts. In particular, it is crucial to:

- To adopt laws on both waste management and waste disposal. This will allow the introduction of European approaches to waste management and enable Ukraine to set stricter requirements for the landfill operation and their maintenance in the post-exploitation period;
- To adopt a law on packaging and packaging waste and the necessary by-laws, which will allow the implementation and extension of producer responsibility principle on practice, which is modelled and operating in EU countries. The implementation of this principle should lead to an increase in the recycling of resource components of household waste and to reduce their landfill. In addition, it is planned to create an integrated information system; in particular, it will allow for monitoring, generation and further processing of green waste as an element of adaptation for cities to implement against climate change;
- To adopt by-laws to create a mechanism to set tariffs for waste disposal and to include in the tariff of the costs of landfill decommission and land restoration (in the tariff for municipal waste management services);
- To amend the Tax and Budget Codes of Ukraine in order to increase the rate of environmental tax on waste disposal (for waste of all hazard classes) and to channel received revenues to special environmental funds (as of 2019, 45% of the total tax revenue goes to the general state budget). These changes will contribute to the development of other technologies, as landfill waste will become a less acceptable option not only from an environmental but also an economic point of view. In addition, the funds accumulated in the special funds will be spent on environmental issues only. Alternatively, it is advisable to set up a separate Waste Management Fund. Implementation of these changes requires a preliminary feasibility study to be carried out;
- To review the National Waste Management Strategy by 2030 to assess if the indicators identified in the final sections of the Strategy are achievable in: number of municipal waste processing facilities, municipal waste incineration facilities, volume of municipal waste disposal;
- The target indicators for the recycling of household waste should be set;
- To develop a waste prevention program and a waste management plan in accordance with the EU-Ukraine Association Agreement and Directive 2008/98/EC;
- To review existing strategic planning documents (strategies, plans, programs) to take into account additional waste management measures that have an impact on climate change.

Part of the changes will apply to the process of developing regional waste management plans (RWMP), that include a section on household waste management. In particular, the RWMP should:

- Provide an inventory of existing landfills;
- If feasible, either bring existing landfills in line with the requirements of ecological safety or decommission them;

- Create new regional waste management facilities – landfills, facilities for recycling household waste;
- Use differentiated approaches to the planning and organization of household waste (HW) management in rural and urban areas.

In rural areas and in private households, priority should be given to providing the public with HW removal services (to prevent the creation of unauthorized landfills) and the introduction of home composting, as foreseen by the National Waste Management Strategy of Ukraine until 2030.

GOAL 1 Increase the amount of recycled resource components and dispose of mixed household waste

	Baseline	Target for 2030
Recycling household waste	4,2%	12%

Under more ambitious efforts applied, a percentage of recycling can reach **25%**

Units:

- The share of resource components of household waste collected through separate waste collection in the total amount of waste generated in the current year,%;
- The share of recycled household waste in the total amount of household waste generated,%.

Baseline: In 2018, 4.2% of household waste was recycled. This indicator has barely changed from previous years (4.18% in 2017 and 3.09% in 2016). The household waste utilization rate in 2018 constituted 6.2%[113].

Target for 2030:

- 12% of resource components of household waste collected through separate waste collection in the total amount of waste generated in the current year. Applying more ambitious efforts, a 25% of recycling can reach[114].

Sub-target 1. Composting in households is introduced; 3%.of green waste in settlements is composted

RATIONALE

The main problem is that the revenue from the sale of recyclables (for sorting lines available in Ukraine) does not cover all the costs of separate collection and sorting.

As of the 3rd of September 2019, separate collection of household waste was implemented in 1462 settlements[115]. In Ukraine, the number of settlements with separate collection is increasing every year (53 settlements in 2009, 185 – 2011, 398 – 2015, 822 – 2017)[116]. However, only 2–3% of total household waste is separated into containers for resource components. According to various experts, the potential content of resource components in household waste ranges from 25 to 30%[117].

However, given the dynamics of the implementation of separate collection of municipal waste (about 0.75% of growth in 1 year), by 2030, potentially 12% of household waste can be recycled. Thanks to the introduction of composting in private households and the creation of pilot composting

[113] Ministry of Development of Communities and Territories of Ukraine. Information on the implementation of modern methods and technologies in the field of household waste management.

[114] The figure can be achieved by creating additional waste disposal facilities with a total capacity of 450–500 thousand tons / year. Recycling included. The number of sites will depend on the capacity of each of them and the local conditions. The capacity of the facility is determined at the stage of developing a regional or local waste management plan and is refined at the feasibility stage.

[115] Ministry of Development of Communities and Territories of Ukraine. Information on the implementation of modern methods and technologies in the field of household waste management.

[116] State of household waste management in Ukraine for 2015.

[117] Draft of the National Waste Management Strategy for further public consultation.

sites in green areas of settlements, another 3% of household waste can be recycled by 2030.

In Ukraine there is no problem with the recycling of already prepared secondary raw materials (after additional sorting of separately collected resource components). As of 2018, there are 17 cardboard factories in the country that use waste paper for the production of new products, 39 enterprises engaged in the recycling of polymer waste, 19 enterprises for the recycling of PET bottles, 16 enterprises using glass cullet for manufacturing of new products, as well as enterprises using scrap metal in technological processes[118].

In order to sufficiently provide these capacities with secondary raw materials in Ukraine, it is necessary to introduce a mechanism for the implementation of the extended responsibility principle of the manufacturer. This must be introduced and implemented during product design stages, but also for the waste resulting from the use of these products, in particular for their collection and processing, which implies responsibility for all stages of product life.

As of January 1 2018, in Ukraine in accordance with the provisions of the Law on Waste, there is a ban on the disposal of unprocessed household waste. However, this rule is not fulfilled due to the lack of the necessary infrastructure for this purpose, namely, factories for the recycling and preparation of household waste. It should be noted that the presence of such businesses will reduce the amount of household waste, hence it is necessary to begin with creating favorable investment conditions for the construction of new facilities. For this purpose, it is necessary to guarantee availability and continuous supply of household waste in volumes necessary for the operation of such plants, as well as to create mechanisms for long-term financing of projects (with payback periods of 10–20 years).

To realistically evaluate the achievement of these targets, the accounting and reporting system needs to be improved.

[118] Association of Ukrvtorma, 2018. Presentation on Waste management – 2018: http://wm-expo.com/en/vse-vistavki/wm-2018/itogi-wm-2018

GOAL 2 Reduction municipal solid waste disposal

	Target for 2030	Baseline
The amount of landfill	75%	93,8%
The amount of waste per capita (t/person/year)	0,20	0,30

Units:

- Share of disposed household waste of the total volume of waste generated,%;
- Amount of waste per capita.

Baseline:

- In 2018, 93.8% of the household waste has been landfilled[119];
- The amount per capita of waste landfilled is about 0.30 t/person/year[120].

Target for 2030:

- The amount of landfill has been reduced to 75% (subject to the construction of new facilities of regional waste management plants) of the total amount of household waste generation;
- The amount of waste per capita has been reduced by 0.20–0.23 t/person/year (including recyclables)[121].

Sub-target 1: Disposable plastic bags are prohibited from 2020.

Sub-target 2: Disposable packaging is prohibited from 2023, and the principle of extended producer responsibility is introduced.

RATIONALE

An array of strategies could be implement to reduce solid municipal waste that is dumped into landfill. These include reducing waste generation, introducing technologies for reuse, separating collection of household waste, recycling and disposing waste safely, in accordance with the waste hierarchy (Fig. 7). The waste hierarchy is laid down in Directive 2008/98/EC; Ukraine took an obligation to implement this directive in accordance with the Association Agreement with the EU. The introduction of these technologies is limited by the availability of technology itself, as well as by legislative and regulatory factors, the need to raise tariffs on waste management services for the public.

In 2018, approximately 9 million tons of municipal solid waste was generated. 2% of this was burned at the incineration plant Energy, 4.2% was processed at secondary raw materials collecting points and waste recycling plants.

The reduction of disposal volumes should first be ensured by preventing their formation. Therefore, regulatory mechanisms such as the ban on disposable packages and disposable plastic bags, as well as the introduction of cost-effective incentives to support waste reduction, are the key to the most desirable and economically feasible path to reduction of waste disposal.

