

**Draft version 2.0**

**SEA Scoping Report for the draft  
“Roadmap for production and use of  
hydrogen in Ukraine”**

**Kyiv, Ukraine  
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## List of abbreviations used

AEL	Alkaline Water Electrolysis
IPPU	Industrial Processes and Product Use
FC	Fuel Cell
FCV	Fuel Cell Vehicles
GDP	Gross Domestic Product
GHG	Greenhouse Gas
LCA	Life Cycle Analysis
LULUCF	Land Use, Land Use Change and Forestry
PEM	Proton Exchange Membrane Electrolysis
PEMFC	Polymer Electrolyte Membrane Fuel Cell
RES	Renewable Energy Sources
SEA	Strategic Environmental Assessment
SMR	Steam Methane Reforming
TPES	Total Primary Energy Supply
UNECE	United Nations Economic Commission for Europe

## Executive summary

### Background

Strategic Environmental Assessment (SEA) aims to promote sustainable development by mainstreaming environmental and health issues into the planning and decision-making processes at the national, regional and local levels.

The United Nations Economic Commission for Europe (UNECE) Protocol on SEA<sup>1</sup> represents – together with the European Union's SEA Directive<sup>2</sup> – one of the key international legal documents, which outlines main SEA principles and steps. The UNECE Protocol on SEA is an international agreement that provides for legal obligations and a procedural framework for the implementation of SEA in countries that are Parties to it. Ukraine ratified the Protocol in 2015.

In Ukraine, the SEA procedure should be implemented in accordance with the Law of Ukraine "On Strategic Environmental Assessment" and relevant sectoral legislation.

The initial stage of the SEA process is the scoping, which aims to determine the scope of further assessment i.e. in particular to identify environmental and health issues related to the plan or program, which should be analyzed in the next steps of the SEA. Thus, the scoping is important for the efficiency of the SEA process, since it ensures that SEA further focuses only on the issues, and therefore the likely significant effects, which are relevant for the proposed plan or program.

This draft SEA scoping report reflects the draft Roadmap, version of 18 January 2021.

Since August 2020, UNECE has been implementing project "Improving capacity of the Government of Ukraine to develop infrastructure for production and use of hydrogen to support green post-covid-19 recovery".<sup>3</sup> The project was developed by UNECE in response to a request of the Government of Ukraine to UNECE to provide technical assistance in preparing a roadmap for the hydrogen technologies market development. The roadmap should become a basis for preparing a Concept (Strategy) on Development of Hydrogen Economy in Ukraine that would be adopted by Ukrainian national authorities (Parliament or Government).

In the framework of the project, UNECE assists the country in developing a draft 'Roadmap for production and use of hydrogen' as well as in conducting relevant steps of SEA – the preparation of the scoping report and carrying out scoping consultation with relevant stakeholders in in line with the requirements of the UNECE Protocol on SEA and the national legal SEA framework.

### Overview of the draft Roadmap for production and use of hydrogen

The Roadmap for production and use of hydrogen attempts to draw attention to areas of current success and areas in which renewable hydrogen could provide a compelling solution for Ukrainian economy to address the current and anticipated energy challenges faced by the country.

In the Roadmap, hydrogen represents a wide range of possibilities and technologies. It can be used to produce ammonia, urea, hydrocarbons and bio and synthetic fuels, in conjunction with other molecules (primarily nitrogen and carbon dioxide). Hydrogen can be stored and transported in various ways: as a liquid, in a gaseous state or bound to other substances. Hydrogen can be produced in different ways.

Development of hydrogen technologies in Ukraine is envisaged in the following three phases:

- 1) First phase (2021-2023): Assessment of the Ukrainian economy for "green transition" and launch of the hydrogen economy.
- 2) Second phase (2024-2026): Policies prioritization, hydrogen market and supply chain development and demonstration, scale-up.
- 3) Third phase (2027-2029): Put together a Smart Portfolio of Policies and Strategic hydrogen projects development, regulatory reform, technological development

The Roadmap includes actions and measures at the national level and at regional and municipal levels. It also identifies two pilot projects.

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<sup>1</sup> More information about the Protocol on SEA can be found on the UNECE website:

[https://www.unece.org/env/eia/sea\\_protocol.html](https://www.unece.org/env/eia/sea_protocol.html).

<sup>2</sup> More information about the EU SEA Directive can be found on <https://ec.europa.eu/environment/eia/sea-legalcontext.htm>

<sup>3</sup> The project is funded by UNECE's Regular Programme of Technical Cooperation (RPTC).

## Environmental and health baseline

Environmental and health baseline describes the current status and the main trends for environmental and health components and aspects, as a basis for an identification of the specific issues which may be relevant to the production and use of hydrogen.

The main trends are the following:

- Most probably, the trend of emission reduction will continue in the nearest future. The trend will become even more evident taking into account the COVID-19 pandemic-related decline in industrial production in Ukraine.
- The trend of decrease of the GHG emissions will continue.
- The increase in average temperature and uneven distribution of precipitation caused by global climate change can lead to a significant transformation of most of the climatic and agricultural zones of Ukraine. It should be noted that the most noticeable consequence of climate change will be not so much gradual warming, but an increase in the number and intensity of extreme weather events: severe droughts, floods, storms, hurricanes, extremely hot days.
- The dynamics of water intake and consumption in Ukraine indicates a certain stabilization of water use in recent years. This stabilization in water consumption has been followed by stabilized wastewater discharge.

## Identification of the environmental and health issues

This Scoping Report determines the key environmental and health issues, which are relevant to the draft Roadmap, and which should be further addressed in the next stages of the SEA process – i.e. it will be further analysed, how these issues can be affected by the implementation of the Roadmap. It identifies environmental and health objectives established in the existing policy, strategic and legal documents of Ukraine, which will serve as a basis for the development of the reference framework for the policy evaluation of the Roadmap. The Scoping Report formulates initial recommendations to be considered in the draft Roadmap and further steps of its preparation.

The table below, based on the initial analysis of the likely environmental and health effects of the hydrogen production, storage and use, summarizes the key environmental and health issues to be addressed in further SEA steps.

**Table 1: The key environmental and health issues for the Roadmap**

Environmental and health aspects	The key issues to be addressed in SEA
Air	Possible changes of air emissions from the energy sector Possible changes of air emissions from the transport sector Air emissions from biomass use
GHG emissions	GHG emissions from hydrogen production (comparison of technology options) Possible changes of GHG emissions from energy sector (as a result of a reduction of energy production from fossil fuels)
Climate change	Likely consequences of the climate change regarding energy sector (both fossil fuels and RES)
Water resources	Water consumption for hydrogen production Water consumption related to solar energy Likely effects of SMR production on water quality Likely effects of offshore windfarms development on coastal waters Possible changes of water pollution from energy sector (as a result of a reduction of energy production from fossil fuels)
Land and soil	Possible changes of impacts of energy sector on land and soil (as a result of a reduction of energy production from fossil fuels) Likely effects of solar power plans on soil
Landscape	Possible changes of impacts of energy sector on the landscape (as a result of a reduction of energy production from fossil fuels) Likely effects of new pipelines for hydrogen transport Likely effects of new wind farms (both onshore and offshore)
Biodiversity	Likely effects of new wind farms (both onshore and offshore) on sea birds,

	migratory birds, and bats Likely effects of new offshore wind farms on marine biodiversity Likely effects of solar plants on birds, bats, and insects
Waste management	Capacities to manage waste related to hydrogen production (in particular catalysts used for SMR, PEMFCs used in vehicles, and used solar panels)
Human health	Possible changes of impacts of energy sector (as a result of a reduction of energy production from fossil fuels) and transport sector Noise from hydrogen production facilities Disturbance by the windfarms (noise, vibrations, flick-effect) Likely effects of biomass use Implementation of safety measure for hydrogen use
Livelihood	Likely effects of diversification of energy resources and decentralization of energy sector, which can potentially result in improved energy supply Likely effects on employment rates Land acquisitions related to the new wind and solar farms

Based on the initial analysis of the linkages between the hydrogen production and use and the environmental and health issues, it can be concluded that there is a potential the implementation of the Roadmap will result in certain positive environmental and health effects. **However, such conclusions is to a large extent based on the assumption that the hydrogen production will use the energy from renewable energy resources i.e. the Roadmap will focus on the green hydrogen production.** Although also renewable energy production may cause adverse environmental and health effects, they, most probably, be of a local nature. It should be possible to effectively address them in the next steps of planning and/or during the preparation and approval procedure for specific projects.

# 1. Introduction

## 1.1. What is strategic environmental assessment (SEA)

Strategic Environmental Assessment (SEA) aims to promote sustainable development by mainstreaming environmental and health issues into the planning and decision-making processes at the national, regional and local levels. SEA is a well-established, practical and efficient planning and decision-making support tool. Its effective application should ensure that the strategic documents (plans, programs, policies, strategies, etc.) in the key sectors, including for instance energy, water, or waste management, which may cause significant adverse environmental and/or health effects are developed taking into account these likely effects. SEA supports the identification of the most sustainable and cost-effective strategic development alternatives for attracting new investments, as well as it helps strengthening governance through fostering transparency and facilitating consultations with relevant stakeholders, including environmental and health authorities and the public, prior to the approval of plans and programs.

The United Nations Economic Commission for Europe (UNECE) Protocol on SEA<sup>1</sup> represents – together with the European Union's SEA Directive<sup>2</sup> – one of the key international legal documents, which outlines main SEA principles and steps. The UNECE Protocol on SEA augments the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) by ensuring that individual Parties integrate environmental, including health, considerations into their plans and programs at early stages of their preparation. It also sets a non-mandatory framework for the assessment of policies and legislation. The Protocol on SEA was negotiated under the Espoo Convention to extend the scope of the Convention; however, it is a legally distinct instrument. It was signed in Kyiv in 2003 and entered into force on 11 July 2010. The Protocol is an international agreement that provides for legal obligations and a procedural framework for the implementation of SEA in countries that are Parties to it. It is open to all member States of the United Nations. UNECE serves as the secretariat to both the Protocol on SEA and the Espoo Convention.

## 1.2. Purpose and role of scoping and the scoping report

Generally, the scoping is the initial stage of the SEA process, which aims to determine the scope of further assessment i.e. in particular to identify environmental and health issues related to a draft plan or program, which should be analyzed in the next steps of the SEA. Thus, the scoping is important for the efficiency of the SEA process, since it ensures that SEA further focuses only on the issues, and therefore the likely significant effects, which are relevant for the proposed plan or program.

This draft SEA scoping report, which will be subject to the consultations with stakeholders, summarizes the findings and conclusions of an initial assessment i.e.:

- Preliminary analysis of the environmental and health baseline;
- Identification of environmental and health policy objectives relevant for the Roadmap;
- Identification of key environmental and health issues relevant to the Roadmap;
- Formulation of initial recommendations to be considered in the draft Roadmap and further steps of its preparation;
- Recommendations for further SEA steps, including
  - o Analysis to be carried out / questions to be addressed in the next SEA steps;
  - o Consultations with competent authorities and public participation in the SEA process of a draft strategic document on hydrogen in line with Ukraine's law on SEA.

This draft SEA scoping report reflects the draft Roadmap, version of 18 January 2021.

## 1.3. Preparation of the Roadmap for production and use of hydrogen

Since August 2020, UNECE has been implementing project "Improving capacity of the Government of Ukraine to develop infrastructure for production and use of hydrogen to support

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<sup>1</sup> More information about the Protocol on SEA can be found on the UNECE website:

[https://www.unece.org/env/eia/sea\\_protocol.html](https://www.unece.org/env/eia/sea_protocol.html).

<sup>2</sup> More information about the EU SEA Directive can be found on <https://ec.europa.eu/environment/eia/sea-legalcontext.htm>

green post-covid-19 recovery".<sup>1</sup> The project was developed in response to a request of the Government of Ukraine to UNECE to provide technical assistance to the country in preparing a roadmap for the hydrogen technologies market development. The roadmap should become a basis for preparing a Concept (Strategy) on Development of Hydrogen Economy in Ukraine<sup>2</sup> that would be adopted by Ukrainian national authorities (Parliament or Government).

In the framework of the project, UNECE assists the country in developing a draft 'Roadmap for production and use of hydrogen' as well as in conducting relevant steps of SEA – the preparation of the scoping report and carrying out scoping consultation with relevant stakeholders in line with the requirements of the UNECE Protocol on SEA and the national legal SEA framework.

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<sup>1</sup> The project is funded by UNECE's Regular Programme of Technical Cooperation (RPTC).

<sup>2</sup> This is only a provisional title of the future concept/strategy.



## 2. Legislative basis for SEA in Ukraine

The Law of Ukraine "On Strategic Environmental Assessment" defines the scope of the Law, purpose, principles of regulation, the subjective composition of legal relations, establishes the procedure for implementing SEA.

To comply with the requirements of the Law, as well as to bring other acts into line with it, several bylaws were adopted, namely:

- Resolution of the Cabinet of Ministers of Ukraine "On Amendments and Repeal of Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, #128;
- Resolution of the Cabinet of Ministers of Ukraine "On Amendments to Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, #45;
- Resolution of the Cabinet of Ministers of Ukraine of December 16, 2020, #1272 "On approval of the Procedure for monitoring the effects of implementing the public planning document for the environment, including for human health";
- "Methodological recommendations for the implementation of the strategic environmental assessment of public planning documents" approved by order of the Ministry of Ecology and Natural Resources of Ukraine from 10.08.2018 #296.

According to the Law on SEA, the SEA is an administrative procedure commissioned by executive authorities or local governments (i.e. the governmental agencies responsible for preparation of the public planning documents). The SEA is not a permitting procedure.

### Stages of the SEA procedure

The Law on SEA stipulates 6 stages of SEA implementation (Article 9), namely:

- 1) determining the scope of SEA (scoping);
- 2) preparation of SEA report;
- 3) carrying out consultations, including public consultations and transboundary consultations;
- 4) taking into account the SEA report and the results of the consultations in decision-making;
- 5) information on the adoption of the public planning document;
- 6) monitoring the effects of implementing the public planning document on the environment, including human health.

### Determining a need for SEA (screening)

Before proceeding with the SEA procedure as outlined above, there is a need to determine if a public planning document requires SEA (this is called 'screening'). The responsibility for screening belongs to the executive authorities or local governments i.e. planners of the public planning document. Based on Article 2 and Article 5 of the Law, a planner must independently determine whether a particular public planning document falls within the Law's scope of regulation.

### Determining the scope of SEA (scoping)

After the need for SEA is determined, the further SEA procedure differs depending on the level the public planning document is prepared at (i.e. national, regional or local level). This further determines bodies that will be involved in the consultations. The executive authorities or local governments i.e. planners of the public planning document, have to determine the scope of research, environmental assessment methods, and the level of detail of the information to be included in the SEA report.

### Preparation of SEA report

The SEA report is compiled according to the structure defined in the Law on SEA and has to contain information considering the conclusions of the scoping stage.

### Consultations

Before deciding on the public planning document's approval, the planner of the public planning document organizes consultations with the relevant executive authorities as well as publicly discloses the draft public planning document, a SEA report, and notification of the disclosure of the draft public planning document.

All comments and suggestions, received within the time frames established in the Law on SEA, shall be subject to mandatory consideration by the planner of the public planning document.

Simultaneously with the consultations, the planner ensures public consultations by publishing documents (the SEA report and the draft of public planning document) on its website and publishing notification of the disclosure of the draft public planning document in mass media. Time frames for public consultations shall be established by the planner and shall not be less than 30 days from the date of making publicly available the notification. The authorities upon the receipt of the draft public planning document and the SEA report shall submit to the planner in a written form comments and suggestions to the draft public planning document and the SEA report within the time frames not exceeding 30 days of the date of receipt.

#### **Taking into account the SEA report and the results of the consultations in decision making**

After public consultation and consultation with state executive authorities, the planner prepares consultation statements, reflecting all the comments and suggestions received. Comments and suggestions are subject to mandatory consideration; they may be taken into account or rejected with reasons provided. All these documents are submitted together with the draft public planning document to the decision-making body.

#### **Information on the adoption of the public planning document**

After the adoption of the public planning document, the planner shall inform thereabout in writing the authorities that were involved in the consultation process.

#### **Monitoring the effects of implementing the public planning document on the environment, including human health**

The planner within its competence shall monitor the effects of the implementation of the public planning document on the environment, including human health. The planner develops measures taking into account the results of public consultations, consultations with the executive authorities, and transboundary consultations (if any).

The implementation of such measures provides an opportunity:

- identification of the effects of the implementation of the public planning document for the environment, including human health, namely secondary, cumulative, synergistic, short-, medium- and long-term (one, three-five, 10-15 years, 50- 100 years, respectively), permanent and temporary, positive and adverse effects;
- prevention, reduction, and compensation of adverse effects caused by the implementation of the public planning document;
- identifying adverse effects for the environment, including human health, unforeseen by the SEA report.

The planner makes publicly the results of monitoring annually on its official website.

### 3. Overview of the draft Roadmap for production and use of hydrogen

Developing infrastructure to produce and use hydrogen in Ukraine is intended to facilitate the country's economic recovery – after the COVID-19 crisis – in an environmentally friendly manner, increase its energy security and efficiency, improve the economic climate and create new employment opportunities. This is also consistent with the goals in the UN Framework for the Immediate Socio-Economic Response to COVID-19<sup>1</sup>.

The Roadmap for production and use of hydrogen (hereinafter the 'Roadmap') attempts to draw attention to areas of current success and areas in which renewable hydrogen could provide a compelling solution for Ukrainian economy to address the current and anticipated energy challenges faced by the country. In this way, the Roadmap focuses on how hydrogen and fuel cell technologies could be initially rolled out in the country. The Roadmap also focuses on some of technology risks, implementation challenges, and knowledge gaps that are emerging as new hydrogen projects and technologies are being deployed and tested in other countries. Crucially, the Roadmap seeks to draw attention to where these challenges are universal and where they are more specific to Ukraine.

The Roadmap highlights the hydrogen technologies as a substantial part of a mix of technologies required to transit Ukraine to the climate neutral economy in the second half of this century and is designed to provide a clarity on their adaptation as one of the main technologies capable to support full "green transition" process with great potential to:

- reduce Ukraine's dependence on fossil fuels;
- decarbonize industry, which is highly dependent on fossil fuels;
- decarbonize the transport sector;
- develop mobility on renewable basis;
- improve energy efficiency and energy saving; and
- integrate flexibility options in order to match generation of renewable electricity with demand.