It is both advisable and desirable to introduce separate collection of waste with the subsequent directing of resource components to recycling and

[119] Ministry of Development of Communities and Territories of Ukraine.State of household waste management in Ukraine for 2018.

[120] Solid municipal waste in Ukraine: potential for development. Solid Municipal Waste Management Scenarios: https://bitly.su/8L1Fwl

[121] Indicative assessment. The indicator was calculated based on the assumption that as GDP grows by 1%, the volume of SMW will increase by 0.2%. According to Sandra Cointreau. City documents. Occupational and environmental issues of solid municipal waste management. The average annual GDP growth of Ukraine is estimated by the World Bank to be at level of 3.7–4.2% (https://emerging-europe.com/news/world-bank-upgrades-gdp-forecast-for-ukraine/). It is taken into account that the landfill utilization rate by 2030 will reach 22%, including recycling – 17%.

WASTE MANAGEMENT HIERARCHY

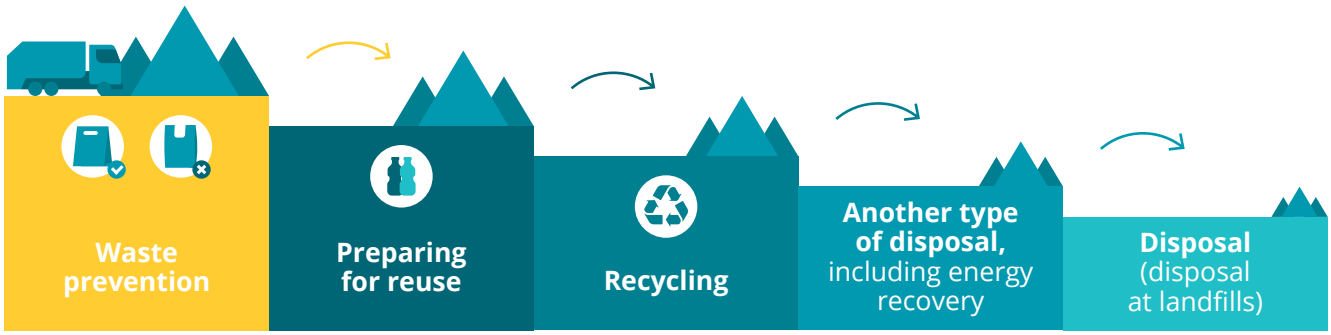

Figure 7. Waste management hierarchy.*

** Best European Waste Management Practices (Handbook) / A. Voytsikhovskaya, O. Kravchenko, O. Melen-Zabramna, M. Pankevich [head. ed. O. Kravchenko] – Lviv: Manuscript Company Publishing House, 2019. – 64 p.: http://epl.org.ua/wp-content/uploads/2019/07/Krashchi_ES_praktuku_NET.pdf*

organic to composting. Given the dynamics of the implementation of separate collection of household waste (about 0.75% of growth for 1 year), by 2030, potentially 12% of household waste could be recycled through a separate collection system. Thanks to the introduction of composting in private households and the creation of pilot composting sites, another 3% of household waste could be recycled by 2030.

The waste-to-energy technologies[122] are undesirable solutions in terms of both the decarbonisation of the economy and the impact on the environment, health and the conservation of valuable resources. To date, construction of two municipal waste disposal facilities (integrated facilities in Kharkiv and Lviv oblasts) with a total capacity of up to 320,000 tons/year has already begun in Ukraine. It is planned that they will be put into operation somewhere between 2022 to 2023. That is, a real reduction in the volume of disposal of unprocessed municipal solid waste (MSW) can be expected no earlier than 2023. Provided that additional facilities with a total capacity of 450–500 thousand tons / year will be commissioned during 2023–2030, and this will include sorting and recycling of resource constituents of household waste, by 2030 it may be possible to reach a recycling rate of about 10% more. It is also equally appropriate to achieve this reduction through waste reduction measures.

Hence, by 2030 it is possible to reach an indicator of up to 75% of the disposal of household waste from the total volume of their generation.

The data available today is not very reliable, so further steps are needed to improve the accounting and reporting system to monitor compliance with the targets. In order to ensure proper management, attention should be paid to monitoring the system, especially the volume of generation and subsequent management of household waste and its individual components. In the presence of dynamic reliable information and analytical data, it will be possible to develop a set of realistic and effective measures aimed at preventing the generation of household waste.

[122] Ministry of Development of Communities and Territories of Ukraine, 2019. Information on implementation of modern methods and technologies in the field of household waste management: http://www.minregion.gov.ua/napryamki-diyalnosti/zhkh/terretory/informatsiya-shhodo-vprovadzhennya-suchasnih-metodiv-ta-tehnologiy-in-sphere-povodzhennya-with-pobutovy-vidhodami-4/

GOAL 3 Reduction greenhouse gas emissions from landfills

Methane emissions from landfills
(million tonnes of CO_2 equivalent)

Target for 2030 7,1 — **Baseline** 8,1

In case of full implementation of the National Waste Management Strategy in Ukraine by 2030: GHG emissions are reduced by 25% compared to the level of 2017

Units: Methane greenhouse gas emissions, million tons of CO_2 equivalent[123] and%.

Baseline: Methane emissions from landfills at landfills and landfills in 2017 were 8.1 million tonnes of CO_2 equivalent.

Targets for 2030:

- Under the realistic scenario presented in this document (Goal 2. Reduction of municipal solid waste disposal): GHG emissions will have been reduced by 12.5% compared to 2017;
- In case of full implementation of the National Waste Management Strategy in Ukraine by 2030: GHG emissions will have been reduced by 25% compared to the level of 2017.

RATIONALE

Gas produced by landfill is formed as a result of biodegradation of organic matter in the MSW under anaerobic conditions. Generalized estimates indicate that landfill gas contains up to 50% methane and 50% carbon dioxide; there are also minor impurities of hydrogen, hydrogen sulfide, nitrogen oxides and the like. It is the methane component that affects global climate change, as methane is a potent greenhouse gas with a global warming coefficient of 25 compared to CO_2. However, carbon dioxide emissions from the decomposition of MSW does not count towards the global carbon footprint, as these are biomass emissions[124].

The amount of landfill methane formed depends primarily on the component composition of the MSW and the conditions for their disposal. Other important factors are the water regime, the concentration of pathogens and climatic conditions. Moreover, in the context of global warming, the intensity of landfill methane formation will increase, especially in Ukraine, where it is expected that the average annual long-term air temperature in the 21st century will increase much more than the average air temperature in the world[125]. In regard to the landfill conditions, emissions from the same landfill specimen buried at a properly equipped landfill will be 2–3 times lower than at an unauthorized landfill 4 to 5 m deep.

Landfills and waste dumps are the only significant source of greenhouse gas emissions in Ukraine, which has a steady tendency to increase annually since 1990, except for the last reporting year, when emissions decreased by 1.1% compared to the previous year due to an increase of landfill gas utilization for electricity production. General information on the formation of landfill methane from landfills and landfill sites and the volumes of its disposal are shown in Figure 8. It also implies that the proliferation of landfill gas utilization systems in 2017 has prevented an increase in methane emissions compared to 2016, while its generation has increased by 1.2%. In general, the methane contribution from landfills at landfills and waste dumps in Ukraine amounted to 2.6% of total greenhouse gas emissions in Ukraine, or 12.8% of total methane emissions, with these indicators increasing year on year.

[123] National Inventory Report, 2019. Common reporting format tables: https://unfccc.int/documents/195606

[124] IPCC, 2006. Guidelines for National Greenhouse Gas Inventories.

[125] V. A. Balabukh, L. V. Malitskaya, S. N. Yagodinets, E. N. Lavrinenko. Projections of changes in climatic averages and extreme extremes of thermal regime in Ukraine by the middle of the 21st century // Prirodopolzovanie.– Minsk, Republic of Belarus, 2018.– № 1.– p. 97–113.

METHANE GREENHOUSE GAS EMISSIONS FROM LANDFILLS AND WASTE DUMPS IN UKRAINE FROM 1990 TO 2017

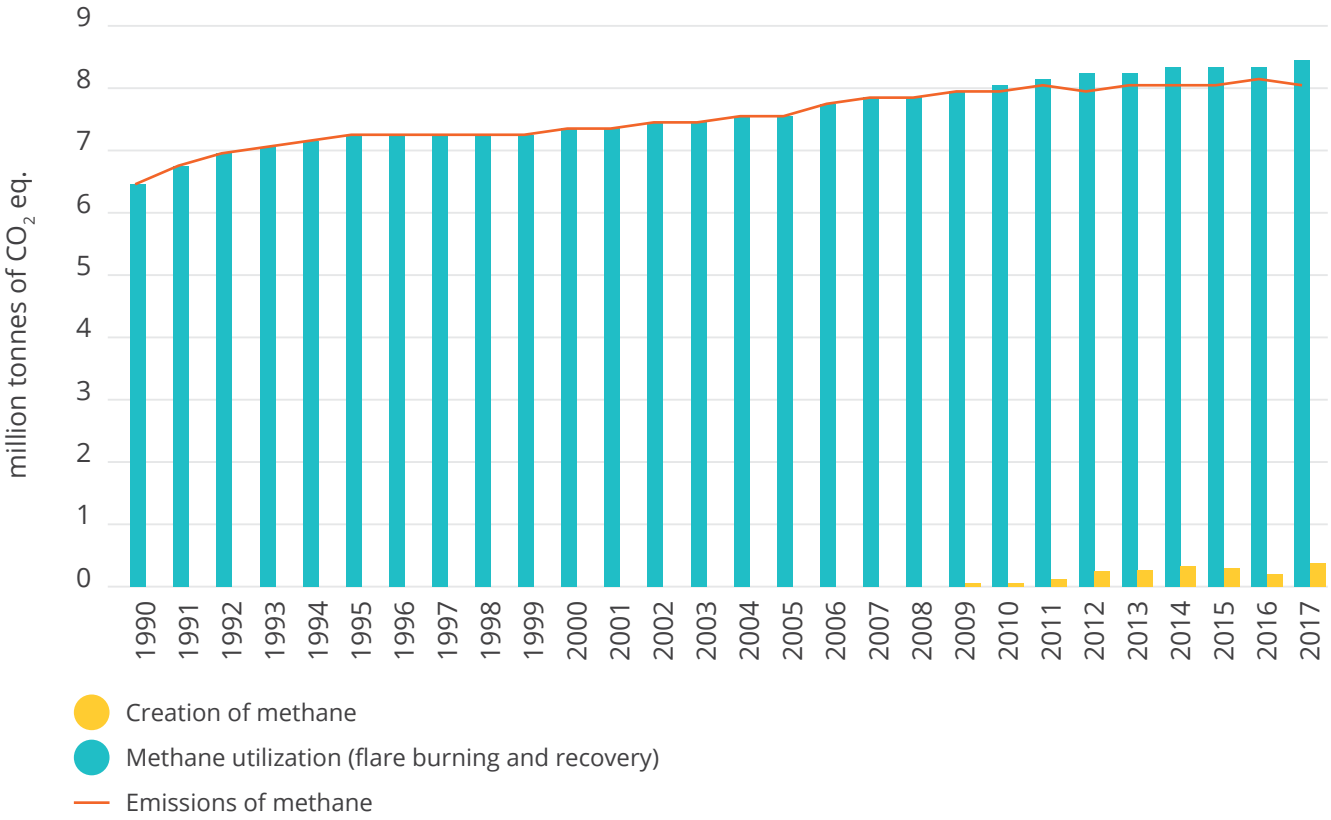

Figure 8. Methane greenhouse gas emissions from landfills and waste dumps in Ukraine from 1990 to 2017 (National Greenhouse Gas Inventory, 2019).

A list of the most effective feasible measures to reduce greenhouse gas emissions in Ukraine was formulated in the «Technology Needs Assessment in Ukraine»[126] project framework. This framework focuses upon on measures applicable to MSW landfills and waste dumps, namely:

- the introduction of landfill gas recovery systems at landfills: recovery systems for all new and large old landfills and flare systems at medium and small landfills, where appropriate in order to reduce the negative environmental impact;
- reducing the share of MSW landfill disposal from the total amount of their formation (through recycling, composting);
- reduction of biodegradable components content in landfilled waste;
- closing outdated landfills and eliminating illegal waste dumps.

It should be noted that the main barrier to reducing methane emissions from landfill in Ukraine in the short term is not the institutional or infrastructure components. The problem lies in the hundreds of millions of tons of landfill that has previously been stored in poorly equipped landfills and waste dumps. An additional problem is the limited efficiency of collection recovery and flare systems. If no effective measures are taken to reduce methane emissions from landfills in the near future, their contribution to total greenhouse gas emissions in Ukraine by 2030 could reach 5%.

With regard to the impact on GHG emissions from landfill sites, the key provisions of the National Waste Management Strategy to 2030 (2017) and

[126] TNA, 2019. In 2020, within the framework of the project "Technological Needs Assessment in Ukraine" there will be prepared separate reports on the existing barriers to transfer of climate-friendly technologies in the field of MSW management and ways of their elimination, as well as specific examples of feasibility studies for introduction of such technologies in Ukraine.

the National Waste Management Plan to 2030 (2019) are:

- To reduce MSW disposal by up to 30%, including by increasing bio-waste composting capacity to 500 sites;
- To create a network of regional landfills comprising of 50 objects (with landfill gas systems);
- To reduce the number of municipal waste dumps from 6,000 to 300 sites.

However, objectively, the targets declared in the National Waste Management Strategy for Ukraine by 2030 are too ambitious and are unlikely to be met and therefore need revision.

According to expert assessments on the basis of the IPCC GHG estimation methodology[127] and the baseline data of the National inventory report of anthropogenic GHG emissions and sinks in Ukraine for 1990–2017[128], the annual methane emissions from landfill at waste dumps in Ukraine will constitute approximately 6 million tons of CO2 equivalent by 2030, which is 25% below 2017 level. In order to achieve this, there should be implemented technologies defined within the project, Technological Needs Assessment in Ukraine (TNA, 2019). The second condition is that there is stable economic growth in place. The third prerequisite is the full implementation of the provisions set out in the National Waste Management Strategy in Ukraine until 2030[129] and the National Plan for Waste Management by 2030[130].

Considering the current situation in MSW management sphere in Ukraine, it can be expected that by 2030 the landfill disposal rate will rise to 75%, about 25 landfills will be put into service or upgraded, and the centralized waste collection services will be provided to 90% of households. Under such a realistic scenario, greenhouse gas emission reductions from landfill sites will reach about 12.5% compared to 2017.

[127] IPCC Guidelines for National Greenhouse Gas Inventories: 5 Volumes / [TFI IPCC]; edited by H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, K. Tanabe – Hayama: IGES, 2006.– Vol. 5: Waste / [R. Pipatti and S. M. Manso Vieira]; edited by D. Kruger, K. Parikh.– 2006.

[128] Ministry of Environment and Natural Resources, 2019. National Greenhouse Gas Inventory: sources and sinks in Ukraine for 1990–2017.

[129] Cabinet of Ministers of Ukraine. Order "On approval of the National Waste Management Strategy in Ukraine until 2030" of February 20, 2019 № 117-p.

[130] Cabinet of Ministers of Ukraine. Order "On Approval of the National Waste Management Plan for Ukraine by 2030" of November 8, 2017 No. 820-p.

AGRICULTURE AND FORESTRY, LAND USE

Legislative framework, regulatory and institutional conditions for achieving the goals in the agriculture and forestry, land use sectors

Agriculture and forestry and other forms of land use produce 23% of global greenhouse gas emissions[131], while at the same time more than other sectors are affected by climate change right now. The peculiarity of this industry is that it is both a source of greenhouse gas emissions and their absorber. In addition, emission reduction measures in this sector often do not require significant and cost-effective technological upgrades, and reorientation of production can be flexible enough to make the necessary changes due to the relatively short production cycle, known as production periods. All this in combination makes it possible to achieve significant emission reductions in a shorter time and at less cost.

Agriculture in Ukraine is one of the key sectors of the economy as it ranks third in source of GDP, leads in exports and shows a steady upward trend. GHG emissions from industry, excluding land use, land-use change, and forestry (LULUCF), in 2017 accounted for 12.2% of the total structure, or 39074,48 CO_2 equivalent[132]. Although emissions have fallen by 56% since 1990, the industry shows an upward trend in greenhouse gas emissions, which has increased by more than 30% over the last reporting decade (2007–2016)[133].