In the Roadmap, hydrogen represents a wide range of possibilities and technologies. It can be used to produce ammonia, urea, hydrocarbons and bio and synthetic fuels, in conjunction with other molecules (primarily nitrogen and carbon dioxide). Hydrogen can be stored and transported in various ways: as a liquid, in a gaseous state or bound to other substances. Hydrogen can be produced in different ways. In all of these areas, companies and scientific and research institutes are working on basic and applied research and innovations aimed at making processes and applications more efficient, more sustainable, and cheaper.

The Roadmap identifies four sectors (pillars) for introduction of hydrogen technologies in Ukraine:

Pillar 1: Transformation of electrical power supply and heating systems

Pillar 2: Transformation of industrial process heat

Pillar 3: Transformation of transport sector

Pillar 4: National gas pipelines system and scaling-up of hydrogen manufacturing, storage and transportation

Development of hydrogen technologies in Ukraine is envisaged in the following three phases:

- 1) First phase (2021-2023): Assessment of the Ukrainian economy for "green transition" and launch of the hydrogen economy.
- 2) Second phase (2024-2026): Policies prioritization, hydrogen market and supply chain development and demonstration, scale-up.
- 3) Third phase (2027-2029): Put together a Smart Portfolio of Policies and Strategic hydrogen projects development, regulatory reform, technological development

Each phase of Roadmap implementation at the national level includes activities in four key areas:

- Legislation;
- Economic;
- Support for research and development; and
- Public awareness.

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<sup>1</sup> <https://unsdg.un.org/sites/default/files/2020-04/UN-framework-for-the-immediate-socio-economic-response-to-COVID-19.pdf>

The Roadmap also includes actions and measures at the oblast and municipal level.

The Roadmap identifies two pilot projects:

1. Development of the hydrogen strategy of Ukraine (EUR 2 million, duration 24 months).
2. Analysis of various aspects of introducing hydrogen economy in Ukraine ((EUR 1 million, duration 12 months).

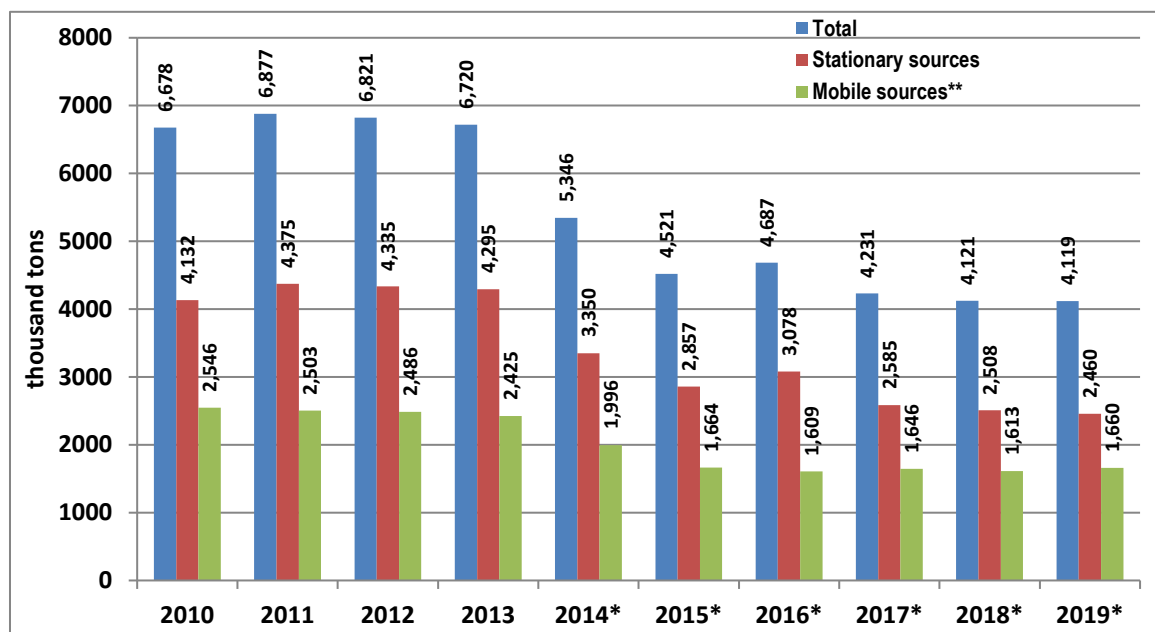
Relationship of the Roadmap with other public planning documents is to be further elaborated in the Roadmap. The objectives stipulated by the key national strategic documents and legal acts, which are relevant to the draft Roadmap, and relate to main environmental, health and other sustainability aspects addressed in this scoping report, are listed in Chapter 5 below.

## 4. Environmental and health baseline

The following sections describes the current status and the main trends for environmental and health components and aspects, as a basis for an identification of the specific issues which may be relevant to the production and use of hydrogen.

### 4.1. Ambient air

As shown in Fig. 1 below, there has been a decrease in emissions from stationary and mobile sources into air (temporarily occupied territories are not taken into account). More than half of the total air emissions are caused by the stationary sources.



\* Excluding the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and part of the temporarily occupied territories in Donetsk and Luhansk oblasts.

\*\* For 2016-2018, data on emissions from motor vehicles are reflected

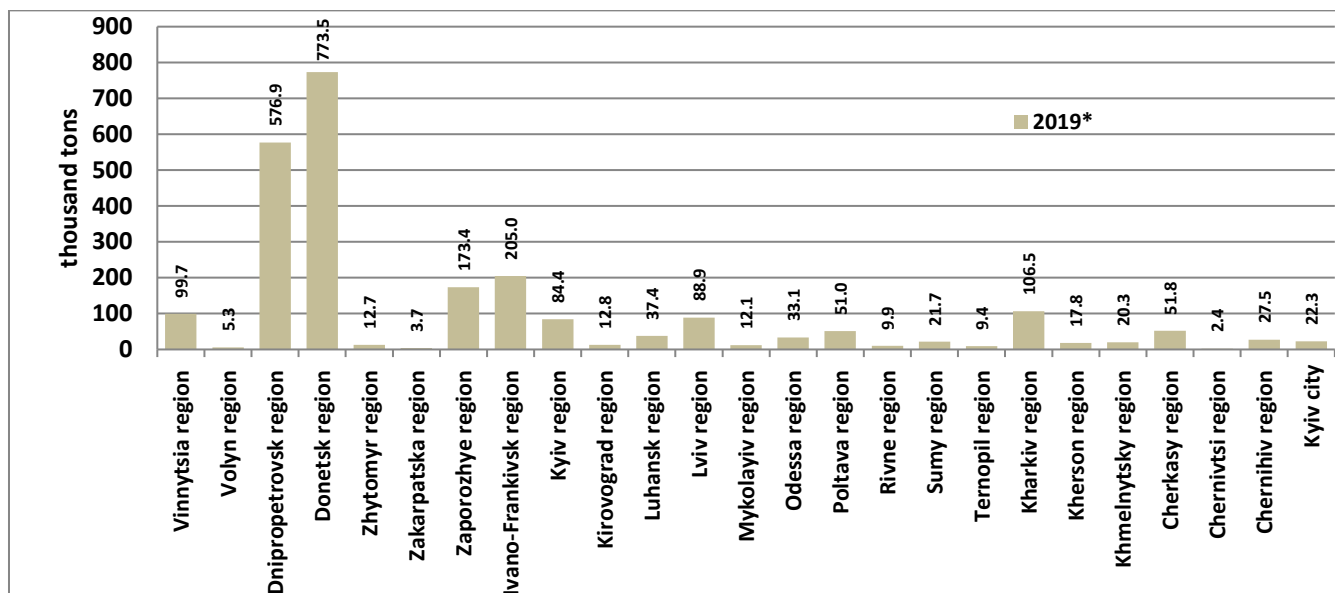
**Figure 1: The dynamics of pollutant emissions into the atmosphere in Ukraine during 2010-2019<sup>1</sup>**

The following types of economic activities belonged to the major stationary sources of air emissions in 2019:

- Supply of electricity, gas, steam and air conditioning (39.1% of the total air emissions);
- Processing industry (36.2%), including metallurgical production (30.1%);
- Mining and quarrying (17.0%), including coal and lignite mining (12.5%).

In total, emissions from the above listed economic activities release more than 92% of the total air emissions in Ukraine. The largest volumes of emissions in 2019 were registered in Donetsk region (31.4% of the total emissions), Dnipropetrovsk region (23.5%) and Ivano-Frankivsk region (8.3%) (Fig. 2).

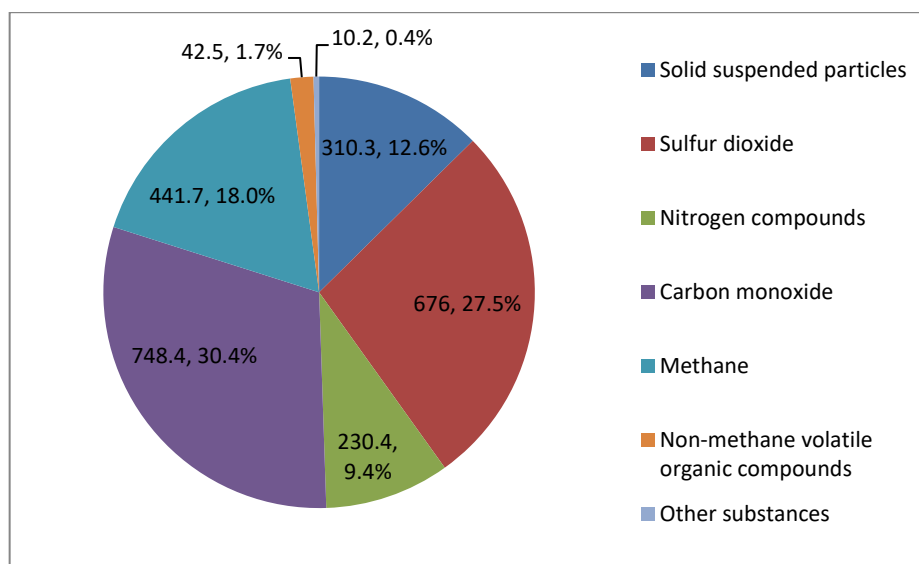
<sup>1</sup> State Statistics Service of Ukraine – [http://www.ukrstat.gov.ua/operativ/operativ2009/ns\\_rik/ns\\_u/dvsr\\_u2008.html](http://www.ukrstat.gov.ua/operativ/operativ2009/ns_rik/ns_u/dvsr_u2008.html)



\* Excluding the part of the temporarily occupied territories in Donetsk and Luhansk oblasts.

**Figure 2: Emissions of pollutants into the atmosphere by regions of Ukraine in 2019<sup>1</sup>**

The main pollutants emitted by the stationary sources are carbon monoxide (30.4%), sulfur dioxide (27.5%), methane (18%), solid suspended particles (12.6%) and nitrogen compounds (nitrogen oxide, nitrogen dioxide and ammonia) (9.4%) (Fig. 3).



**Figure 3: Volumes of emissions of major pollutants into the ambient air from stationary sources in Ukraine in 2019, thousand tons<sup>2</sup>**

Despite the decrease of the total emissions, an increase of the number of cases when the stationary source exceeds a legal threshold (i.e. established rates of maximal permissible emissions of pollutants by stationary source) can be observed in the last years, mainly due to non-compliance of the enterprises with the regime of operation of dust purification equipment, and a slow pace of introducing the advanced and innovative technologies. This – together with a considerable increase in the number of transportation vehicles, in particular, those that have exceeded their lifetime – belongs to the main reasons causing unsatisfactory condition of ambient air quality in settlements.

The main pollutants being emitted by mobile sources in 2018 are carbon monoxide (74.9% of the total emission from mobile resources i.e. 1016.9 thousand tons), nitrogen dioxide (11.6% i.e. 156.9

<sup>1</sup> State Statistics Service of Ukraine – [http://www.ukrstat.gov.ua/operativ/operativ2008/ns\\_rik/ns.html](http://www.ukrstat.gov.ua/operativ/operativ2008/ns_rik/ns.html)

<sup>2</sup> State Statistics Service of Ukraine – [http://www.ukrstat.gov.ua/operativ/operativ2018/ns/vzap/arch\\_vzrap\\_u.htm](http://www.ukrstat.gov.ua/operativ/operativ2018/ns/vzap/arch_vzrap_u.htm)

thousand tons), non-methane volatile organic compounds (10.1% i.e. 137.6 thousand tons), soot (1.7% i.e. 24.1 thousand tons) and sulfur dioxide (1.3% i.e. 27.6 thousand tons).

The assessment of the state of air pollution in the cities of Ukraine in 2018 was carried out according to the data of observations in 39 cities at 129 stationary posts of the monitoring network of hydrometeorological organizations.

The above assessment identified altogether 22 air pollutants, including eight heavy metals, in the atmosphere. The average annual concentration of formaldehyde in the cities, where the observations were conducted, was at the level of 2.3 maximum permissible average daily concentrations (MPC<sub>AD</sub>), nitrogen dioxide – 1.5 MPC<sub>AD</sub>, phenol – 1.3 MPC<sub>AD</sub>. Exceeding the relevant MPC<sub>AD</sub> for average annual concentrations was observed for formaldehyde in 25 cities, nitrogen dioxide in 22 cities, suspended solids in 11 cities, phenol in 7 cities, carbon monoxide in 3 cities, hydrogen fluoride and nitric oxide in 2 cities, and ammonia and soot in 1 city.

Most probably the emission reduction trend (Fig. 1) will continue in the nearest future. The trend will become even more evident taking into account the pandemic-related decline in industrial production in Ukraine. According to the State Statistics Service, in 2020, compared to 2019, the industrial production index was 94.8%<sup>1</sup>.

## 4.2. GHG emissions and climate change

The economic decline that followed the collapse of the USSR in 1991 led to significant reduction of production, energy consumption, and thus to lower GHG emissions. The trend of slight decrease of the GHG emissions after 2008 was mainly the result of decreased production level due to the outflow of investment capital, unstable export dynamics, contraction of the domestic market, as well as the discrepancies in established "raw material-production-sales" connections in the regions of the country, including significantly affected industrial development on the east of the country, which is has not been only limited to Donetsk and Lugansk regions, but also in the neighboring regions, which had strong production-sales connections with Donbass region.

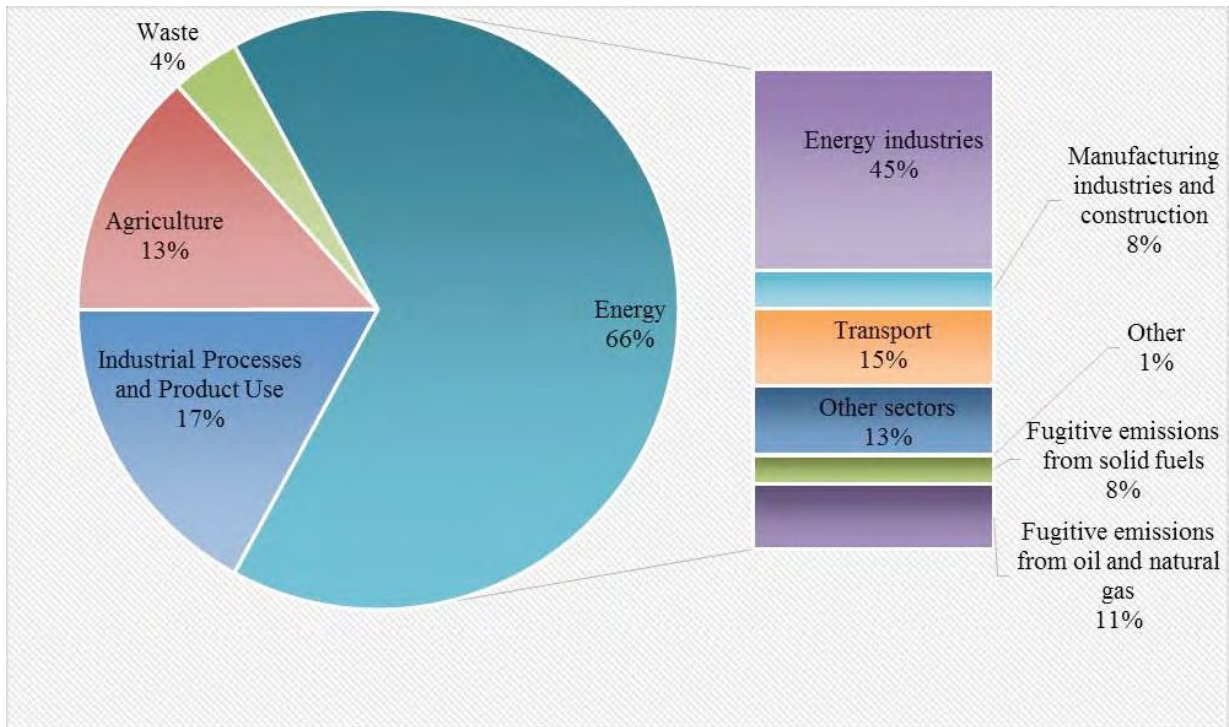
In Ukraine, GHG emissions occur in the following sectors set by the IPCC:

- Energy;
- Industrial Processes and Product Use (IPPU);
- Agriculture;
- Land Use, Land Use Change and Forestry (LULUCF);
- Waste.

The highest GHG emissions in Ukraine are produced by energy sector. In 2018, the share of this sector accounted for around 66% of the total GHG emission (without the LULUCF sector). About 80% of emissions in energy sector account for emissions in the Fuel Combustion category, which include the categories of Energy Industries, Manufacturing Industries and Construction, Transport, Other Sectors, and Other, as well as 20% - emissions in the category of Fugitive Emissions from Fuels. Fig. 4 shows a histogram of total emissions of carbon dioxide, methane, and nitrous oxide in Ukraine, including LULUCF sector.