The LULUCF sector, which has a strong dual function in terms of emissions, absorption and retention, tends to reduce greenhouse gas absorption. In 2016, the absorption rate reached the lowest value and amounted to –1.8 Mt CO_2 equivalent, in 2017 it rose to –10.2 Mt CO_2 equivalent, but was still 83% lower than the level greenhouse gas absorption by the sector in 1990. The leveling of emissions in this sector has decreased to a large extent due to the tendency towards intensification of agricultural activities, particularly in agriculture. The reduction of greenhouse gas absorption by forests due to the decrease of their quantitative and qualitative characteristics.

On August 14, 2019, the Cabinet of Ministers of Ukraine issued decree No. 688-p «On Approval of the Irrigation and Drainage Strategy in Ukraine for the Period up to 2030»[134]. However, the approved Strategy is not based on the principles of climate change prevention. The main vector of the document is the growth of irrigation volumes to temporarily maintain agricultural production volumes. The indirect consequences of the increase in irrigation volumes in the steppe zone of Ukraine in the future, including large-scale salinisation and soil erosion, i.e. desertification. It is therefore necessary to amend this document in order to adapt it to the objectives of global climate change prevention and desertification.

Significant amounts of the emissions are caused by the intensification of the agricultural sector. The requirements for current and effective technological processes and management methods are stated in the EU directives, which are to be implemented at national level, in particular in the Directive 2010/75/EU on industrial emissions[135] (including Commission Implementing Decision (EU) 2017/302) and the Directive 91/676/EEC concerning the protection of waters against pollution

[131] IPCC, 2019. Summary for Policymakers of the Special Report on Climate Change and Land.

[132] Ministry of energy and environmental protection of Ukraine, 2019. Ukraine's Greenhouse Gas Inventory 1990–2017.

[133] Technology Needs Assessment Report – Mitigation.

[134] Irrigation and drainage strategy in Ukraine until 2030: https://zakon.rada.gov.ua/laws/show/688–2019-%D1%80

[135] Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075

caused by nitrates from agricultural sources (the Nitrates Directive)[136]. These directives identify a list of Best Available Techniques and Best Agricultural Practices that have the potential to prevent or significantly reduce pollution and emissions. The implementation of these requirements and standards is envisaged through the development and approval of the following documents:

- The Law of Ukraine «On the prevention, reduction and control of industrial pollution», which, introduces the notion of «best available technologies», which should become the basis for conducting of business activities;
- The Law of Ukraine «On the National Pollutant Release and Transfer Register" in order to create a transparent monitoring and control system for emissions;
- The Code of Best Agricultural Practices that would regulate the use of fertilizers (terms of application and storage) and Manure Management;
- To amend the current Law of Ukraine «On animal by-products not intended for human consumption»[137] in accordance with the Best Available Techniques and Best Agricultural Practices.

In addition, climate policy should be reflected in sectoral strategies, programs and action plans. For example, the integration of environmental and climatic aspects into the development of agriculture was identified as one of the priorities in the draft of the Integrated Strategy for the Development of Agriculture and Rural Territories in Ukraine for 2015–2020,. The indicator of implementation was «reduction of greenhouse gas emissions from agricultural sources by 20% by 2020» (base year not specified)[138]. However, the document was not implemented.

In 2019, a draft State Target Program for the Development of the Agricultural Sector of the Economy for the Period up to 2022 was developed[139], which, to some extent, described the need for adaptation to climate change in agriculture and forestry in Ukraine. This year, a draft Strategy for the Prevention and Adaptation to Climate Change of Agriculture, Forestry, Hunting and Fisheries of Ukraine by 2030 was developed[140]. The work on the document has begun in the Ministry of Agrarian Policy and Food of Ukraine and should be continued in the newly created Ministry of Economic Development, Trade and Agriculture of Ukraine. This strategy may be the first sectoral document aimed at creating a system of prevention and adaptation to climate change in the agricultural sector.

In forestry sector, legislative changes should be made both to the Forest Code of Ukraine and by-laws. These include the development and implementation of:

- the state program for afforestation of degraded lands of the forest zone of Ukraine,
- an inventory of self-forested agricultural lands and transfer them to forest land category, and
- the provision of state funding for forest protection measures.

It is necessary to ensure that by 2030 the pre-approved indicators are achieved, namely: additional decommissioning of 15% of arable land; increasing the area of pastures and hayfields to 15.8% of the country and, as a consequence, restoring fertility through the deposition of carbon in the soil. These imperative indicators are outlined in the following documents:

- Laws of Ukraine "On the Fundamental Principles (Strategy) of the State Environmental Policy of Ukraine until 2020" of December 21, 2010;
- National Action Plan for Combating Land Degradation and Desertification No. 271-p of March 30, 2016;
- Strategies to improve the management mechanism in the field of use and protection of state-owned agricultural lands, June 7, 2017 No. 413;
- Laws of Ukraine "On the Fundamental Principles (Strategy) of the State Environmental Policy of Ukraine until 2030" of February 28, 2019.

[136] Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31991L0676

[137] Law of Ukraine "On animal by-products not intended for human consumption" https://zakon.rada.gov.ua/laws/show/287–19

[138] Integrated Strategy for the Development of Agriculture and Rural Territories in Ukraine for 2015–2020.

[139] Draft state target program for development of agro sector of economy for the period up to 2022

[140] The climate component of the German-Ukrainian Agrarian Policy Dialogue project: https://apd-ukraine.de/ua/klimat/robocha-grupa

GOAL 1 Increase forest carbon sink and carbon sequestration

Greenhouse gas emission/sink by forests
(million tonnes of CO_2 equivalent/year)

Baseline 51 — **Target for 2030** 75,6

Units: Greenhouse gas emission/sink by Ukrainian forests, million tons of CO_2 equivalent/year.

Additional units for ***Sub-target 1:*** forest area of Ukraine, thousand hectares; for ***Sub-target 2:*** average annual area of fires, thousand ha; for ***Sub-target 3:*** forest biomass, t/ha; for ***Sub-target 4:*** not defined.

Baseline: –51 million tons of CO_2 equivalent/year (2017)[141]. Additionally for ***Sub-target 1:*** 9537.9 thousand hectares, or 15.9% of the country's territory (2018)[142]; for ***Sub-target 2:*** 6700 ha (average for the year 2006–2015)[143]; for ***Sub-target 3:*** 18.7% of the area of mature and overgrowth stands from the total forest area[144]; for ***Sub-target 4:*** not defined.

Target for 2030: The amount of greenhouse gas has been reduced by 50% in Ukrainian forests

Sub-target 1: The forest area of Ukraine has been increased by 20% of the country's overall territory (additionally included in the forest fund 2.4 million hectares) by:

- development and implementation of the state program for afforestation of degraded lands of the forest zone of Ukraine;
- inventory of self-forested agricultural lands and transfer them to forest land category.

Sub-target 2: The area of fires in Ukrainian forests has been reduced by 50% by providing state funding for forest protection measures.

Sub-target 3: To increase the overall biomass volume of Ukraine's forests by:

- increasing the area of mature and overmatured forests to 20%;
- increase share of dead wood left in forests by prohibiting its removal in protected areas and establishing the minimum required amount of dead wood (30 m^3) in forests of other categories[145,146].

Sub-target 4: To ensure stable carbon sequestration and carbon retention by preventing degradation of forest biodiversity and forest habitats, in particular by:

- developing and implementing a national action plan on adaptation of forests to climate change;
- implementation of programs for national monitoring of forest biodiversity and inventory of forest habitats;
- implementation of sustainable forestry practices that do not lead to degradation of forest biodiversity and habitats.

RATIONALE

The level of carbon sequestration and retention by forests is influenced by the following: switching of forest territories to other land categories and vice versa (total forest area), forest fires and the removal of timber during forest management and the general condition of forest ecosystems (their degree of degradation). Unfortunately, the

[141] National Greenhouse Gas Inventory: sources and sinks in Ukraine for 1990–2017. Narrative part according to the UNFCCC standard.

[142] Official data of the State Forest Resources Agency of Ukraine for 2018.

[143] S. V. Zibtsev, O. M. Soshenskyi, V. V. Humeniek, V. A. Koren, 2019. Long term dynamic of forest fires in Ukraine. Ukrainian Journal of Forest and Wood Science, 10(3): 27–40.

[144] Makarenko A. S. Accounting and analytical support of sustainable forest management // Dissertation

[145] WWF, 2004. Deadwood – living forests.

[146] Flannigan et al., 2006. Forest Fires and Climate Change in the 21st Century. Mitigation and Adaptation Strategies for Global Change.

greenhouse gas sequestration figures of Ukrainian forests, as reported in official sources[147], are based on calculations using the total area of forests and their growth. However, it would be advisable to take into account indirect indicators such as, total forest biomass, age composition and presence of dead wood.

Forests cover about 15.9% of the territory of Ukraine[148]. However, official statistics only take the lands of the state forest fund into account. This means, the areas of self-forested agricultural and other lands that do not have the legal status of the forest fund, but are in fact, young natural forests, forest strips are not accounted for. Inventory of such territories was not carried out. Given that young forests have the highest capacity to absorb atmospheric carbon, it is necessary to implement a state program for the inventory of self-afforested lands and their inclusion to forest land category, which will ensure their proper protection in forest status. In addition, it is necessary to develop and implement a state program of afforestation of degraded agricultural lands of the forest zone of Ukraine.

It is important to prevent forest fires, the total annual area of which may increase due to climate change[149]. The effectiveness of forest fire prevention measures is significantly reduced. In particular, the relative area of fires in neighboring Poland, where an effective forest fire protection system is in place, is approximately twice as low. Therefore, in Ukraine, it is also advisable and possible to reduce the area of fire by halving them effectively. State funding for the protection of forests should be ensured, as well as increased enforcement in the area of fire prevention in areas adjacent to the forest fund.

Carbon emissions from forests are also increasing due to the harvesting of fuel wood, whose natural decomposition takes much longer. It is vital to reduce the volume of fuel wood harvesting by setting a minimum volume of dead wood per unit area of forest, abiding by scientific recommendations (at least 30 m^3)[150]. In addition, it is important to increase the proportion of mature and overmatured forests that serve the largest carbon depots up to 20%[151].

In addition to enhancing carbon sequestration and deposition, it is also important to ensure the continuity of such processes. According to scientific data, even optimistic climate forecasts suggest a decrease of forests in temperate zones and their degradation, which will adversely affect the carbon sequestration and retention of forests[152]. It is important to develop and implement a national action plan on adaptation of forests to climate change, which will also ensure the protection of forest biodiversity and habitats. The latter is of the utmost importance as systems with higher biodiversity are more resilient to climate change and have better adaptive capacity[153].

There is almost no scientific data on the state of forest biodiversity and the level of degradation of forests in Ukraine. It is vitally important to undertake large-scale monitoring of forest biodiversity and make an inventory of forest habitats. There must be an effective legal basis and enforcement ensured to prevent loss of forest biodiversity and degradation of forest habitats, increase the proportion of natural and close to natural resources.

[147] National Greenhouse Gas Inventory: sources and sinks in Ukraine for 1990–2017.

[148] State Agency of Forest Resources of Ukraine. 2016 Public Report: http://dklg.kmu.gov.ua/forest/document/178794; jsessionid=35B4BB09240AE5574400EEC013461126.app1;/01.Iushkevych.pdf; also Volinets I. G. The current state of development of Ukrainian forestry enterprises // Bulletin of the National University "Lviv Polytechnic". Management and entrepreneurship in Ukraine: stages of development and development problems.– 2015 http://nbuv.gov.ua/UJRN/VNULPM_2015_819_50

[149] Flannigan et al., 2006. Forest Fires and Climate Change in the 21ST Century. Mitigation and Adaptation Strategies for Global Change.

[150] Müller, Jörg & Bütler, Rita, 2010. A review of habitat thresholds for dead wood: A baseline for management recommendations in European forests. European Journal of Forest Research. 129. 981–992. 10.1007/s10342–010–0400–5.

[151] Kopiy L. I. Age structure of forests and prospects of its regulation in the western region of Ukraine // Scientific Bulletin of NLTU Ukraine.– 2004

[152] Locatelli et al., 2010. Forests and adaptation to climate change: challenges and opportunities. Forests and society – responding to global drivers of change. 21–42.

[153] Hooper et al., 2005. Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. Ecological Monographs, 75: 3–35.2.

GOAL 2 Reduction peat production and to recover peatlands

Peat production (thousand tons/year)

Target for 2030: 54

Baseline: 539

Units: Peat production, thousand tons/year; area of drained peatlands, thousand ha.

Baseline: 539 thousand tons (2018)[154]; none – requires analysis of areas of drained peatlands.

Target for 2030: Peat production has been reduced by 90%; completely drained peatlands are restored.

RATIONALE

Occupying only 3% of the Earth's surface, peatlands deposit more than 30% of the planet's soil carbon[155]. Peat use accounts for approximately 25% of anthropogenic greenhouse gas emissions from land and forest use[156].

According to the State Service of Geology and Subsoil of Ukraine, there are roughly 2 billion tons of peat deposits with geological reserves discovered and explored with varying degrees of detail in the territory of Ukraine. The total area of the deposits is about 1 million hectares; peat profitable cut-off exceeds 838 million tons. Peat reserves in industrial fields constitute 22.6 million tons, and the assured reserves of peat equals 2.1 million tons (for the production of peat briquettes – 0.7 million tons). Volyn Oblast (165 million tons, or about 20% of all industrial deposits in Ukraine) has the biggest reserves, with Rivne Oblast holding the second largest stock with over 133 million tons, or 16% of all Ukrainian reserves[157,158].

The rise in cost of traditional energy resources has led to an increase in fuel peat production in Ukraine[159]. In addition, there are significant areas of peatlands in Ukraine that have been degraded as a result of peat production in the past or that have been drained and planted with wood. Unfortunately, there is no official statistics on the areas of degraded and drained peatlands in Ukraine. Drained peatlands are sources of greenhouse gas emissions, including as a result of fires, which are extremely difficult to eliminate. Thus, it is necessary not only to significantly reduce the volumes of production of fuel peat, but also to restore the drained peatlands to reduce emissions in the future. An additional cause of carbon emission from peat is its use for enriching arable land: peat is used as compost and ground to soil, which causes its rapid decomposition and release into the atmosphere of greenhouse gases[160].

[154] State Statistics Service of Ukraine: http://www.ukrstat.gov.ua/druk/publicat/kat_u/2018/zb/12/zb_peru2017pdf.pdf

[155] IUCN: https://www.iucn.org/sites/dev/files/peatlands_and_climate_change_issues_brief_final.pdf

[156] FAO and Wetlands International, 2012. Peatlands – guidance for climate change mitigation through conservation, rehabilitation and sustainable use.

[157] State balance of mineral resources of Ukraine as of 01.01.2008 92. Peat.– K., 2008.

[158] State Service of Geology and Subsoil of Ukraine. State Geological Information Fund of Ukraine "Geoinform". Analysis of the state of the raw material base of peat and sapropel of Ukraine in 1991–1995. Report of the Department of Accounting for Solid Fuel Resources for the results of work performed in 1991–1995, in 9 volumes. Volume 1. Analysis of the state of the raw material base of peat. Explanatory note.– K., 1996.

[159] S. I. Veremeyenko, V. A. Strykha, A. M. Ozerchuk. Prospects of using peat for restoration of soil fertility // Bulletin of ZhNAEU.– 2017.– No. 1 (58).

[160] Sivy M. Y. Peat resources of Ukraine: current state, prospects of use // Scientific notes of Ternopil Volodymyr Hnatiuk National Pedagogical University. Series: Geography.– 2012.– № 1.– P. 81–86.

GOAL 3 Reduction emissions from agricultural land use

Baseline
Unplowed pastures and hayfields (steppes) in 2017 absorbed **0.4** million tonnes of CO_2 equivalent, in 1990 – **0.9**

Target for 2030
Zero emissions from land use (emissions are offset by absorption)

Units: Greenhouse gas emission/absorption by agricultural lands of Ukraine, million tons of CO_2 equivalent/year.