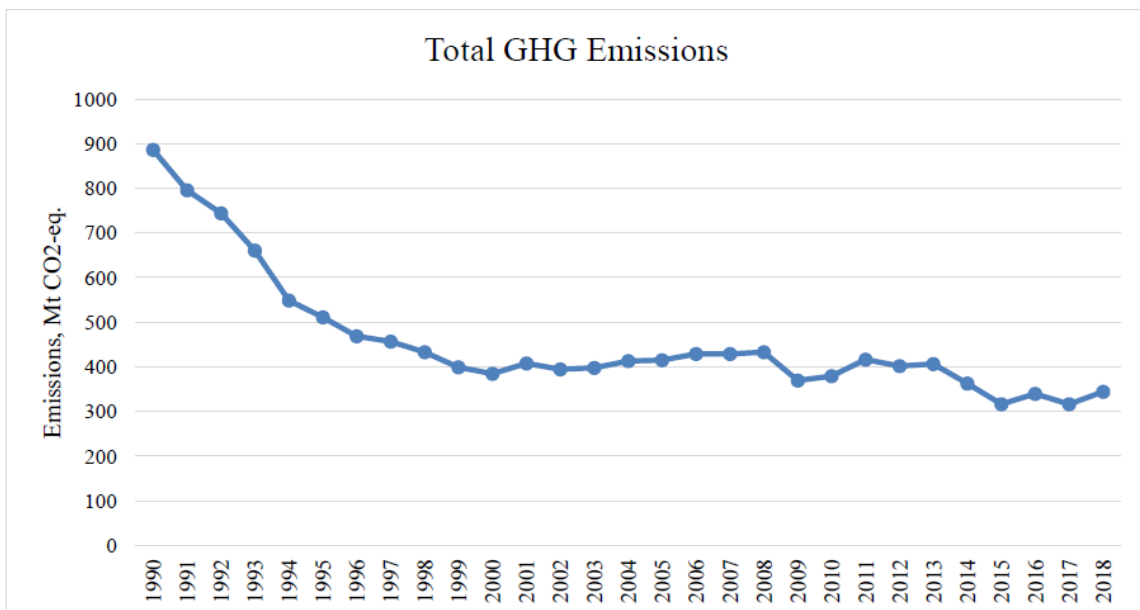
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<sup>1</sup> State Statistics Service of Ukraine. – <http://www.ukrstat.gov.ua/express/expr2021/01/06.pdf>



**Figure 4: The GHG emission structure in Ukraine in 2018<sup>1</sup>**

The largest share of GHG emissions in 2018 is carbon dioxide – 68.0% including LULUCF. Methane emissions in 2018 were 20.7%, and those of nitrous oxide – 11.3%. In 1990, the proportion was 72.9%, 21.0%, and 6.0% for carbon dioxide, methane, and nitrous oxide, respectively.



**Figure 5: GHG emissions in Ukraine (including LULUCF), 1990-2018, Mt CO<sub>2</sub>-eq.<sup>2</sup>**

In Ukraine over the last decade, the average annual temperature of the surface layer of atmosphere has increased by 0.6°C, and over the past 30 years, the average annual temperature in Ukraine has increased by almost 1°C. These overall national trends, however, are characterized by unevenness - periods of rapid temperature increase are followed by its slowdown or cooling. During such periods, cold waves with frosts have been observed, which represents a threat for many economic sectors, in particular, for agriculture.

<sup>1</sup> Ukraine's greenhouse gas inventory 1990-2018 (draft). – P. 8. – [https://mepr.gov.ua/files/docs/Zmina\\_klimaty/2020/Ukraine\\_NIR\\_2020%20draft.pdf](https://mepr.gov.ua/files/docs/Zmina_klimaty/2020/Ukraine_NIR_2020%20draft.pdf)

<sup>2</sup> Ukraine's greenhouse gas inventory 1990-2018 (draft). – P. 56. – [https://mepr.gov.ua/files/docs/Zmina\\_klimaty/2020/Ukraine\\_NIR\\_2020%20draft.pdf](https://mepr.gov.ua/files/docs/Zmina_klimaty/2020/Ukraine_NIR_2020%20draft.pdf)



The average annual temperature during the year can be changed significantly, forming temperature anomalies. Also, high differences in daily air temperatures fluctuating by 10-15°C in 1-2 days have been observed<sup>1</sup>. Sudden changes in weather are accompanied by various meteorological phenomena – heavy rain, strong wind, heavy snowfall, heavy fog, heavy hail, squalls, heavy ice, and heavy blizzard – whose frequency has increased<sup>2</sup>. Climatic seasons have shifted: spring and autumn air temperature transitions through 0 degrees occur earlier, on average, by 1-6 days, depending on the region.

Ukraine is a country with a medium level of vulnerability to climate change, with following main potential climate threats:

- Increasing the frequency and intensity of climatic anomalies and extreme weather events;
- Changes in rainfall, hydrodynamic regime and water balance of rivers, increasing numbers of floods and excessive droughts, fresh water shortage;
- Yield losses due to increased flood frequency, the need for more intensive irrigation in summer, the spread of desertification, the occurrence of off-season frosts and increasing of temperature fluctuations, changes in crop ripening regimes and increasing their vulnerability to pests;
- Increasing the level of morbidity and mortality due to changes in temperature, the emergence of new diseases;
- Increased demand for electricity during the summer heat, complicating the operation of hydropower facilities due to changes in the nature of precipitation and river runoff;
- Increasing sea level and the formation of the threat of flooding and erosion of the coastal zone, reducing the attendance of resort areas and deteriorating tourism development, increasing the risk for the population living at altitudes up to 10 m above sea level;
- Change in the species composition of flora and fauna, soil degradation and change in the species composition of soil flora and fauna<sup>3</sup>.

Climate change manifests itself in different ways in different regions of the country by a wide range of natural phenomena – dry winds, floods, droughts, etc. The water flow of rivers in the summer months has been much lower than the established levels for several years now. In July 2015, for example, it was 38-63% of the standard norm in most domestic rivers<sup>4</sup>. The amount of precipitation decreased in winter, changed insignificantly in spring and summer, while it increased in autumn. There have been more cases when half or the monthly rainfall falls in a few hours. The likely effects of climate change (changes in temperature trends, increasing numbers and intensities of extreme weather events etc.), together with the high level of vulnerability of certain segments of the population, may lead to social and economic losses in future. In particular, it should be noted the growing threat of catastrophic floods in the Carpathians, large-scale fires in peatlands, flooding, expansion of the arid zone of the southern region, increasing frequency and duration of droughts, drying of rivers and reservoirs of the Black Sea region and Azov Sea region, including estuaries, transformation of steppes of southern regions into a desert, flooding of coastal areas and acute shortage of drinking water in the central, southern and eastern regions of Ukraine<sup>5</sup>.

For the energy sector of Ukraine, the possible consequences of climate change are:

- Reduction of the heating season by up to 5%;
- Influence of climatic conditions on operating conditions and equipment of energy facilities (temperature and humidity, water temperature affects the efficiency of boilers and turbines of thermal power plants; rising temperatures lead to disruption of NPPs due to rising cooling water temperature; the mode of HPPs operation is changes due to the reduction of water supply in light snow winters, etc.);

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<sup>1</sup> Ukrainian Hydrometeorological Center. - <https://meteo.gov.ua/ua/33446/zmi/articles/read/61>

<sup>2</sup> Ukrainian Hydrometeorological Institute (2013) «Report on the research work of conducting a spatial analysis of trends in the frequency and intensity of extreme hydrometeorological phenomena in Ukraine due to climate change». - <https://uhmi.org.ua/project/rvndr/extrime.pdf>

<sup>3</sup> National Institute for Strategic Studies (2016) “Adaptation to climate change in Ukraine: problems and prospects: Analytical note”. – <https://niss.gov.ua/doslidzhennya/nacionalna-bezpeka/adaptaciya-do-zmin-klimatu-v-ukraini-problemi-i-perspektivi>

<sup>4</sup> For example, the maximum daily water inflow to the Kyiv reservoir was 950 m<sup>3</sup>/s in 30-31 March with, while the norm is 4,200 m<sup>3</sup>/s. This is one of the lowest inflows in the last 100 years, with the only lower daily inflow of 892 m<sup>3</sup>/s in 1925.

<sup>5</sup> Law of Ukraine "Basic principles (strategy) of state environmental policy of Ukraine until 2030" (from 28.02.2019 № 2697-VIII). - <https://zakon.rada.gov.ua/laws/show/2697-19>

- Influence of weather phenomena (snowfalls, ice, strong gusty wind) on the operation of power lines and reliability of energy supply;
- Significant increase of irregularity in energy consumption due to instability and variability of weather conditions and increase in the frequency of adverse anomalous weather phenomena;
- Change of repair schedules of power generating capacities;
- Increasing the probability of emergencies due to the increased threat of dangerous natural phenomena;
- Need to transform Ukraine's energy system in accordance with requirements of the world community to prevent climate change<sup>1</sup>.

The increase in average temperature and uneven distribution of precipitation caused by global climate change can lead to a significant transformation of most of the climatic and agricultural zones of Ukraine. It should be noted that the most noticeable consequence of climate change will be not so much gradual warming, but an increase in the number and intensity of extreme weather events: severe droughts, floods, storms, hurricanes, extremely hot days.

### 4.3. Water resources and waste water

The surface of the territory of Ukraine is covered by a relatively sparse hydrographic network of rivers. The river runoff resources are formed due to inflow (transit) along the Danube River (123 km<sup>3</sup>), Dniro River (34.4 km<sup>3</sup>), Dniester River (0.8 km<sup>3</sup>), Seversky Donets River (1.8 km<sup>3</sup>) and the local runoff 52.4 km<sup>3</sup>. The average density of the river network is 0.34 km/km<sup>2</sup>.

Besides rivers, the natural and artificial water reservoirs are of great economic importance. To provide water for the economic activity of the country, 1103 reservoirs with a total volume of 55 km<sup>3</sup> of water were built on the rivers (including 6 large reservoirs on the Dniro River with a total volume of 43.8 km<sup>3</sup> of water).

The forecast groundwater resources are 22.5 km<sup>3</sup>/year, of which 26% are available groundwater supplies (about 5.7 km<sup>3</sup>/year).

Compared to the other European countries, Ukraine has one of the lowest water-supply per person (approx. 1000 m<sup>3</sup> per year).

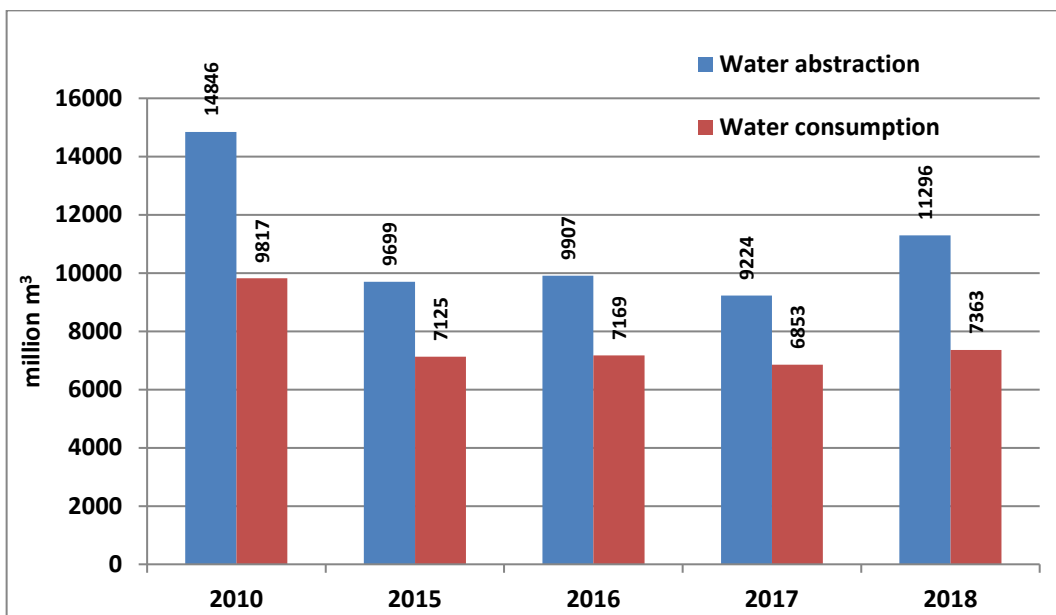
The dynamics of water intake and consumption in Ukraine (Fig. 6) indicates a certain stabilization of water use in recent years. In 2018, 11.3 billion m<sup>3</sup> of water was taken from natural water bodies, which is 2.1 billion m<sup>3</sup> more than in 2017. The intake of water from underground sources decreased, which in 2018 amounted to 1.17 billion m<sup>3</sup>.

In 2018, the main water consumers by sectors were agricultural enterprises (and in particular irrigation), which took 41.66% of the total water intake in the country, industry - 36.18% (including also thermal power stations, nuclear power stations, ferrous metallurgy and coal industry enterprises), followed by housing and communal services sector – 21.78%.

In 2018, the most water resources were used for production needs (61.1%), for irrigation (21.6%) and for drinking and sanitary needs (15.9%).

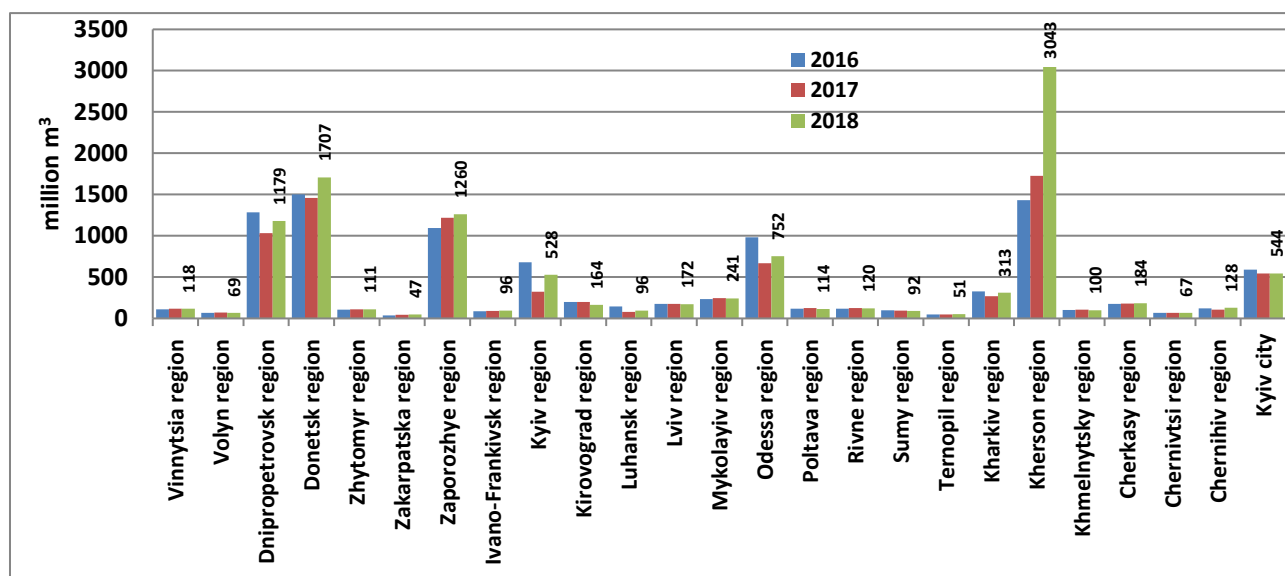
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<sup>1</sup> Ivanyuta S.P. et al. (2020) "Climate change: consequences and adaptation measures: analytical report. - [https://niss.gov.ua/sites/default/files/2020-10/dop-climate-final-5\\_sait.pdf](https://niss.gov.ua/sites/default/files/2020-10/dop-climate-final-5_sait.pdf)



**Figure 6: Dynamics of water abstraction from surface and underground sources and water consumption in Ukraine<sup>1</sup>**

The largest water consumers by regions are Kherson region (3043 million m<sup>3</sup>), Donetsk region (1707 million m<sup>3</sup>), Zaporizhia region (1260 million m<sup>3</sup>), Dnipropetrovsk region (1179 million m<sup>3</sup>), Odessa region (752 million m<sup>3</sup>), Kyiv region (528 million m<sup>3</sup>) regions and Kyiv city (544 million m<sup>3</sup>) (Fig. 7).



**Figure 7: Water abstraction from natural water bodies by regions of Ukraine in 2016-2018<sup>2</sup>**

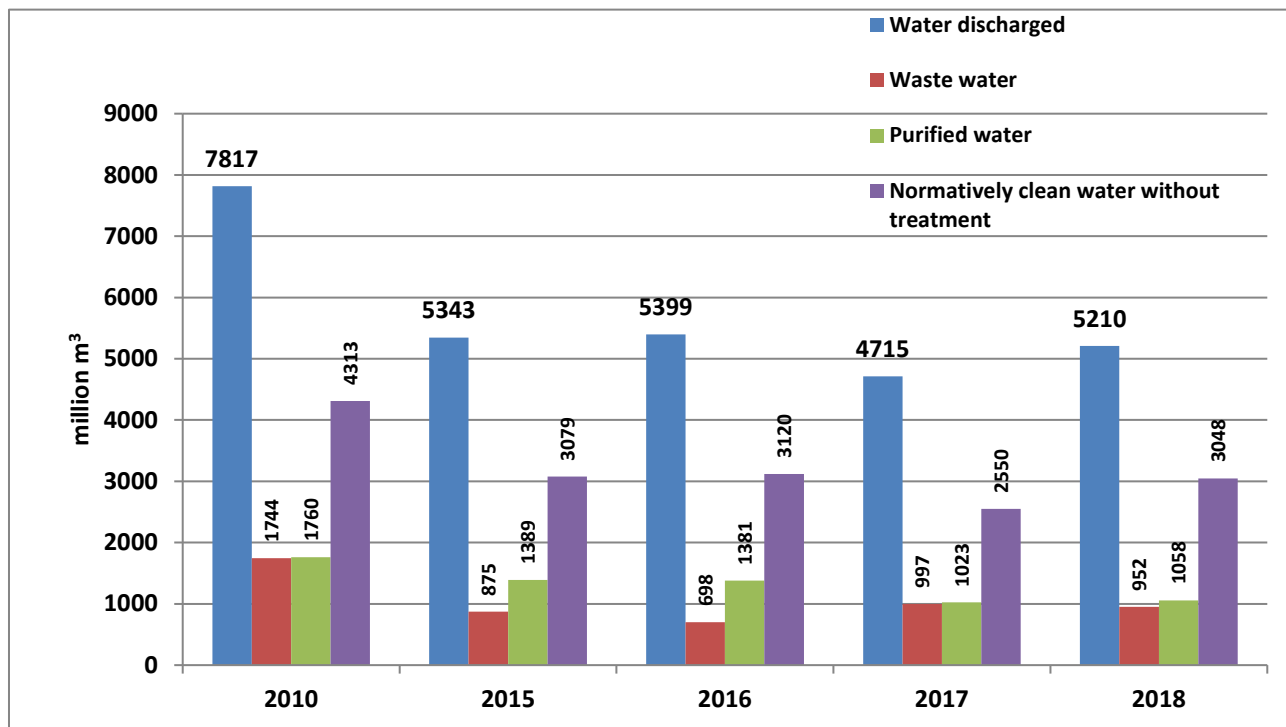
The gradual decrease in water consumption has been followed by reduced wastewater discharge. The main reasons for discharging waste water are the lack of centralized drainage in most settlements of the country, and low efficiency of treatment facilities due to their age and low technological level. Also, it needs to be noted that the composition of treatment facilities and water treatment technologies do not reflect the needs for significantly reducing the water pollution, and the existing treatment facilities, technologies for purification and disinfection of drinking water are not able to purify it to the level of safety indicators.