Baseline: 39.6 million tons of CO_2 equivalent/year (2016); unplowed pastures and hayfields (steppes) in 2017 absorbed 0.4 million tons of CO_2 equivalent, in 1990–0.9[161].

Target for 2030: Zero emissions from land use (emissions are offset by absorption).

Sub-target 1: Degraded lands have not been cultivated. By 2030, 15% of arable land has been further excluded from cultivation; the area of pastures and hayfields increased to 15.8% of the country.

Sub-target 2: Sustainable land use with a view to preventing and adapting to climate change, including by:

- Introduction of a system of monitoring of organic carbon content in soil and development of agrochemical studies of soil on agricultural lands;
- Support for climate technologies in agriculture, in particular organic farming and minimum tillage technologies;
- Stimulating changes in the structure of the acreage with increasing share of extensive use.

By 2030, Ukraine should aim to achieve land degradation neutrality (LDN). This can be defined as- a state, in which the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems[162].

RATIONALE

Sub-target 1: Formation of a fertile soil layer is a by-product of the activity of plants and organisms, saprophages. In arid conditions of the steppe zone the process of deposition is most effective, since the steppe vegetation retains atmospheric moisture in the surface layer of the soil, preventing the accumulated organic matter from decomposing[163]. However, the destruction of natural herbaceous vegetation, such as plowing, leads to the termination of deposition and also causes the emission of carbon previously accumulated by the soil. The plowing results in the release of up to 0.8 tons of carbon from 1 ha of arable land annually[164]. Ukraine has the largest share of agricultural and industrial land among European countries[165]. The area of plowed land in Ukraine is one of the largest in the world, reaching 57% of the country's territory and 78% of the area of agricultural land and is growing over the years[166,167,168]. In Europe, Denmark has the highest levels of plow-

[161] National Greenhouse Gas Inventory of Ukraine 1990–2017, Total Cropland та Total Grassland categories.

[162] Report of the Conference of the Parties on its twelfth session, held in Ankara from 12 to 23 October 2015: https://www.unccd.int/sites/default/files/sessions/documents/ICCD_COP12_20_Add.1/20add1eng.pdf#page=9

[163] Mordkovich V. G. Steppe ecosystems / V. G. Mordkovich; open ed. IE Smelyansky.– 2nd edition with amendments and corrections – Novosibirsk: Geo Academic Publishing House, 2014.– 170 p.

[164] Tool for estimation of change in soil organic carbon stocks due to the implementation of A/RCDM project activities (Version 01.1.0).

[165] The Land Assets of Ukraine in the World Land Resources and the current state of its use. Part 1 // Theoretical Foundations of the State Land Cadastre: Educ. manual / M. G. Stupen, R. Y. Gulko, A. Ya. Mikula, etc .; For the title. ed. M. G. Stupen.– 2nd edition, stereotyped.– Lviv: "New World-2000", 2006.– 336 p.

[166] Gavrilenko O. P. Ecogeography of Ukraine. Tutorial.– K., 2008.– 646 p.

[167] Center intelligence agency – The World Factbook. Ukraine: https://www.cia.gov/library/publications/the-world-factbook/geos/up.html

[168] Gordiychuk A. Regulation of shifts in the structure of agricultural land: institutional principles // Economist.– 2015.– № 9.

ing (53%), followed by Hungary (49%) and Poland (44.5%)[169]. The total area of agricultural land affected by water erosion alone is 10.6 million hectares of arable land (32% of their total area). The annual increase of eroded arable land area in Ukraine amounts to 60–80 thousand hectares. The annual humus loss is 0.65 t per 1 ha[170]. In general, degraded and unproductive soils in Ukraine cover one fifth of arable land (6.5 million ha), which is the largest level in Europe.

The legislation outlines two important tasks necessary for reducing the share of arable land in the oblasts by 5–10% by 2020. These are a) removing slopes with gradient of more than three degrees and water protection zones out of this category, and b) conserving degraded, low-productive and technologically polluted agricultural lands with their further afforestation and afforestation and alkalization of soil in the steppe zone[171]. The share of extensive agricultural land (hayfields, pastures) in the total territory of the country should increase from 13 to 15.8% of the country by 2030[172]. In addition to stopping carbon emissions, restoring vegetation will mean resuming its deposit.

An important additional goal will be the introduction of enforcement measures and the strengthening of control over new, mostly unauthorized, cases of plowing of virgin land on slopes and hollows. In recent years, this has become very widespread in the steppe zone of Ukraine for a number of reasons.

Sub-target 2: The new Strategic Framework for the period of 2018–2030 was approved during the 13th Session of the Conference of the Parties of the United Nations Convention to Combat Desertification (UNCCD), held in September 2017 (Ordos, China)[173],.To date, 116 countries have joined the process of setting voluntary national targets for land degradation neutrality (LDN), supported by the UNCCD Secretariat and a number of international partners through the Land Degradation Neutrality Target Setting Program[174]. Among these countries, more than 120 have already set such tasks, taking into account national circumstances and conditions. Between 2016 and2018, the Ministry of Environment organized a consultative process with the participation of the executive authorities, National Academy of Agrarian Sciences of Ukraine, National Academy of Sciences of Ukraine, non-governmental and international organizations and experts. This resulted in the study of possible directions for establishing voluntary national tasks for the achievement of R&D. The voluntary national goal of LDN is to increase organic carbon in soil by at least 0.1%, including to 0.10–0.16% in Polesie and 0.08–0.10% in forest-steppe and steppe zones. The base level is set for 2010 at 3.14% on average for Ukraine, 2.24% for Polesie, 3.19% for forest-steppe and 3.4% for steppe[175].

In order to achieve LDN it is necessary to increase the area of agricultural land certified for organic farming to 1 million hectares or more, or 10% of the total area of agricultural land. According to the Technology Needs Assessment Report, the introduction of organic farming has the potential to reduce greenhouse gas emissions by approximately 1 tonne of CO_2 equivalent per 1 hectare per year, and the technology implementation potential of up to 4 million hectares[176].

An alternative method for achieving the LDN goal is increasing the area of agricultural land that

[169] Sinitsky S. L. and others. Land Use of Agricultural Purposes of Kirovograd Region and Their Fertility // Scientific Papers of Kirovograd Regional State Design and Technology Center for Soil Fertility Protection and Product Quality.– T. 81.– Vyp. 68.– P. 8–11.

[170] Law of Ukraine "On the Fundamental Principles (Strategy) of the State Environmental Policy of Ukraine for the Period up to 2030" of February 28, 2019 // Verkhovna Rada of Ukraine, 2019, No. 16, p. 70.

[171] Law of Ukraine "On the Fundamental Principles (Strategy) of the State Environmental Policy of Ukraine for the Period up to 2030" of December 21, 2010; National Action Plan for Combating Land Degradation and Desertification No. 271-p of March 30, 2016; A Strategy for Improving the Management Mechanism in the Use and Protection of State-Owned Agricultural Lands and their Management, of 7 June 2017 No. 413.

[172] Land Degradation Neutrality: The Target Setting Programme: http://www.unccd.int/Lists/SiteDocumentLibrary/Publications/4_2016_LDN_TS%20_ENG.pdf

[173] Decision 7/COP.13 The future strategic framework of the Convention.

[174] Land Degradation Neutrality: The Target Setting Programme https://www.unccd.int/actions/ldn-target-setting-programme

[175] National Target Setting to Achieve Land Degradation Neutrality in Ukraine. Final country report: https://knowledge.unccd.int/sites/default/files/ldn_targets/2019–06/Ukraine%20LDN%20TSP%20Country%20Report.pdf

[176] Technology Needs Assessment. Mitigation: https://tech-action.unepdtu.org/country/ukraine/

uses low-till, no-till, strip-till approaches. to up to 3 million hectares, or 10% of the total agricultural land. It is during plowing that the largest amount of greenhouse gases, including CO_2, is released. According to a report from Ukraine's Technology Needs Assessment to prevent climate change, the carbon sequestration potential of the technology is approximately 0.7 tons of CO_2 equivalent per 1 ha per year, and the technology implementation potential is up to 10 million hectares.

In general, it is necessary to implement an agri-environmental approach to agriculture for all agricultural enterprises of Ukraine without exception – from small to large.