In 2018, 5,210 million m<sup>3</sup> of water was discharged into surface water bodies, including 3,284 million m<sup>3</sup> by industrial enterprises (63% of the total volume of discharges), 1,513 million m<sup>3</sup>

<sup>1</sup> Portal of Open Data. – <https://data.gov.ua/dataset/2054e342-fd89-4419-b130-685a9d042990>

<sup>2</sup> Portal of Open Data. – <https://data.gov.ua/dataset/2054e342-fd89-4419-b130-685a9d042990>

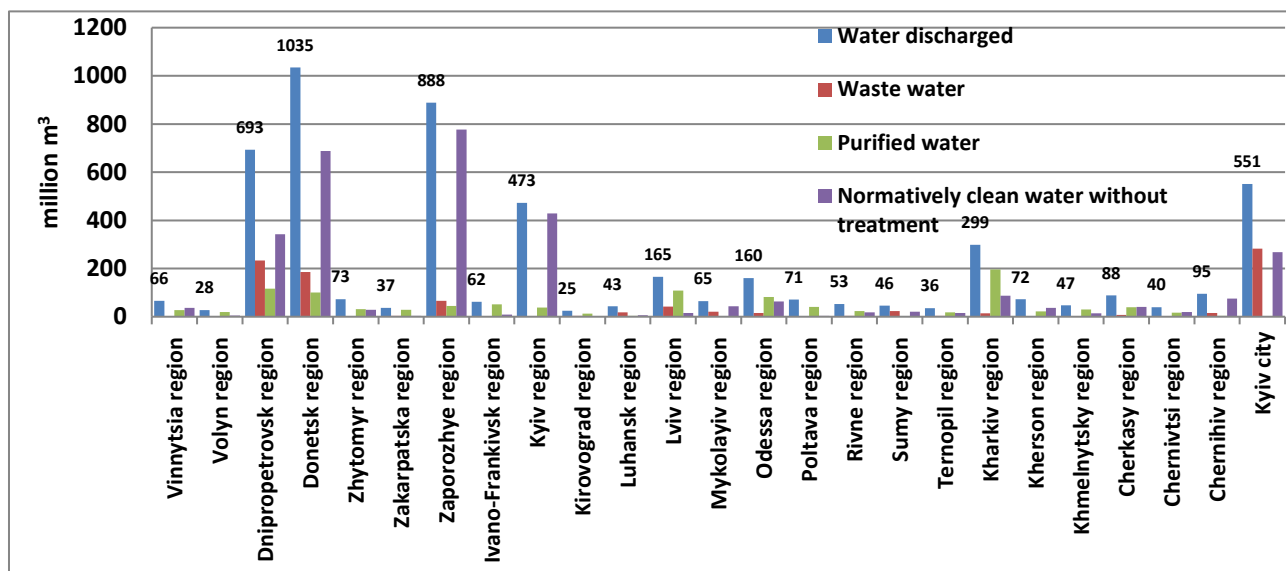
(29%) by the housing and communal services sector and agricultural enterprises – 349.6 million m<sup>3</sup> (6.7%). The dynamics of water discharges into surface water bodies by all water users indicates a gradual decrease in the level of drainage and discharges of polluted water (Fig. 8).



**Figure 8: Dynamics of water discharge into natural water bodies<sup>1</sup>**

In 2018, waters were discharged by categories: waste water – 952 million m<sup>3</sup> (18.3%), normatively clean water without treatment – 3,048 million m<sup>3</sup> (58.5%), and purified waters – 1,058 million m<sup>3</sup> (20.3%).

Most waste waters were discharged by water users of Dnipropetrovsk, Donetsk and Zaporizhia regions and the city of Kyiv (Fig. 9).



**Figure 9: Discharge of waters into surface water bodies by regions in 2018<sup>2</sup>**

Almost 80% of Ukraine's drinking water supply is provided by surface water. Potential available surface water supplies of Ukraine are estimated at about 209 km<sup>3</sup> per year, of which 25% is formed

<sup>1</sup> Portal of Open Data. – <https://data.gov.ua/dataset/2054e342-fd89-4419-b130-685a9d042990>

<sup>2</sup> Portal of Open Data. – <https://data.gov.ua/dataset/2054e342-fd89-4419-b130-685a9d042990>

within the territory of the country (while the rest of the water resources is provided by Dnipro and Pripjat rivers flowing from the territory of Russia and Belarus, respectively).

Most river basins, according to the hygienic classification of water bodies according to the degree of pollution, can be classified as polluted and highly polluted.

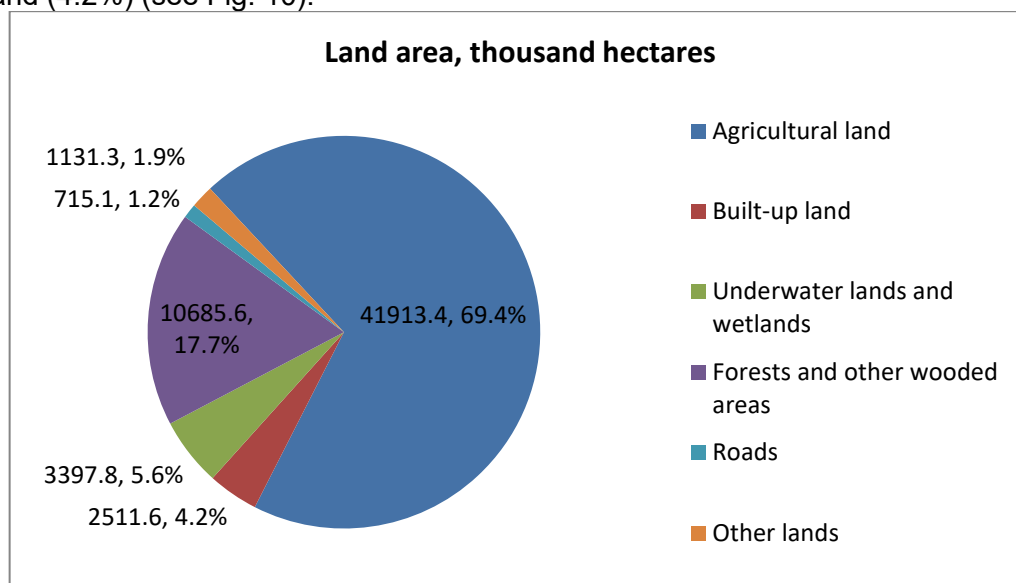
The Water Strategy of Ukraine until 2025 (scientific bases) identifies such main water problems:

- Natural scarcity of water resources, as well as their uneven distribution over the territory and time;
- Depletion of water resources due to a large amount of water intake for economic needs;
- Significant amount of pollutants entering rivers and other water bodies;
- Excessive regulation of river runoff, which causes additional water losses due to evaporation, slow water exchange and, as a consequence, deterioration of water quality and degradation of channels<sup>1</sup>.

Most probably the stabilization of water use (Fig. 6) and relevant stabilization of wastewater discharge (Fig. 8) will continue. Taking into account scarcity of water resources, one can assume that water consumption will be reduced. This is important for southern regions of Ukraine, where issue of scarcity of water resources is most acute and where production of green hydrogen using electrolysis will be developed.

#### 4.4. Land and soil

As of 2018, the land in Ukraine consisted of agricultural land (69.4% of the total area of the country), forests and other wooded areas (17.7%), underwater lands and wetlands (5.6%) and built-up land (4.2%) (see Fig. 10).



**Figure 10: Lands of Ukraine in 2018<sup>2</sup>**

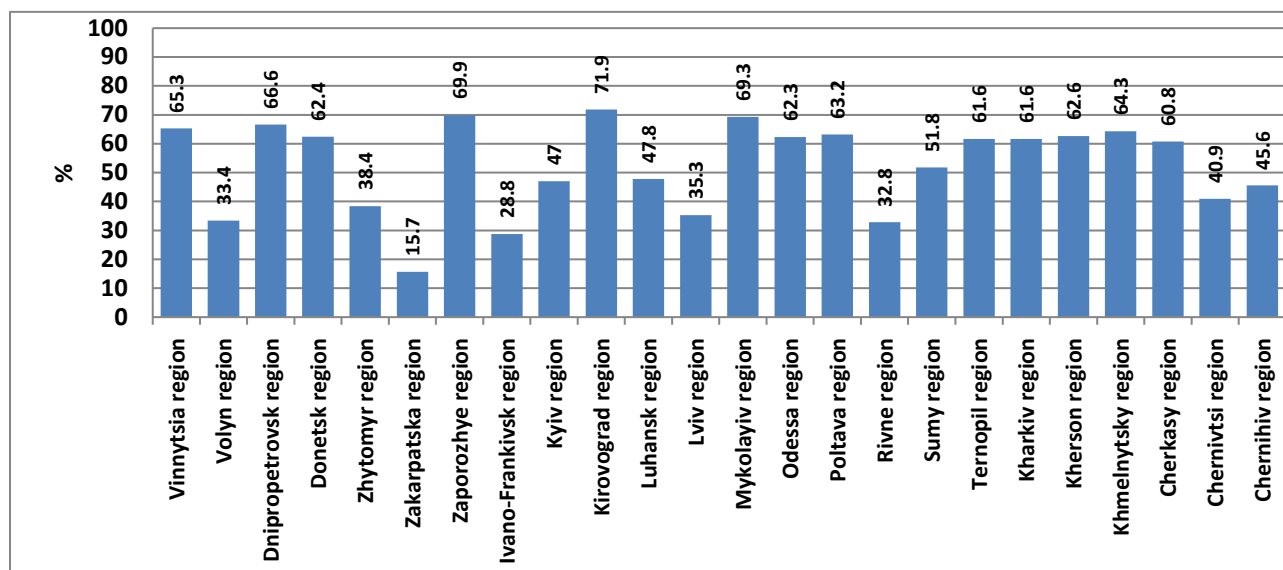
The most valuable lands in Ukraine are lands of the nature reserve fund and agricultural lands with highly valuable soils, which represent a rather large share of the total area of the country. Ukraine has one of the highest rates of agricultural land and arable land per capita in the world. Thus, arable land has the largest share with 54.2% of the country's area; pastures occupy 8.8% and hayfields 3.8%. This distribution of land characterizes the high degree of ploughing and agricultural development of Ukraine.

Excessive ploughing of lands, including on the slopes, has resulted in the ecologically unbalanced ratio between arable lands, hayfields and pastures, and forests, which negatively affects the

<sup>1</sup> The Water Strategy of Ukraine until 2025 (scientific bases) (2015). – [http://iwpim.com.ua/wp-content/uploads/2015/10/11\\_03\\_2015.pdf](http://iwpim.com.ua/wp-content/uploads/2015/10/11_03_2015.pdf)

<sup>2</sup> National report on state of the environment in Ukraine in 2018. – <https://mepr.gov.ua/news/35937.html>

sustainability of agricultural landscapes and causes a significant man-made impact on ecosystems<sup>1</sup>.



**Figure 11: The level of ploughing of Ukraine's land by regions in 2018<sup>2</sup>**

A national survey on the state and quality of soil is carried out every five years, i.e. the last available data (2015) represents the situation between 2011 and 2015.

According to the survey, more than 19% are acidic soils, 57.3% close to neutral and neutral, and 23.6% alkaline soils. The high share of acid soils is typical for the Polissya zone (45.6%), the lowest - in the Steppe zone (1.8%). The average humus content in the soils of Ukraine is 3.16%.

There are more than 1 million hectares of degraded, unproductive and man-caused contaminated lands in the country, which are subject to conservation, altogether 143,700 hectares of disturbed lands requiring reclamation, and 294,600 hectares of low-productive lands, which need improvement.

About 57% of Ukraine's territory is affected by water and wind erosion, more than 12% of the territory is at risk of flooding. Almost 23,000 landslides are recorded annually. As a result of abrasion, up to 60% of the coast of the Azov and Black Seas and 41% of the shoreline of the Dnipro reservoirs are destroyed. More than 150,000 hectares of land have been disturbed as a result of mining and other activities. The number of underground and surface karst manifestations is about 27,000. According to various criteria, about 20% of Ukraine's lands are polluted.

The reasons for this situation are complex and have historical preconditions. Of particular note are:

- Excessive ploughing and disruption of the natural soil formation process;
- Use of ineffective and outdated technologies in agriculture, industry, energy, transport and other sectors; and
- Focus on short- and medium-term economic benefits, ignoring the environmental component and the negative effects in the long run.

#### 4.5. Biodiversity and ecosystems

Over the last century, the landscape as a habitat for fauna and flora has changed significantly in Ukraine. The forest areas have decreased significantly; there is excessive ploughing of lands; the steppe is practically destroyed as a natural biome; steppe habitats continue to be fragmented, degraded, and converted to agriculture or industrial uses; hydrological conditions of the territory have changed due to construction of lowland hydropower plants and creation of reservoirs, drainage of Polissya swamps and steppe irrigation.

<sup>1</sup> Stadnyk A.P. & Slavhorodska Yu. V. (2018). Regulatory and legal support of optimization of the structure of agricultural landscapes *Agroecological journal*, 3, 6–11 [In Ukrainian]. – <http://journalagroeco.org.ua/article/view/147955/147667>

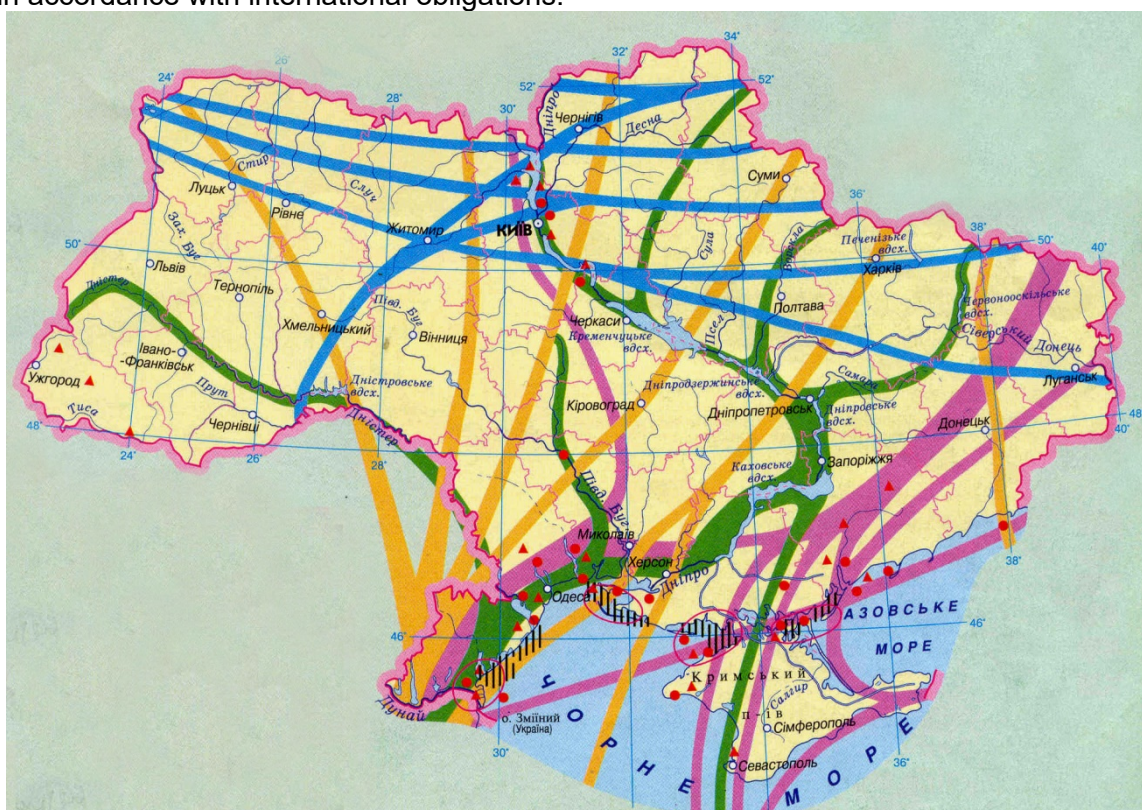
<sup>2</sup> National report on state of the environment in Ukraine in 2018. – P. 173. – <https://mepr.gov.ua/news/35937.html>

Approx. 19 million hectares are occupied by natural vegetation in Ukraine; however, its decline under the impact of human economic activity and climate change is becoming threatening. Steppes in the past occupied about 40% of the area of Ukraine, and currently make up no more than 3% of the area of its primary distribution.

In Ukraine, forests currently occupy 10.4 million hectares (i.e. 15.9% of the territory), including 9.6 million hectares of forested land, of which semi-natural forests grow on an area of 5 million hectares, forest crops (plantations) – on 4.6 million hectares. Natural forests remain on an area of only about 94,000 hectares<sup>1</sup>. Forests in the country are distributed unevenly, from 3.7% in the Zaporizhia region to 51.4% in the Zakarpattia region.

Biota of Ukraine has more than 70,000 species, thus while occupying less than 6% of Europe's area, Ukraine represents about 35% of its population biodiversity. Unfortunately, the species richness of both plants and animals is declining due to anthropogenic pressure. The main reasons are the transformation of habitats, in particular due to the expansion of agricultural use of natural ecosystems, and over-exploitation of species (especially overfishing). Approximately 8.3% of vascular plants, 31.1% of mammals, 19.7% of birds, 38% of reptiles and 26.3% of amphibians are threatened. The last edition (2009) of the Red Book of Ukraine (flora and fauna) includes 826 species of plants and 542 species of animals.

Ukraine is located at the crossroads of migration routes of many species of fauna and some nesting sites are of international importance. Three main global migration routes of wild birds cross the territory of Ukraine: Azov-Black Sea latitudinal (southern corridor) with the largest concentration of migratory birds in Ukraine, Polissya latitudinal (northern corridor) - along the forest belt of Polissya and in the north of the Forest-Steppe zone and Dnipro meridional migration route along the Dnipro river and its tributary – Desna River (Fig. 12). More than 100 species of migratory birds are protected in accordance with international obligations. More than 130 species of migratory birds, 8 species of fish, 3 species of marine mammals, 28 species of bats are protected in Ukraine in accordance with international obligations.