GOAL 4 Reduction livestock greenhouse gas emissions

Baseline
Livestock emissions constitute
10.5 million tonnes of CO_2 equivalent

Target for 2030
Livestock emissions do not rise from 2017 level

Units: CO_2 equivalent of GHG emissions (i.e. N_2O, CH_4, CO_2) from the full livestock production cycle.

Baseline: Livestock emissions constitute 10.5 million tons of CO_2 equivalent (emissions from intestinal fermentation and animal waste management)[177], but there are no estimates for the full livestock production cycle.

Target for 2030: Livestock emissions do not rise from 2017 level. Emissions from the full livestock production cycle were monitored.

Sub-target 1. The estimation of greenhouse gas emissions from livestock has been carried out, taking into account the entire production cycle (direct and indirect emissions are taken into account).

RATIONALE

Livestock has a significant contribution to the global greenhouse gas emissions and produces 16.5% of greenhouse gases, or 8.1 Gt CO_2 equivalent/year (2010), according to a methodology calculates direct and indirect emissions for the entire production cycle, starting from changes in land use and forage production for processing and transportation[178]. The main groups of emission sources, as indicated in figure 9 are enteric fermentation, forage production (production and use of organic and synthetic fertilizers, direct cultivation of fodder crops, land use change), manure management and energy consumption.

GREENHOUSE GAS EMISSIONS FROM LIVESTOCK BY SOURCES

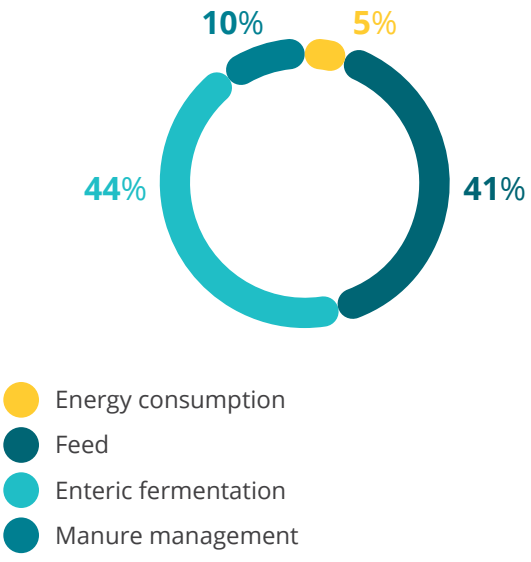

Figure 9. Greenhouse gas emissions from livestock by sources[179].

[177] National Greenhouse Gas Inventory of Ukraine 1990–2017: https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019

[178] Growing the Good. The Case for Low-Carbon Transition in the Food Sector, 2019: https://changingmarkets.org/wp-content/uploads/2018/10/Growing-the-Good-report-v3.pdf

[179] FAO. Global Livestock Environmental Assessment Model (GLEAM) 2.0.

In recent years, there has been an increase in poultry and pork production in the world, while livestock production is stagnant[180]. There is a similar trend in Ukraine: the cattle population has declined significantly since the early 1990s, which is also linked to the reduction of methane emissions from the agricultural sector, the main source of which is intestinal fermentation[181]. However, in less than a decade, poultry production in Ukraine has almost doubled and pork production has increased by a third[182]. Therefore, due to the inherent nature of animal husbandry, the significant environmental impact (greenhouse gas emissions, high water and land requirements, pollution of natural components, etc.) the livestock population and productivity should be adjusted to take into account environmental footprint and the demand for the healthy consumption of animal products.

KEY INDICATORS OF GREENHOUSE GAS EMISSIONS FROM THE SOURCES AND ABSORPTION BY THE AGRICULTURAL SECTOR IN UKRAINE IN 1990–2017

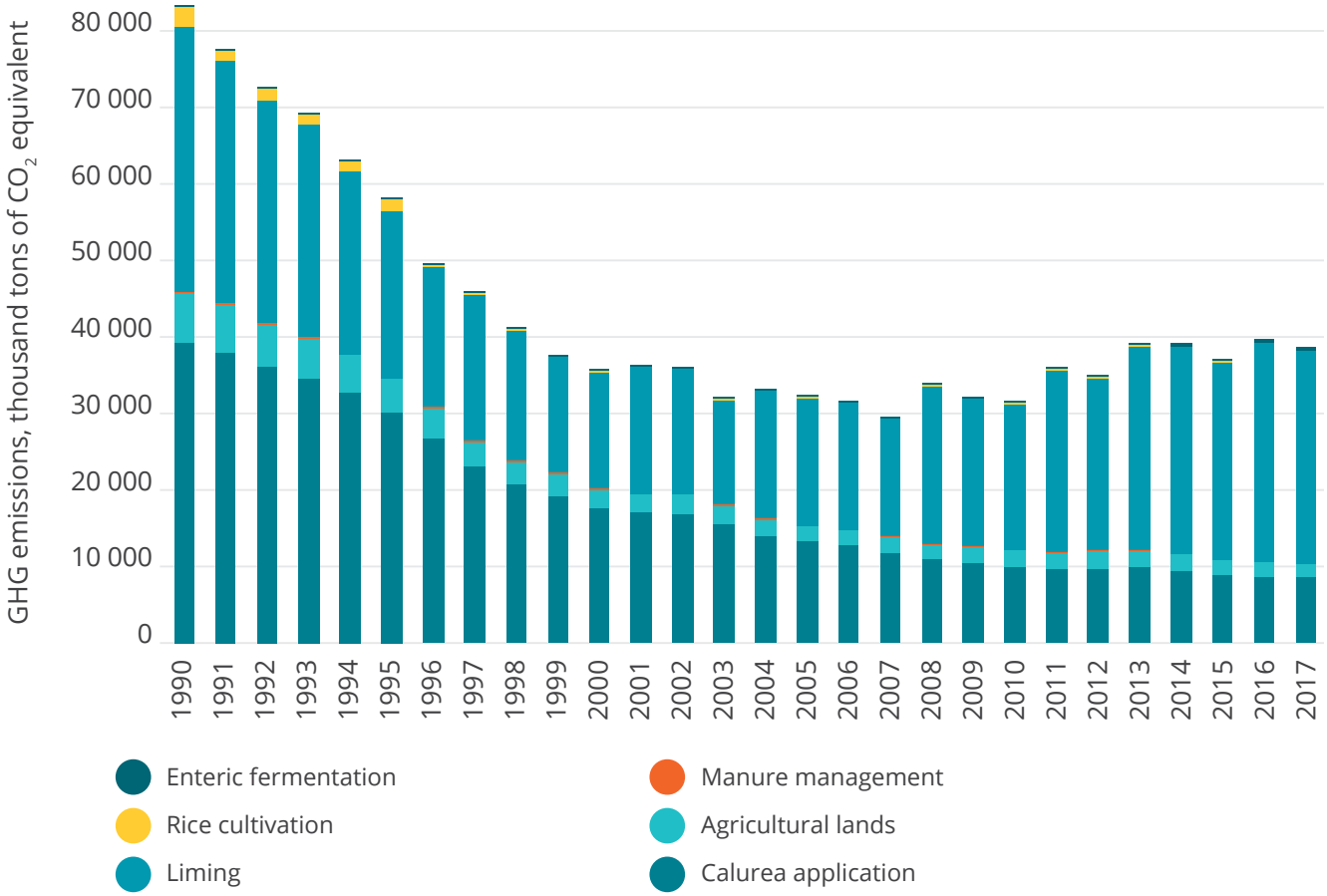

Figure 10. Key Indicators of Greenhouse Gas Emissions from the Sources and Absorption by the Agricultural Sector in Ukraine in 1990–2017 (National Greenhouse Gas Inventory, 2019).

[180] Heinrich Boell Foundation, 2014. Meat Atlas – Facts and figures about the animals we eat: https://www.boell.de/sites/default/files/meat_atlas2014_kommentierbar.pdf

[181] Ukraine. Technology Needs Assessment Report – Mitigation, 2019: https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2019/08/tna-01-mitigation-ua-final-190731.pdf

[182] Agribusiness in Ukraine 2019 https://agribusinessinukraine.com/the-infographics-report-ukrainian-agribusiness-2019/?utm_source=facebook&utm_medium=organic&utm_campaign=agro2019&utm_content=post_v_den_vihoda&fbclid=IwAR2Mi_VXjFTNeYwPs3yrXi8gzJ7fDK7eeRemc97ycKNDUVTS1mEnC5gJ3iY

Depending on the direction of the livestock sector, the main sources of emissions are different, therefore, the necessary steps to reduce these emissions will be different. Thus, most greenhouse gases originate from livestock breeding as a result of gastrointestinal fermentation and forage production. In poultry and pig breeding, the most greenhouse gases are fodder production, production and waste management (manure) and energy consumption (to ensure technological process on industrial farms)[183,184].