Azov-Black Sea latitudinal route (southern corridor)  
 Polissya latitudinal route (northern corridor)

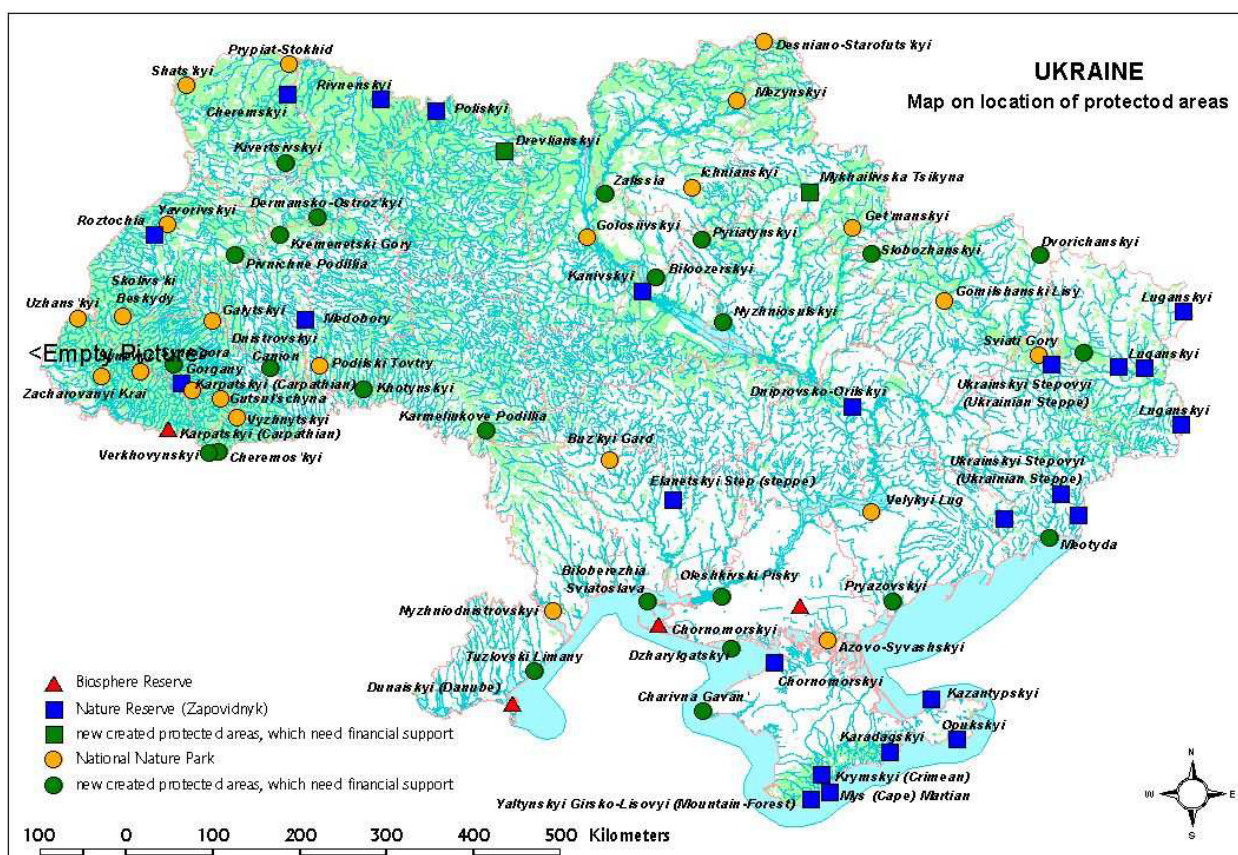
<sup>1</sup> As of the end of 2018, more than 94,000 hectares of virgin and old-growth forests in Zakarpattia, Ivano-Frankivsk, Chernivtsi and partly Lviv oblasts have been described by WWF and other organizations. – [https://wwf.ua/our\\_work/forests/virgin\\_forests/](https://wwf.ua/our_work/forests/virgin_forests/)

- Dnipro meridional route
- Wide front meridional route
- Points of mass ringing of birds
- Bird migration monitoring points
- Wetlands of international importance

**Figure 12: Migration routes of wild birds<sup>1</sup>**

As of January 2020, the nature reserve fund of Ukraine consisted of 8,512 territories and objects with a total area of 4.418 million hectares within the territory of Ukraine, and 402,500 hectares of water area within the Black Sea, which in total covers 6.77% of the country's territory. The territories and objects of the nature reserve fund of Ukraine includes 4 biosphere reserves, 19 nature reserves, 49 national nature parks (see Fig. 13), 3,258 reserves, 3,492 natural monuments, 83 regional landscape parks, 815 protected tracts, and also a number of artificial objects (botanical gardens, zoological parks, arboretums and parks and monuments of landscape art). A total of 8,396 protected areas with a total area of 3.992 million hectares and 1 marine botanical reserve of national importance "Zernov's Phyllophora Field" with an area of 402,500 hectares. Reserves, national nature parks and regional landscape parks constitute more than 85.5% area of protected areas in Ukraine.

The "protected areas ratio" varies significantly by regions. The lowest (up to 5%) is in Vinnytsia, Dnipropetrovsk, Donetsk, Zhytomyr, Zaporizhia, Kyiv, Kirovohrad, Luhansk, Mykolaiv, Odesa, Poltava, Cherkasy and Kharkiv regions; the largest (over 12%) - in Ivano-Frankivsk, Khmelnytsky, Zakarpattia and Chernivtsi regions, and in Kyiv and Sevastopol it is 14.9% and 30.3%, respectively. In Volyn, Lviv, Rivne, Sumy, Ternopil, Kherson, Chernihiv regions and the Autonomous Republic of Crimea – 6-12%. Thus, in different regions of Ukraine, the area of protected areas in 2018 ranged from 2.24% to 15.71% of the total area of region.



**Figure 13: Map on location of protected areas<sup>2</sup>**

<sup>1</sup> [http://pernatidruzi.org.ua/karta\\_sezonnykh\\_mihratsiy\\_ptakhiv.html](http://pernatidruzi.org.ua/karta_sezonnykh_mihratsiy_ptakhiv.html)

<sup>2</sup> <https://www.cbd.int/doc/world/ua/ua-nbsap-powpa-en.pdf>

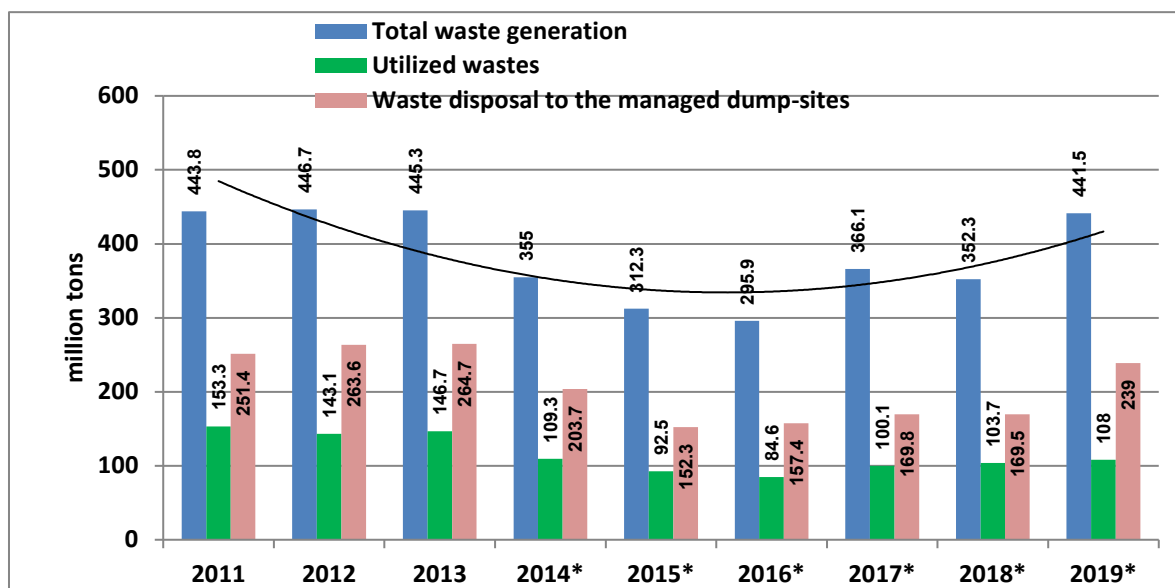


The main threats to biodiversity in Ukraine can be summarized as follows:

- Destruction of natural habitats of animals and plants as a result of ploughing of lands, deforestation, drainage or flooding of territories, industrial, transport, housing and country construction, etc.;
- Fragmentation of habitats, landscapes, ecosystems occurs during the construction of a network of transport communications (roads, highways), pipelines, reservoirs and related irrigation facilities (dams, pumping stations), etc. The fragmentation of habitats increases the risk of extinction of local populations of animals and plants, making it difficult for them to migrate and spread;
- Degradation of natural habitats occurs mainly due to environmental pollution, in particular pollution of water bodies with nutrients and heavy metals;
- Exploitation of species, their populations and plant communities due to inefficient management of forestry, hunting and fisheries;
- The spread of alien species that may adversely affect ecosystems, local species or public health causes significant imbalances in natural ecosystems;
- Distribution of diseases, pests and parasites among species of natural flora and fauna;
- Low level of environmental management and environmental awareness in matters of biodiversity conservation.

#### 4.6. Solid waste

The dynamics of waste generation and management in Ukraine is presented in Fig. 14. As it can be seen, the amount of waste generated, utilized and disposed decreased significantly in 2014 (excluding the temporarily occupied territories), and has been increasing significantly since 2016. In 2019, according to the State Statistics Service, 441.5 million tons of wastes were generated in Ukraine.



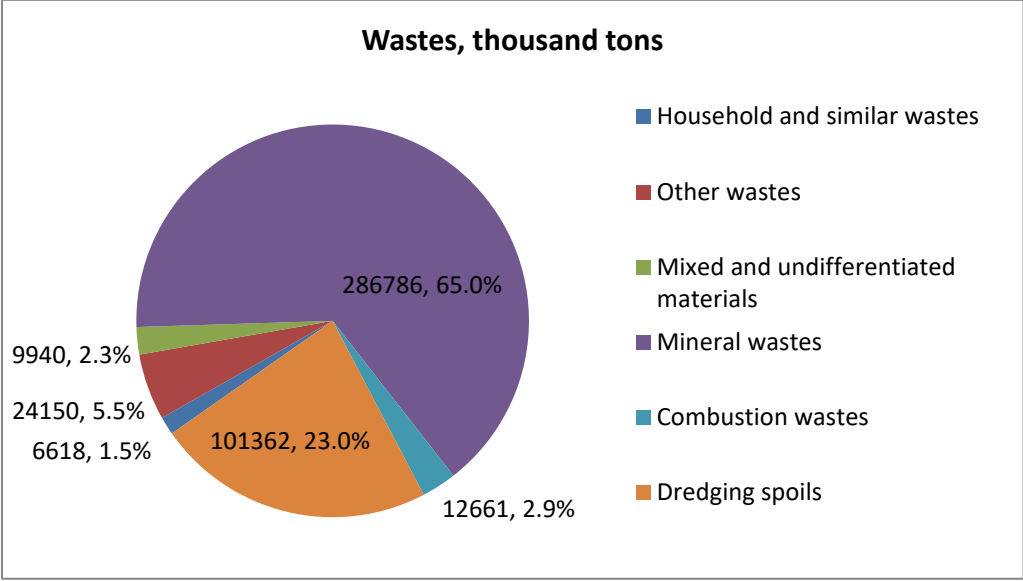
\* Data exclude the temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol and a part of temporarily occupied territories in the Donetsk and Luhansk regions.

**Figure 14: Dynamics of waste generation and management in Ukraine<sup>1</sup>**

Of the total amount of waste generated, 98.7% wastes (435.6 million tons) are generated by economic activities of enterprises and organizations, and 1.3% (5.9 million tons) by households. In connection with the raw material orientation of the Ukraine's economy, the structure of waste generation in Ukraine is characterized by the high share of mining waste (overburdens and mineral processing products - sludge, tailings, etc.) - more than 75%. The largest amount of waste is generated at the enterprises of mining and metallurgical, coal, chemical industry and energy sector. Mineral wastes of IV hazard class (Fig. 15) are dominated in the structure of total waste generation by categories of materials. Their generation was 286.8 million tons (65% of the total

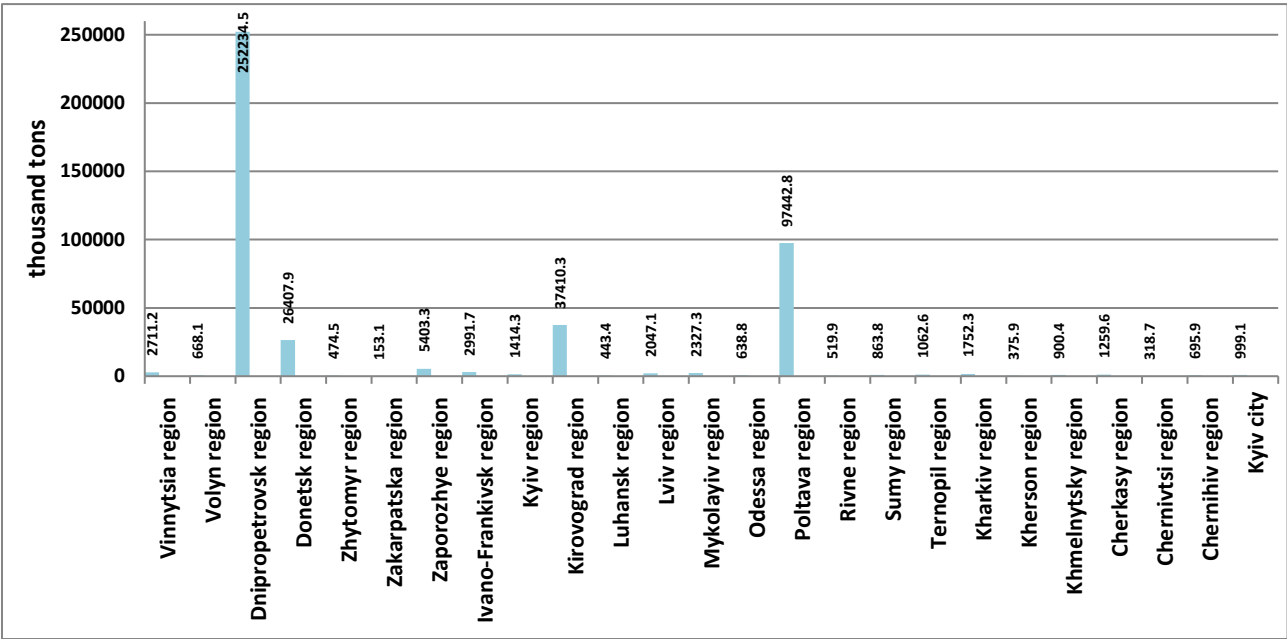
<sup>1</sup> State Statistics Service of Ukraine – <http://www.ukrstat.gov.ua/>

volume), which together with wastes from dredging (101.4 million tons) are 88% of the total waste generation.



**Figure 15: Structure of waste generation by categories of materials in 2019**

The largest amount of waste is generated by industrialized regions. In 2019, the total amount of waste generated in Dnipropetrovsk, Poltava, Kirovohrad and Donetsk regions represented 93.7% of the total waste production.



**Figure 16: Waste generation by regions in 2019<sup>1</sup>**

The total amount of accumulated waste is constantly growing. In 2019, the amount of accumulated waste amounted to 15.4 billion tons, including 12.3 thousand tons of hazardous waste of I-III hazard classes.

In 2019, Ukraine (without taking into account Crimea) generated almost 53 million m<sup>3</sup> of household wastes (or more than 10 million tons).

The general trend for Ukraine, in contrast to European countries, is the low level of processing and utilization of solid waste and a high rate of their disposal in landfills.

<sup>1</sup> State Statistics Service of Ukraine – <http://www.ukrstat.gov.ua/>

In total, about 78% of the population of Ukraine is covered by household waste disposal services, and there is a tendency to continuous growth in the collection and removal of household waste. However, it should be noted that despite some positive developments, the problem of household waste remains one of the most acute economic and environmental problems of the country. Renewal of the waste component composition and limited areas for landfills leads to increasing the costs of their management and an increasing public concern too.

According to 2019 data, a total of 905 of landfills (15%) do not meet environmental safety standards, 258 landfills are overloaded (4.2%), 483 landfills require reclamation, and 57 landfills were actually reclaimed. There is a need to establish more than 384 landfills, with a highest demand in Ukraine's Transcarpathian region (44 units).

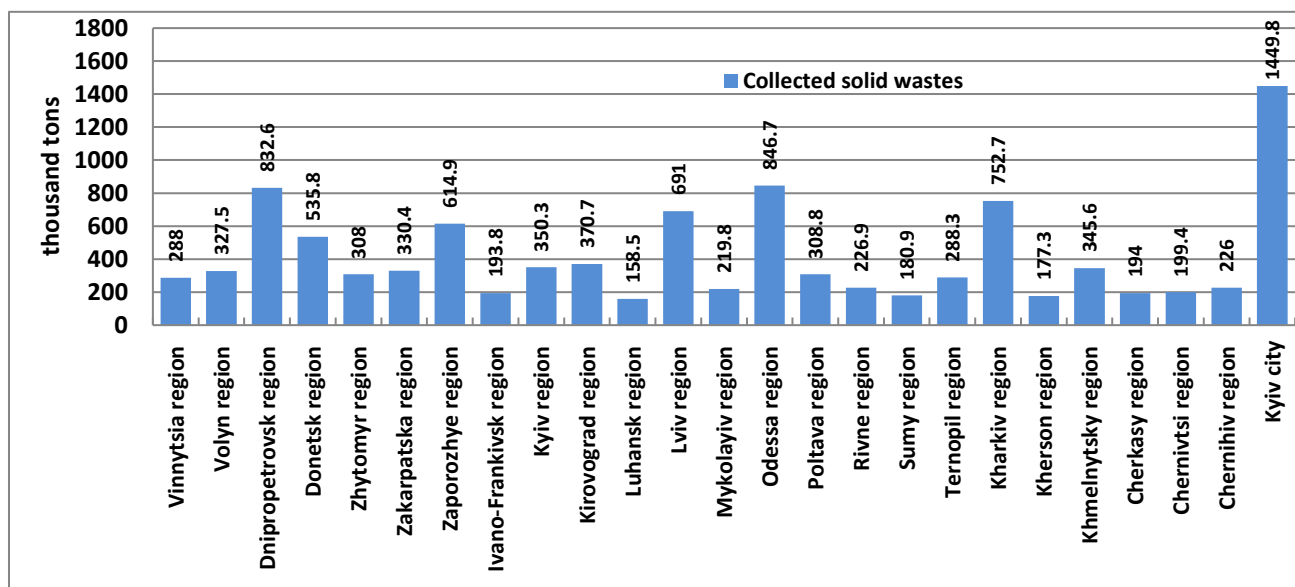


Figure 17: Collected solid wastes by region in 2019<sup>1</sup>

Inefficient waste management has a significant negative impact on the environment (air, groundwater, wildlife, soils, the need to remove large plots of land), as well as on human health.

The main issues regarding the waste management in Ukraine can be summarized as follows:

- 1) High volumes of waste generation and accumulation in both industrial and household sectors;
- 2) Continuing focus on landfilling;
- 3) Waste disposal dumps, which do not meet the requirements of environmental safety (most of them), and existence and use of unauthorized dumps;
- 4) Low level of waste use as secondary raw materials;
- 5) Lack of application of effective approaches to and new technologies of waste management.

#### 4.7. Population and health

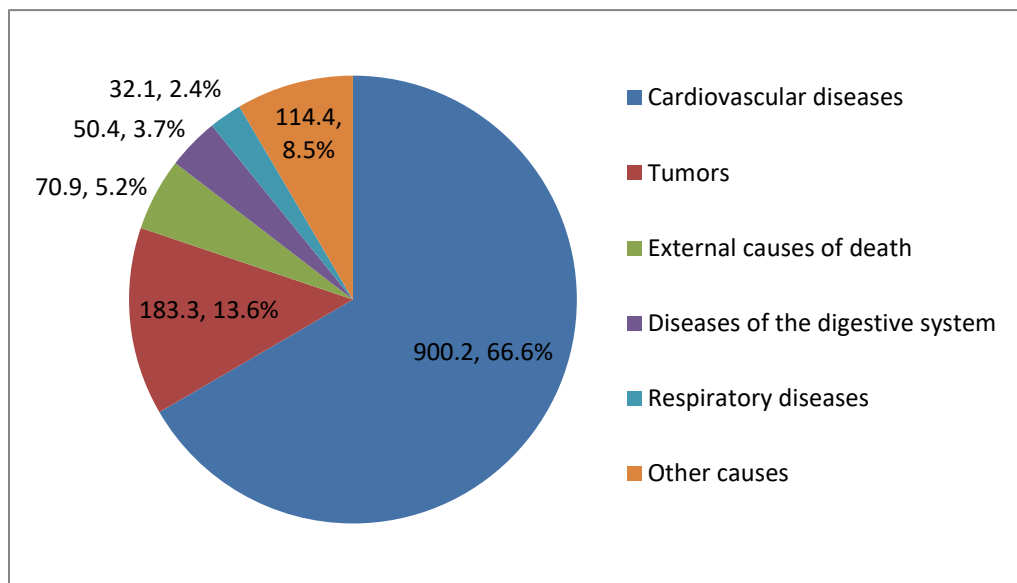
Although Ukraine is one of the five largest countries in Europe in terms of population, its population has been declining since 1994. According to the State Statistics Service, the population of Ukraine on January 1, 2020 was 41.9 million people (excluding the temporarily occupied territory of the Autonomous Republic of Crimea and the city of Sevastopol), of which 29.1 million people (69.5%) are urban residents and 12.8 million people (30.5%) live in rural areas. Compared to 2002 (48.5 million people according to the All-Ukrainian Census of December 5, 2001), the population of Ukraine at the beginning of 2020 decreased by 6.6 million people.

The composition of the permanent population of Ukraine (41.7 million people) is characterized by a significant gender disparity. The numerical superiority of women over men in the population of Ukraine has been observed since the age of 36 and is increasing with age. The number of men on January 1, 2020 was 19.3 million people (46.3%) and women – 22.4 million people (53.7%).

<sup>1</sup> Ministry for Communities and Territories Development of Ukraine. – <https://www.minregion.gov.ua/napryamki-diyalnosti/zhkh/terretory/stan-sfery-povodzhennya-z-pobutovymy-vi/>

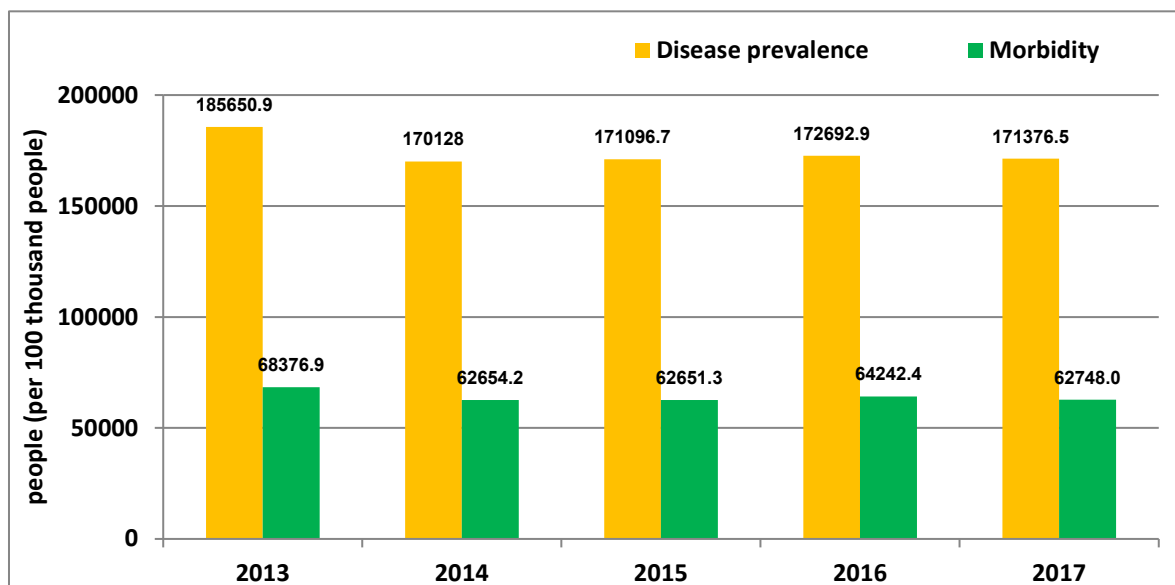
Despite the positive dynamics of the overall mortality rate in recent years, in 2017 it remained one of the highest in Europe.

In 2017, the main causes of death in Ukraine were cardiovascular diseases (66.6% of total deaths), tumors (13.6%), external causes of death (5.2%), diseases of the digestive system (3.7%) and diseases of respiratory organs (2.4%) (see Fig.18).



**Figure 18: Mortality of Ukraine's population by causes of death in 2017 (per 100 thousand people)<sup>1</sup>**

In 2017, the prevalence of diseases among Ukraine's population decreased by 7.69% compared to 2013, and the level of primary morbidity decreased by 8.2% compared to 2013 (Fig. 19).



**Figure 19: Dynamics of indicators of disease prevalence and morbidity of Ukraine's population for the period 2013–2017 (per 100 thousand people)<sup>2</sup>**

In 2017, the structure of primary morbidity of Ukraine's population by the main classes of diseases, was as follows:

- 1) Respiratory diseases (45.23%);
- 2) Diseases of the cardiovascular system (6.69%);

<sup>1</sup> Ministry of Health of Ukraine (2017) "Annual report on the state of public health, the sanitary and epidemiological situation and results of the health care system of Ukraine". – P. 24.

<sup>2</sup> Ministry of Health of Ukraine (2017) "Annual report on the state of public health, the sanitary and epidemiological situation and results of the health care system of Ukraine". – P. 33.

- 3) Injuries, poisoning and some other consequences of external factors (6.38%);
- 4) Diseases of the skin and subcutaneous tissue (5.88%);
- 5) Diseases of the eye and its appendages (5.13%).

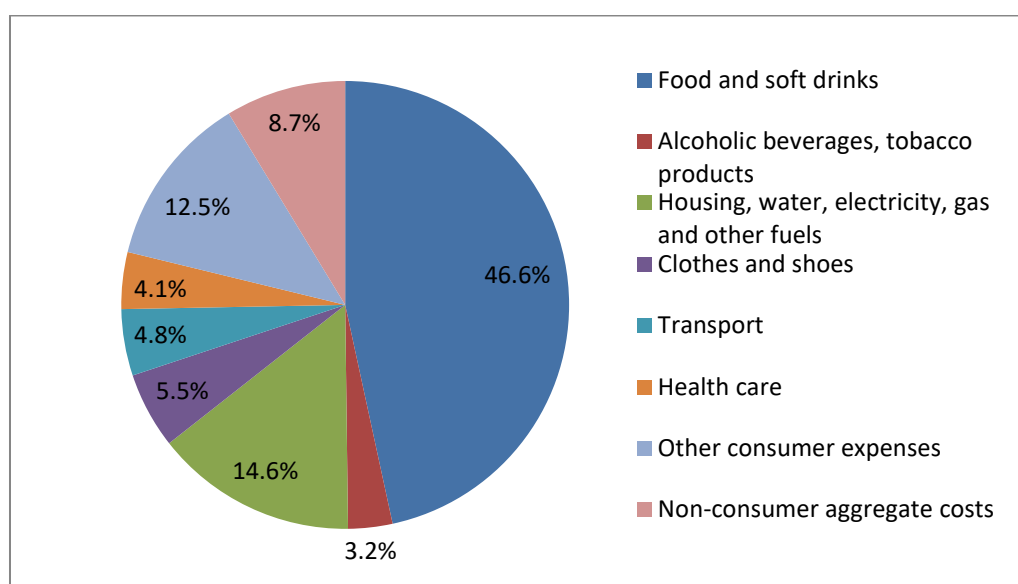
One of the most significant environmental risk factors affecting health is air pollution. As mentioned above, air pollution remains high in the large cities and industrial centers. Approximately one third of Ukraine's population lives in the areas with poor air quality, which significantly reduces immunity, and contributes to the emergence of respiratory diseases. Besides environmental factors, deterioration of the quality of life of the majority of Ukrainian population is caused by socio-economic factors including underemployment or unemployment, low wages and pensions, socio-political tensions, etc., as well as social factors – the level of health care, food quality (due to deteriorating food quality system of many people), unhealthy lifestyle and bad habits (alcoholism, smoking, drug addiction)<sup>1</sup>.

According to the WHO, in 2019 the average life expectancy at birth in Ukraine was 73 years for both sexes (for comparison: the average in Europe - 78.2 years), 68 years - for men (on average in Europe - 75.1 years) and 77.8 years - for women (average in Europe - 81.3 years). Although in recent years there has been a tendency to increase the life expectancy of Ukrainian people, however, the difference in the life expectancy between men and women remains at the level of 10 years as well as between Ukraine and Western Europe, Canada, USA, Australia, where these figures are 10 years higher on average.

#### 4.8. Livelihood and socio-economic aspects

According to the State Statistics Service, generally in Ukraine for the period 2013-2019, the number of employed people aged 15-70 years decreased sharply - from 19.3 million people in 2013 to 16.6 million people in 2019. At the same time, the number of the unemployed, according to the methodology of the International Labor Organization, reached 1.5 million people. The unemployment rate among the economically active population aged 15–70 as a percentage of the economically active population of the corresponding age group increased from 7.8% in 2013 to 8.6% in 2019.

In 2018, there were 14.9 million households in Ukraine. The total aggregate expenditures of households consist of consumer (food, water, housing, heat, etc.) and non-consumer (assistance to relatives and others, purchase of shares, bank deposits, construction and overhaul of housing, etc.) expenditures. The structure of total household expenditures is presented in Fig. 20.



**Figure 20: Structure of total household expenditures in Ukraine in 2019, %<sup>2</sup>**

<sup>1</sup> Tsiborovsky, O. (2015) "Population health and risk factors affecting on his condition as an object of management (literature review) // Ukraine. Health of Nation. - #2 (34). - P. 13-19.

<sup>2</sup> State Statistics Service of Ukraine. – <http://www.ukrstat.gov.ua/>

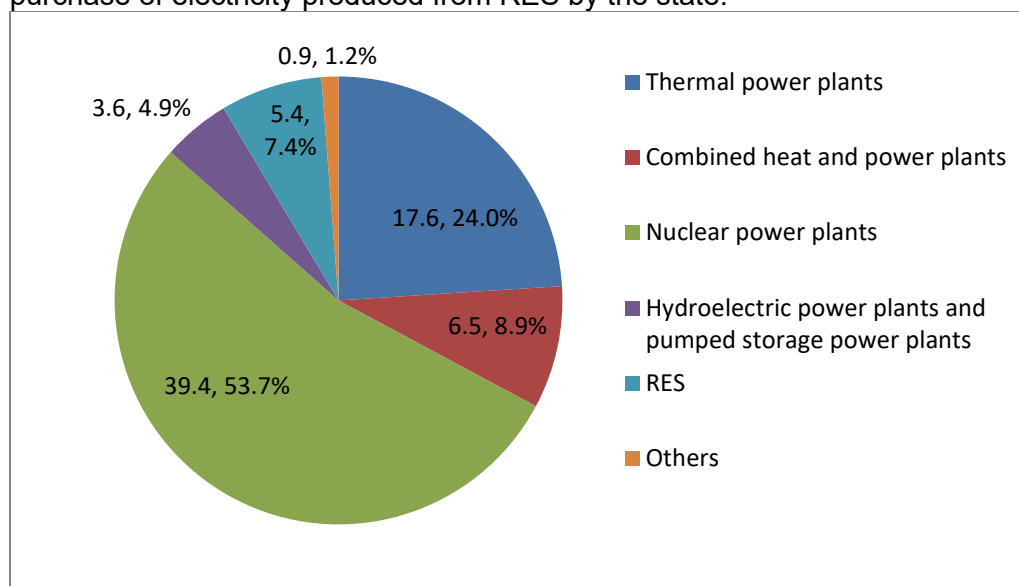
In 2019, the share of total energy expenditures of households was 14.6%. The lack of funds to maintain a sufficient temperature in their homes during the heating season in 2019 was found in 21.8% of households. The government provides subsidies to the population to reimburse the cost of housing and communal services, the purchase of liquefied gas, solid and liquid household fuel. Numerous opinion polls show that utility bills, including central heating, gas and electricity, are a significant problem for the majority of the country's population, and housing and utility subsidies in early 2019 accounted for 65% of households<sup>1</sup>. Socio-economic consequences of the economy functioning in the quarantine period caused by the spread of COVID-19 may be the impetus for the deepening of energy poverty of the population of Ukraine with the beginning of the heating season in 2020-2021.

#### 4.9. Renewable energy sources

In recent years, there is a gradual increase the installed RES capacity in Ukraine. At the same time, the difficult economic situation in the country did not allow to achieve goals adopted in the National Renewable Energy Action Plan, in particular the national indicative target for increasing the share of RES in energy consumption to 11% in 2020. In 2019, the share of energy supply from RES was 4.9% of the total primary energy supply<sup>2</sup>.

In 2019, the largest share in the production of electricity by RES in Ukraine was occupied by wind and solar power plants, which produced 1.76 billion kWh (45.1% of total electricity production from RES, which amounted to 3.906 billion kWh) and 1.883 billion kWh (48.2%) electricity, respectively.

The share of RES in the structure of electricity production in the first half of 2020 was 7.4% (5.4 billion kWh) (Fig. 21). Compared to the first half of 2019, this share increased 2.3 times<sup>3</sup> that was caused by the intensive introduction of new RES capacity during 2019 and the first half of 2020 and a decrease in consumption. As a result, the installed RES capacity has doubled (from 2.9 GW in June 2019 to 5.8 GW in June 2020). This growth is explained by the legally established economic incentives for the construction of RES, in particular, the "green" tariff and the guaranteed purchase of electricity produced from RES by the state.



**Figure 21: Structure of electricity production in the first half of 2020, billion kWh<sup>4</sup>**

Ukraine has significant technical potential for the use of RES (wind and solar power plants). According to the International Renewable Energy Agency (IRENA), the RES potential is 537 GW, while according to the Institute of Renewable Energy of the National Academy of Sciences of

<sup>1</sup> Government portal: Official web-site. - <https://www.kmu.gov.ua/news/monetizovani-subsidiyi-mayut-peretvoritis-na-investiciyi-v-energoefektivnist-gennadij-zubko>

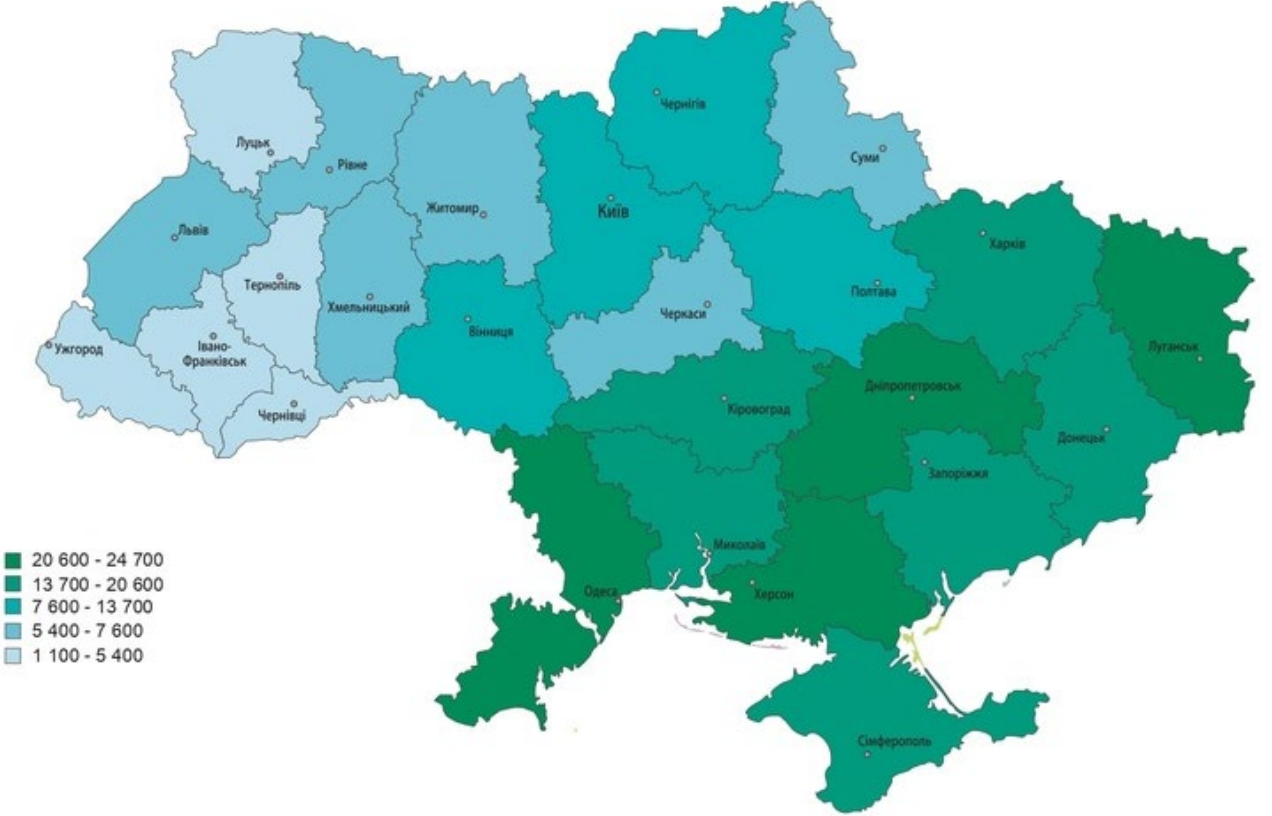
<sup>2</sup> State Statistics Service of Ukraine. – <http://www.ukrstat.gov.ua/>

<sup>3</sup> National Energy Company "Ukrenergo". – <https://ua.energy/robotaipts/u-i-pivrichchi-chastka-vde-u-strukturi-generatsiyi-zrosla-u-ponad-2-razy-porivnyano-z-2019-rokom/>

<sup>4</sup> National Energy Company "Ukrenergo". – <https://ua.energy/robotaipts/u-i-pivrichchi-chastka-vde-u-strukturi-generatsiyi-zrosla-u-ponad-2-razy-porivnyano-z-2019-rokom/>

Ukraine it is 771 GW. The potential of average annual electricity production is estimated at 1516 billion kWh and 2273 billion kWh, respectively<sup>1</sup>.