In order to reduce emissions from forage production and animal waste management, it will be relevant to introduce regulations that comply with the EU standards. These outline specific standards for the production, storage and application of fertilizers (organic and synthetic), storage conditions, processing, utilization and processing of manure and other agricultural waste. The legislative prerequisite will be to consolidate the best available technologies (Directive 2010/75/EC) and best agricultural practices (Directive 91/676/EC). These should describe the procedures and conditions for the procurement and storage of forage; animal breeding; collection, storage and application of manure. Likewise space and time constraints for fertilizer application; set limits on emissions of ammonia, other nitrogen-containing compounds and phosphorus.

According to the Technological Needs Assessment in Ukraine findings, the potential to reduce emissions due to the development of technology for the production of biogas from animal waste constitutes 1.8 million tons of CO_2 equivalent[185].

It is advisable to carry out a separate assessment of greenhouse gas emissions from the livestock sector, which would assess the entire production chain, starting with the production of forage and conditions of housing (especially chickens and pigs, given the significant increase in these livestock species). It is the housing that significantly affects the further production process and meat consumption. It is necessary to define the most problematic links and opportunities to optimize production and supply chain.

Along with technological solutions to reduce emissions, an important goal is to correct the demand for animal food, especially meat[186187], and those products that exceed healthy nutrition. Today, these rates are 2–3 times higher in developed countries, and such a food model, in addition to having a significant carbon footprint, is associated with a number of diseases. According to the recommendations of the World Health Organization concerning the sustainable (from the point of view of health and climate impact) of consumption, people who find it difficult to refuse such products should limit their consumption: meat and meat products should not exceed 100 g per day per person (average value may depend on age and health status)[188], and, if possible, refuse red meat and processed meat products. According to other recommendations, one should reduce meat consumption to 500 g per week[189,190]. According to national statistics, Ukrainians consume on average 167 grams of meat and meat products per day[191].

Thus, climate policy in the context of the development of sustainable food systems also applies directly to the health system. National policies should encourage the development of low-carbon and healthy diets and support low-carbon footprint producers. The production of such products may be stimulated or considered a priority in the formulation of subsidies or government support programs, concessional loans, etc.

[183] FAO, 2017. Livestock solutions for climate change: http://www.fao.org/3/a-i8098e.pdf

[184] FAO, 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities: http://www.fao.org/3/a-i3437e.pdf

[185] Technology Needs Assessment. Mitigation: https://tech-action.unepdtu.org/country/ukraine/

[186] IPCC, 2019. Summary for Policymakers of the Special Report on Climate Change and Land: https://www.ipcc.ch/site/assets/uploads/2019/08/Edited-SPM_Approved_Microsite_FINAL.pdfhttps://agribusinessinukraine.com/get_file/id/the-infographics-report-ukrainian-agribusiness-2019.pdf

[187] FAO, 2017. Livestock solutions for climate change: http://www.fao.org/3/a-i8098e.pdf

[188] Growing the Good. The Case for Low-Carbon Transition in the Food Sector, 2019. http://changingmarkets.org/wp-content/uploads/2019/02/Growing_the_Good-The_Case_for_Low-Carbon_Transition_in_the_Food_Sector.pdf

[189] World Health organization, 2018. A healthy diet sustainably produced: https://apps.who.int/iris/bitstream/handle/10665/278948/WHO-NMH-NHD-18.12-eng.pdf?ua=1

[190] Growing the Good. The Case for Low-Carbon Transition in the Food Sector, 2019: https://changingmarkets.org/wp-content/uploads/2018/10/Growing-the-Good-report-v3.pdf

[191] State Statistics Service of Ukraine: http://www.ukrstat.gov.ua/

CONCLUSIONS

The 2030 Climate Goals Roadmap for Ukraine is a list of targets that Ukraine needs to reach by 2030 in order to reduce greenhouse gas emissions. Achieving these goals will make a sufficient contribution to keep the global temperature rise at +1.5 °C. This document is supported by organizations operating in different sectors. The document describes quantitative targets for energy, buildings, transport, waste and the general agricultural, forestry and land use sectors.

The main source of greenhouse gas emissions in Ukraine is energy, which is why the goal for this sector is the fossil fuels phase out and the steady transition to renewable energy. This includes the elimination of subsidies for fossil fuel production and consumption, the implementation of EU Energy 4th Package, the integration of RES on a market basis and the support of small generation. It is necessary to increase the tax on greenhouse gas emissions and to enforce accurate monitoring and verification. By 2030, the share of coal in annual electricity production should not exceed 5% and all public and private mines should be closed (except those that provide fuel for TPPs during the transition period). Nuclear power units that are working beyond their design lifetime must be decommissioned and new ones should not be built. Overall, energy and carbon intensity of the economy must be reduced.

The main goal in the field of buildings should be to improve energy efficiency so that by 2050 the characteristics of buildings in Ukraine meet standards for nearly zero energy buildings. For this purpose, it is necessary to carry out an inventory of buildings, to introduce energy management systems, to adopt a strategy of thermal modernization of buildings with an estimation of the amount of energy savings and the possibility of attracting finances through the State Energy Efficiency Fund. The minimum energy efficiency standards for existing and new buildings from 2030 should ensure that more than half of their energy needs are covered from renewable sources. The energy consumption of buildings should be reduced by 25% by 2030, with primary energy consumption up to 120 kWh/m^2 and heat losses less than 5.6%. At least 30% of buildings in the country must have an energy efficiency rating of “B” and above.

In the transport sector, it is pivotal to gradually phase out fossil fuels (gas, gasoline, kerosene) and to shift from private cars to public transport, micromobility and railways. The development of public transport, especially electric transport, should be a priority for cities and the state. At least 50% of local transport spending should be designated to public transport and at least 5% to micro-mobility. It is necessary to re-install the environmental taxes on cars and to cancel privileges for old cars from Europe that have not been taxed. Similar to the tax benefits to purchase of electric vehicles, it is advisable to abolish taxes on the purchase of electric bicycles and electric scooters. In 2030, the share of motorized transport use should be reduced to 10%, while the share of micro-mobility and public transport should increase from the current level. It is necessary to strive to convert all public transport to electricity and to increase the number of passenger trips by rail, including by city railway transport. At least 70% of the rail tracks must be electrified, more freight should be carried by rail and water then by road.

In order to reduce emissions from waste it is necessary to gradually reduce waste generation and increase recycling rate. To do this, it is necessary to adopt a number of laws that would encourage this shift. The share of resource components of solid municipal waste collected through separate collection should be at level of 12–25%. The amount of

waste per capita should be reduced by one third from the current level.

In the sector of agriculture, land use and forestry it is necessary to withdraw from cultivation 15% of arable land (degraded), increase the area of pastures and hayfields to 15.8% of the country and restore the fertility of lands. Livestock emissions should remain at or below 2019 levels. The absorption of greenhouse gases by forests in Ukraine should increase by 50%, which can be achieved by increasing the area of forests up to 20% of the country, reducing the area of forest fires by 50% and increasing the total biomass of forests. Peat production should be reduced by 90% and dehydrated peatlands restored.

As a result of meeting the public targets, Ukraine will make a significant contribution to reducing global emissions and will have an ambitious climate policy. It will also improve public health by reducing urban air pollution by refusing to burn fossil fuels, polluting soil, water and air in settlements near mines and large industrial enterprises. It will also benefit the economy, as renewable energy becomes cheaper and more profitable, creating new jobs and being resource-free. The population will be provided with high-quality and energy-efficient housing, improving the overall environment.

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RECOMMENDATIONS TO THE GOVERNMENT

Integrate this document into national sector plans and strategies, which should occur during the development and review process of these national plans.

This will prepare an ambitious climate policy and involve the public, whose involvement should be an integral part of drafting national documents.