Significant potential for the use of RES can be directed not only to the generation of heat and electricity, but also to create long-term energy storage in the form of hydrogen. The total potential of Ukraine (including the Crimea and the temporarily occupied territories of Donbass) in the production of "green" hydrogen was estimated by the Institute of Renewable Energy at 505 billion m<sup>3</sup> (or 45 million tons).



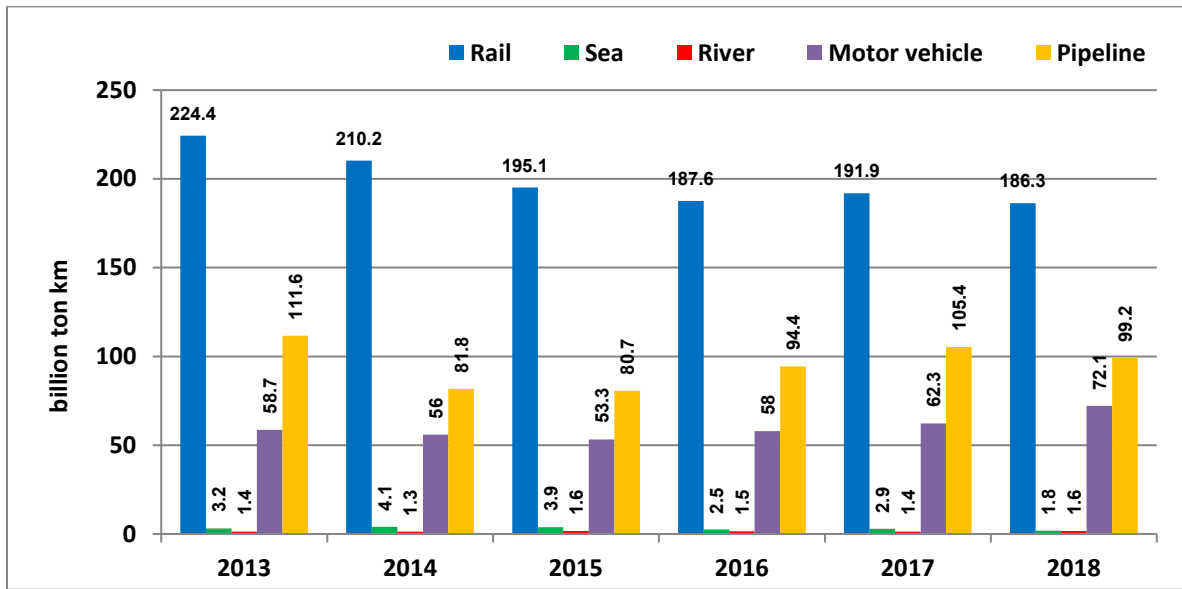
**Figure 22: Distribution of potential average annual production of "green" hydrogen by regions (million m<sup>3</sup>)<sup>2</sup>**

**4.10. Transport**

The geographical location of Ukraine from a transport perspective is highly favorable, even though this advantage has been insufficiently used thus far. Ukraine's transport network has a high potential for development, as the country is located at the intersection of roads between Western European and East Asian countries, has an extensive network of transport routes and developed modern stock of all modes of transport. The transport sector occupies an important place in the economy of Ukraine, which provides services for both domestic and export/import and transit transportation of goods and passengers.

The country's general transport network includes 20,952 km of railways, 159,462 km of paved public roads, 1,569 km of navigable waterways with an exit to the Black Sea and Sea of Azov and 43,500 km of main pipelines. The turnover in the transportation of both goods and passengers are shown in Fig. 23 and 24.

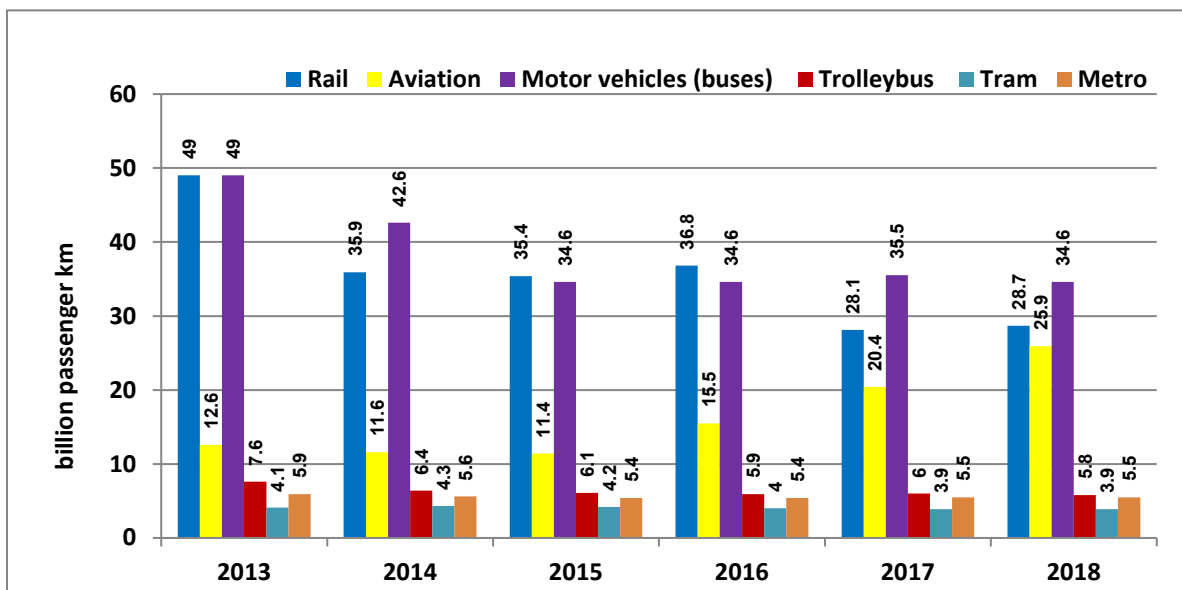
<sup>1</sup> Atlas of energy potential of renewable energy sources of Ukraine, Institute of Renewable Energy Sources (2019). – <https://www.yumpu.com/ru/document/read/62959987>  
<sup>2</sup> Atlas of energy potential of renewable energy sources of Ukraine, Institute of Renewable Energy Sources (2019). – <https://www.yumpu.com/ru/document/read/62959987>



**Figure 23: Freight turnover by transport mode (billion ton km)<sup>1</sup>**

Freight transport is dominated by rail, which has slightly decreased over the past years, while road transport has slightly increased.

In 2018, the freight turnover was 361.3 billion ton km. The highest share within freight turnover was carried by rail (51.6%), followed by pipeline (27.5%) and road (20%).



**Figure 24: Turnover of passengers by types of transport (billion passenger km)**

In 2018, the passenger turnover was 104.4 billion passenger km. The highest share within passenger turnover was carried by buses (33.1%), followed by rail (27.5%) and aviation (24.8%).

Passenger transport by bus and coaches as well as by tram and metro has remained roughly constant in recent years. The volume of domestic aviation has increased since 2015.

In 2018, the freight turnover was 361.3 billion ton km. The highest share within freight turnover was carried by rail (51.6%), followed by pipeline (27.5%) and road (20%).

The dominant fuels in transport are oil and petroleum products including gasoline, diesel (gasoil) and liquefied petroleum gas (LPG). The next most important fuel is electricity in rail and to a lesser extent in other transport including trolleybuses, trams, etc. Also, there have been small shares of natural gas and solid fuels which each have remained roughly constant since 2014 (Fig. 25).

<sup>1</sup> Transport and communication of Ukraine - 2018. State Statistics Service of Ukraine. – [http://www.ukrstat.gov.ua/druk/publicat/kat\\_u/2019/zb/08/zb\\_tr2018pdf.pdf](http://www.ukrstat.gov.ua/druk/publicat/kat_u/2019/zb/08/zb_tr2018pdf.pdf)



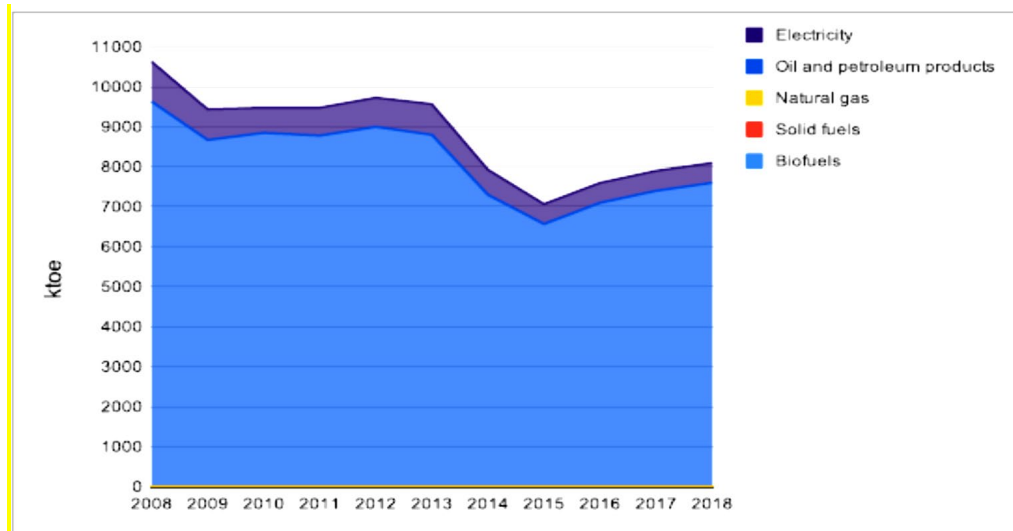


Figure 25: Energy consumption in transport by type of fuel<sup>1</sup>

<sup>1</sup> Modalities to foster use of renewable energy sources in the transport sector by the Energy Community Contracting Parties (2020) - <https://www.euneighbours.eu/en/east/stay-informed/publications/modalities-foster-use-renewable-energy-sources-transport-sector>

## 5. Environmental and health objectives

This section identifies environmental and health objectives established in the existing policy, strategic and legal documents of Ukraine. The identified environmental and health objectives will serve as a basis for the development of the reference framework for the policy evaluation of the Roadmap.

At the strategic level, the main priorities of environmental policy of Ukraine are defined in the Law of Ukraine "Basic principles (strategy) of state environmental policy of Ukraine until 2030" (from 28.02.2019 № 2697-VIII)<sup>1</sup>. These priorities relate to air quality, water and land resources, forests and biodiversity, waste management and biosafety.

National targets for sustainable development, indicators for monitoring the implementation of targets and targets for achievement by 2030 are reflected in the National Report "Sustainable Development Goals: Ukraine", prepared by the Ministry of Economic Development and Trade of Ukraine in 2017. On September 30, 2019, the President of Ukraine issued a Decree "On the Sustainable Development Goals of Ukraine until 2030", aimed at ensuring the achievement of global SDGs goals and the results of their adaptation to the specifics of Ukraine's development set out in the National Report "Sustainable Development Goals: Ukraine".

Main objectives for environmental and health issues stipulated by the key national legal acts are shown in table 2.

**Table 2: Main objectives stipulated by the key national strategic documents and legal acts relevant to the draft Roadmap and to the SEA process**

Strategic or legal document	Main objectives/targets
<b>Ambient air</b>	
Law of Ukraine "On Atmospheric Air Protection" (1992)	- To preserve and restore the natural state of atmospheric air, create favorable conditions for life, ensure environmental safety and prevent the harmful impacts of atmospheric air on human health and the environment
National plan to reduce emissions from large combustion plants (order of the Cabinet of Ministers of Ukraine № 796-r of 08.11.2017). Plan duration is from January 1, 2018 to December 31, 2033.	- To reduce gradually emissions of SO <sub>2</sub> , NO <sub>x</sub> and substances in the form of suspended solids undifferentiated in composition (dust) from existing large combustion plants with a nominal thermal capacity of 50 MW and more, for which the first emission permit or permit to design the installation was issued before July 1, 1992
Law of Ukraine "Basic principles (strategy) of state environmental policy of Ukraine until 2030" (2019)	- To reduce emissions of pollutants into the atmosphere from stationary sources (conditionally reduced to carbon monoxide, taking into account the relative aggressiveness of major pollutants) from 100% in 2015 to 85% in 2030 - To reduce emissions of pollutants into the atmosphere from mobile sources (conditionally reduced to carbon monoxide, taking into account the relative aggressiveness of major pollutants) from 100% in 2015 to 70% in 2030
National Transport Strategy of Ukraine for the period up to 2030 (order of the Cabinet of Ministers of Ukraine dated 30.05.2018 № 430-r)	- The use of fuel-economic and ecological vehicles, the use of alternative fuels, "green" modes of transport, the priority of environmental protection needs and the preservation of valuable protected areas during the development of transport infrastructure - Reduction of total emissions of pollutants into the atmosphere from mobile sources, conditionally reduced to carbon monoxide, taking into account the relative aggressiveness of major pollutants, to 70% (from the level of 2015)
<b>Climate change</b>	
On approval of the Concept of implementation of state policy in the field of climate change for the period up to 2030 (order of the Cabinet of Ministers of Ukraine of 07.12.2016)	- To reduce anthropogenic emissions and increasing the absorption of greenhouse gases and ensuring a gradual transition to low-carbon development of the state - To ensure the achievement in 2030 of the expected nationally determined contribution, which will not exceed 60% of the base 1990 level, and to provide for a revision by 2020 of its level of

<sup>1</sup> <https://zakon.rada.gov.ua/laws/show/2697-19>

#932-r)	ambition, taking into account indicators of socio-economic development of the state - To adapt to climate change, increase resilience and reduce the risks associated with climate change
Action plan for implementation of the Concept of implementation of state policy in the field of climate change for the period up to 2030 (order of the Cabinet of Ministers of Ukraine dated 06.12.2017 for № 878-r)	16. Ensure consideration of climate change factors in the development and implementation of the National Transport Strategy
National Transport Strategy of Ukraine for the period up to 2030 (order of the Cabinet of Ministers of Ukraine dated 30.05.2018 № 430-r)	- Reduction of greenhouse gas emissions into the atmosphere from mobile sources to 60% of the 1990 level, in particular due to an increase in the share of public transport and electric transport, electric buses, bicycles - Increasing the share of the use of electric vehicles and electric vehicles, in particular bringing the share of electric vehicles in domestic traffic to 75%, in 2030 - Increasing the level of use of alternative fuels and electricity to 50% by 2030 - Reduction of specific fuel consumption by 10 ton-kilometers by 30% by 2030
<b>Water resources</b>	
Water Code of Ukraine (№ 213/95-VR of 06.06.1995)	- To ensure the conservation, sustainable and scientifically sound use and restoration of water resources, protection of water resources from pollution, contamination and depletion, prevention and mitigation of negative impacts, improvement of the ecological status of water bodies projects and protection of water users' rights
National target program for the development of water management and ecological rehabilitation of the Dnipro River basin for the period up to 2021 (Law of Ukraine on May 24, 2012)	- To reduce by 1.5-2 times the level of water capacity for industrial production
Law of Ukraine "Basic principles (strategy) of state environmental policy of Ukraine until 2030" (2019)	- To decrease the water capacity of GDP (cubic meters of used water per 1000 hryvnias of GDP, in actual prices) from 3.6 m <sup>3</sup> in 2015 (base year) to 2.5 m <sup>3</sup> in 2030
Concept of implementation of state policy in the field of industrial pollution (order of the Cabinet of Ministers of Ukraine, May 22, 2019 N 402-r)	- To reduce discharges of polluted wastewater into water bodies in 2030 to 5% of total discharges compared to 15.7% in 2015
<b>Land and soil</b>	
Law of Ukraine "On Land Protection" (2003)	- To ensure the rational use of land, reproduction and increase of soil fertility, other useful properties of land, preservation of ecological functions of soil cover and environmental protection
The concept of combating land degradation and desertification (order of the Cabinet of Ministers of Ukraine dated October 22, 2014 № 1024-r)	- increase the effectiveness of state policy to combat land degradation and desertification, prioritize, strengthen institutional capacity and improve coordination of authorized bodies in this area, as well as ensuring that Ukraine, as a party to the UN Convention to Combat Desertification in those countries affected by severe drought and/or desertification, especially in Africa, fulfills its international obligations.
National report "Sustainable Development Goals: Ukraine" (2017)	- Share of arable land in the total area of Ukraine: 2015 - 53.9%, 2030 - 47% - Area of lands of organic production: 2015 - 410,6 thousands of hectares, 2030 – 3000 thousands of hectares - Share of area of agricultural lands of extensive use (hayfields, pastures) in the total area of the country: 2015 - 13%, 2030 - 15.8%
<b>Biodiversity and ecosystems</b>	
Law of Ukraine "On the Red Book of Ukraine" (2002)	- Regulation of public relations in the field of protection, use and reproduction of rare and endangered species of fauna and flora listed in the Red Book of Ukraine, in order to prevent the extinction of such species from nature, ensuring the preservation of their

	gene pool
Law of Ukraine "On the Ecological Network of Ukraine" (2004)	- Regulation of public relations in the field of formation, preservation and rational, inexhaustible use of the ecological network as one of the most important prerequisites for sustainable, ecologically balanced development of Ukraine, environmental protection, modern and promising economic, social, environmental and other interests of society
Law of Ukraine "Basic principles (strategy) of state environmental policy of Ukraine until 2030" (2019)	- Share of area of lands of nature reserve fund in the total area of the country: 2015 - 6,3%, 2030 - 15% - Share of area of the national ecological network in the total area of the country: 2015 - 38.2%, 2030 - 41%
<b>Waste</b>	
On Waste (Law of Ukraine №187 / 98-VR of 05.03.1998)	- To avoid or minimize waste generation, storage and management, prevent and reduce negative consequences for the environment and human health from the generation, storage and management of wastes
National Waste Management Strategy in Ukraine until 2030 (order of the Cabinet of Ministers of Ukraine from 08.11.2017 № 820-p141)	- To introduce a systematic approach to waste management at the state and regional levels, reducing waste generation by increasing its processing and reuse - By 2030 to create 800 new capacities for recycling, utilization and composting of biowaste - To reduce the total volume of household waste disposal from 95% to 30% - To minimize the total amount of landfilled waste from 50% to 35% - To create network of 50 regional landfills that will meet the requirements of the EU Directive on wastes
National Waste Management Plan until 2030 (order of the Cabinet of Ministers of Ukraine from 20.02.2019 № 117-p142)	- To introduce economic instruments to stimulate the use of biomass from agricultural waste for the production of biofuels, electricity and heat
<b>Health</b>	
Law of Ukraine "Fundamentals of the Legislation of Ukraine on Health Care" (№ 2801-XII of 19.11.1992)	- Ensuring the harmonious development of physical and spiritual strength, high efficiency and long active life of citizens, elimination of factors that adversely affect their health, prevention and reduction of morbidity, disability and mortality, improvement of heredity
National Report "Sustainable Development Goals: Ukraine" (2017)	- Mortality of children under 5 years of age: 2015 - 9.3 cases per 1000 live births, 2030 - 6-7 cases - Number of deaths of men from cerebrovascular diseases aged 30-59 years: 2015 - 64 persons per 100,000 men of appropriate age, 2030 – 45 persons - Number of deaths of women from cerebrovascular diseases aged 30-59 years: 2015 - 28.9 persons per 100,000 women of appropriate age, 2030 – 22 persons - Number of deaths due to traffic accidents: 2015 - 12.6 persons per 100,000 people, 2030 - 10-9 persons
<b>Livelihood/Socio-economic aspects</b>	
Law of Ukraine "On Employment" (from 05.07.2012 № 5067-VI)	- The law defines the legal, economic and organizational principles of state policy in the field of employment, state guarantees for the protection of citizens' rights to work and the realization of their rights to social protection against unemployment
Law of Ukraine "On the subsistence minimum" (from 15.07.1999 № 966-XIV)	- The law defines the subsistence minimum, lays the legal basis for its establishment, approval and consideration in the implementation of the state constitutional guarantee of citizens for a sufficient standard of living
National Report "Sustainable Development Goals: Ukraine" (2017)	- Proportion of population whose per capita equivalent total expenditures are lower than the actual (estimated) subsistence level: 2015 - 58.3%, 2030 - 15% - Share of food expenditures in total household expenditures: 2015 - 54.6%, 2030 - 30% - Employment rate of the population aged 20-64: 2015 - 64.4%, 2030 - 70%

	- Number of deaths from accidents at work, % to the level of 2015: 2015 - 100% (831 people), 2030 - 45%
<b>Renewable energy sources</b>	
Energy Strategy of Ukraine until 2035 "Security, Energy Efficiency, Competitiveness" (order of the Cabinet of Ministers of Ukraine from August 18, 2017 № 605-r)	- To halve the energy intensity of Ukraine's GDP - By 2035 increase the share of renewable energy in TPES: 12% in 2025, 17% in 2030, 25% in 2035 (including hydro and thermal energy) - To maintain electricity production by nuclear power plants at 50% - To complete greening of large thermal power generation
National Action Plan on Renewable Energy until 2020	- To increase Ukraine's share of renewables in the energy sector to 11% of total final energy consumption by 2020 - To increase Ukraine's share of renewables in the transport sector to 10% of total final energy consumption by 2020
Concept of implementation of state policy in the field of heat supply (order of the Cabinet of Ministers of Ukraine from August 18, 2017 № 569-r)	- To form and determine ways to implement an effective state policy aimed at reliable provision of consumers with heat supply services, ensuring energy independence and security of Ukraine - To reduce negative environmental impact - To create conditions and stimulate investments in the heat supply sector - To increase the share of RES use in the production of thermal energy in 2019-2025 (up to 30%) - To increase the share of RES in the production of thermal energy in 2026-2035 (up to 40%)
<b>Transport</b>	
National Transport Strategy of Ukraine for the period up to 2030 (order of the Cabinet of Ministers of Ukraine dated 30.05.2018 № 430-r)	- Stimulating the use of alternative energy sources, as well as environmentally friendly modes of transport and special equipment - Ensuring the development of socially and environmentally oriented mobility over short distances in accordance with the models of "City of short roads" and the implementation of the principles of intermodality and ensuring optimal interaction of cycling with other modes of transport

## 6. Identification of the environmental and health issues

This chapter identifies main environmental and health issues, which are relevant to the draft Roadmap, and which should be further addressed in the next stages of the SEA process – i.e. it will be further analysed, how these issues can be affected by the implementation of the Roadmap. Therefore, these environmental and health issues, identified on the basis of the initial baseline analysis (chapter 4 of this report), should be considered as a proposed scope of the SEA.

The list of the main environmental and health issues is based on the initial analysis of the likely effects related to the Roadmap. As there are differences between the likely environmental and health effects related to the hydrogen production and the likely effects related to the hydrogen storage, transport and use, the environmental and health issues are listed for these two aspects separately in section 6.1 and 6.2, respectively. The list of the main environmental and health issues is then provided in section 6.3 below.

### 6.1. Hydrogen production

The Roadmap indicates that in 2019, about 96% of global hydrogen production came from fossil fuel sources, with 4% from electrolysis, 48% from natural gas via steam methane reforming (SMR), and 48% from coal gasification, oil or other chemical processes (such as chlorine production).

Hydrogen can be produced by various methods and technologies, the Roadmap indicates following production technologies:

- Steam methane reforming (SMR);
- Small-scale hydrogen production from natural gas using SMR;
- Alkaline water electrolysis (AEL); and
- Proton exchange membrane (PEM) electrolysis.

In SMR technology, hydrogen is generated by steam reforming of natural gas with the CO<sub>2</sub> as by-product, while the AEL and PEM methods do not lead to the direct CO<sub>2</sub> emissions. However, it should be taken into account that the emissions are produced by the power generating facility producing electricity for electrolysis as well as SMR technology. These indirect emissions are related to the type of fuel used in an electricity generating plant.

Table 3 summarizes the likely environmental and health effects of different technology options for hydrogen production. It also takes into account necessary renewable energy development in the case of the green hydrogen production, assuming that the solar and wind energy will be mainly used<sup>1</sup>).

**Table 3: Likely environmental and health effects related to hydrogen production**

Environmental and health aspects	Potential effects to be considered in the SEA
Air	<p><i>SMR</i></p> <p>(-) The resulting flue gas (mainly carbon dioxide with traces of nitrogen oxides, carbon monoxide, sulfur dioxide and water vapor) is typically vented to the atmosphere without the need for further treatment due to the relatively low levels of pollutants.</p> <p><i>Electrolysis</i></p> <p>(-) Emission of air pollutants from electricity production based on the fossil fuels            (+) Higher use of RES, facilitated by the hydrogen production needs, may lead to a reduction in energy produced from fossil fuels and thus to a decrease in emissions of pollutants into the air</p>

<sup>1</sup> As determined by the 'Energy Strategy of Ukraine until 2035'.

GHG emissions	<p><i>SMR using natural gas as feedstock</i></p> <p>(-) By-product of SMR method is carbon dioxide.</p> <p>(-) For the implementation of endothermic SMR process burns about half of the initial gas. Burning natural gas contributes to GHG emissions.</p> <p><i>Electrolysis</i></p> <p>(+) Higher use of RES, facilitated by the hydrogen production needs, may lead to a reduction in energy produced from fossil fuels and thus to a decrease of GHG emissions</p> <p>(-) Use of conventional grid power would generate more GHG emissions than SMR with natural gas</p>
Climate change	<p>(-) The likely consequences of climate change can affect the use of natural resources for renewable energy production (potential climate threats to Ukraine are described in the section 4.4).</p>
Water resources	<p><i>SMR</i></p> <p>(-) Recycled cooling water usually contains chemical treatment products used as biocides and to control corrosion</p> <p><i>Electrolysis with RES using</i></p> <p>(-) Production of hydrogen using electrolysis requires large amounts of water</p> <p>(+) The use of solar and wind energy may contribute to the decrease of fossil fuels for energy and thus the decrease in pollution and waste spills from fossil fuel facilities into water resources.</p> <p>(-) Use of large amounts of water to wash solar panels and use of chemical substances to the clean dust off the surface of solar panels, and use of herbicides against insects on the surface of solar panels may cause water pollution.</p> <p>(-) Offshore wind farm development (construction, exploitation, transportation and operation of wind farms) may cause lead to pollution of coastal waters (during transport and construction) and can affect sea currents and sea bed in coastal areas</p>
Land and soil	<p><i>Hydrogen production (all technologies)</i></p> <p>(+) Land occupation by H<sub>2</sub> production is insignificant compared with land requirements for renewable energy production in a wind farm or solar plants</p> <p><i>Electrolysis with RES using</i></p> <p>(+) The use of solar and wind energy may contribute to the decrease of fossil fuels for energy and thus the decrease soil pollution and land degradation related to mining activities.</p> <p>(-) Construction of large-scale solar power plants will require large areas of land and may adversely affect soil quality, especially the fertile upper layer of soil</p>
Landscape	<p><i>SMR</i></p> <p>(-) Extracting and transporting natural gas (using pipelines) can harm sensitive landscapes</p> <p><i>Electrolysis with RES using</i></p> <p>(+) The use of solar and wind energy may contribute to the decrease of fossil fuels for energy and thus the decrease the negative effects related to mining.</p> <p>(-) Wind farms (and potentially also large-scale solar plants) may affect natural areas of local, regional or national significance, including national parks, natural heritage and recreational places</p> <p>(-) Onshore wind farms' changes to the visual landscape and excavating for the turbines and underground infrastructure may affect areas that have heritage status</p> <p>(-) Offshore wind farms may have visual impacts on marine areas as well as on coastal areas, which generally provide unique landscape views</p>
Biodiversity	<p><i>Electrolysis with RES using</i></p> <p>(-) Wind farms can have adverse impacts on birds (sea birds, migratory birds) and bats, especially if located close to Protected Areas</p> <p>(-) Underwater noise and vibrations from construction of offshore wind turbines may disturb fish populations and other marine species (including seas mammals, benthos and plankton)</p>

	(-) Birds, bats and insects may be impacted by solar plants
Waste management	<p><i>SMR</i></p> <p>(-) The catalysts (e.g. nickel) contain biotoxic metals and shall be either recycled by returning to the supplier or disposed of by certified waste disposal companies. Catalysts are typically changed every 3-5 years.</p> <p><i>Electrolysis with RES using</i></p> <p>(-) Rapid development of RES may result in an increase in the amount of construction waste and may introduce new types of waste (e.g. used solar panels)</p>
Human health	<p>(+) Supply of hydrogen and renewable energy may reduce the need for fossil fuel power generation, thus decreasing air, water and soil pollution, and thus reducing environmental pressures on human health</p> <p>(-) Hydrogen production facilities will be a new source of noise. Although the likely impacts on the population will be a local nature, the proximity from inhabited areas has to be considered when selecting sites for hydrogen production facilities.</p> <p><i>Electrolysis with RES using</i></p> <p>(-) Wind farms may cause disturbances to residents due to low level noise/vibrations, and flicker-effect. Although the likely impacts on the population will be a local nature, the proximity from inhabited areas has to be considered when selecting sites new wind farms.</p> <p>(-) Biomass energy (and energy from waste) may cause air pollution, which can have negative impacts on human health</p>
Livelihood	<p><i>Hydrogen production (all technologies)</i></p> <p>(+) Development of hydrogen economy may improve the quality of life of people, especially in remote and rural areas, through new sources of livelihood and employment, as well as through the upgrading of local infrastructure and community facilities</p> <p>(-) Hydrogen plants demand land acquisition, which may impact land ownership, cultural heritage and traditional use of lands</p> <p>(-) Communities nearby selected sites for hydrogen production can be concerned about the safety aspects (in particular, the volatility and flammable nature of hydrogen gas). Therefore, addressing safety measures and expectations will be vital for earning the trust of communities and individuals.</p> <p><i>Electrolysis with RES using</i></p> <p>(+) Diversifying energy resources can lead to a reduction in the use of energy from fossil fuels and decentralization of energy sector and thus to an improvement in the energy supply</p> <p>(-) Solar and wind energy plants demand land acquisition, which may impact land ownership, cultural heritage and traditional use of lands</p>

## 6.2. Hydrogen storage, transportation and use

The Roadmap identifies the following main actions for hydrogen storage, transportation and use (Table 4).

**Table 4: The main actions for hydrogen storage, transportation and use identified in the Roadmap**

Sector	Actions identified in the Roadmap
Hydrogen storage	<ul style="list-style-type: none"> <li>• Use the storage system taking into account the requirements of the European Union</li> </ul>
Hydrogen transportation	<ul style="list-style-type: none"> <li>• Use of the existing Gas Transportation System of Ukraine for transport of renewable hydrogen to Europe</li> <li>• Use of the Dnieper River and road transport for hydrogen transportation</li> <li>• Use of Ukrainian ports for the transport of hydrogen in tankers to Europe</li> </ul>
Energy sector	<ul style="list-style-type: none"> <li>• Use of hydrogen for balancing the power system in Ukraine, long-term storage</li> </ul>



	<ul style="list-style-type: none"> <li>• Use of hydrogen as an additional component in the gas industry</li> <li>• Use of fuel cells for replacement of traditional residential energy systems</li> <li>• Replacement of natural gas by hydrogen in municipal utilities up to 10%</li> <li>• Development of hydrogen usage in the energy sector for the gradual replacement of nuclear power plants and coal-fired thermal power plants</li> </ul>
Industry sector	<ul style="list-style-type: none"> <li>• Green ammonia production</li> </ul>
Transport sector	<ul style="list-style-type: none"> <li>• Use of hydrogen and fuel cells in the road transport</li> <li>• Purchase of hydrogen vehicle fleet</li> <li>• Organization of a national network of hydrogen refueling stations for hydrogen vehicles</li> </ul>

Table 5 summarizes the environmental and health issues and potential effects of different options for hydrogen storage, transportation and use.

**Table 5: Likely environmental and health effects related to hydrogen storage and use**

<b>Main issues</b>	<b>Potential effects to be considered in the SEA</b>
Air	<p>(+) Hydrogen use in the transport and energy sector may decrease the air emissions from these sectors</p> <p>(-) The road transport of hydrogen may increase the traffic intensity and therefore lead to higher air emissions from the transport</p>
GHG emissions	<p><i>Transport sector</i></p> <p>(+) Fuel cell electric vehicles could contribute to decarbonizing the transport system because they have no direct CO<sub>2</sub> emissions during the use phase.</p> <p>(+) Development of hydrogen usage in the energy sector for the gradual replacement of nuclear power plants and coal-fired thermal power plants may result in lower GHG emissions from the energy sector</p> <p><i>Hydrogen leakage</i></p> <p>(+) Hydrogen is a tropospheric ozone (third most important GHG) precursor and can be considered as an indirect GHG. As a contributor to global warming its impact is thought to be negligible. It has been estimated that the potential effects on climate from hydrogen-based energy systems will depend on the rate of hydrogen leakage during its synthesis, storage and use (Derwent, 2006). If the leakage rate will be 10% (assuming an extreme situation), then the climate impact would be 6% of the present fossil fuel system. Sensors are required to detect leaks.</p>
Climate change	<p>(+) Hydrogen use will contribute to higher diversity of energy sources and decentralization of energy sector, and therefore may increase adaptability of the energy sector to the climate change.</p>
Water resources	<p>(+) Development of hydrogen usage in the energy sector for the gradual replacement of nuclear power plants and coal-fired thermal power plants may result in lower impacts on water resources from the energy sector</p>
Land and soil	<p>(+) Development of hydrogen usage in the energy sector for the gradual replacement of nuclear power plants and coal-fired thermal power plants may result in lower impacts on land and soil from the energy sector</p>
Landscape	<p>(-) Construction of new pipelines for hydrogen transport may affect the landscape. Therefore, the use of the existing gas transportation system should be preferred</p>
Waste management	<p><i>PEMFC (used in vehicles)</i></p> <p>(-) PEMFCs are typically recycled by pyrometallurgical means, but the process produces highly toxic gas compounds, which then have to be purified, and loses base materials like steel and aluminium</p>
Human health	<p>(+) Hydrogen use in the transport and energy sector may decrease the adverse environmental impact of these sectors and thus improve environmental health determinants</p> <p>(-) Hydrogen is highly flammable, and thus there are safety risks – however, these should be effectively addressed at the project level by following strict safety measures</p>
Livelihood	<p>(+) Hydrogen could be used as a ‘cleaner’ cooking fuel, particularly in</p>

	<p>communities that rely on biomass and fossil fuels, to reduce local pollution and related health effects</p> <p>(+) Diversifying energy resources can lead to a reduction in the use of energy from fossil fuels and decentralization of energy sector and thus to an improvement in the energy supply</p>
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### 6.3. Proposed scope of SEA

The table below, based on the initial analysis of the likely environmental and health effects of the hydrogen production, storage and use (above), summarizes the key environmental and health issues to be addressed in the further SEA steps.

**Table 6: The key environmental and health issues for the Roadmap**

<b>Environmental and health aspects</b>	<b>The key issues to be addressed in SEA</b>
Air	<p>Possible changes of air emissions from the energy sector</p> <p>Possible changes of air emissions from the transport sector</p> <p>Air emissions from biomass use</p>
GHG emissions	<p>GHG emissions from hydrogen production (comparison of technology options)</p> <p>Possible changes of GHG emissions from energy sector (as a result of a reduction of energy production from fossil fuels)</p>
Climate change	<p>Likely consequences of the climate change regarding energy sector (both fossil fuels and RES)</p>
Water resources	<p>Water consumption for hydrogen production</p> <p>Water consumption related to solar energy</p> <p>Likely effects of SMR production on water quality</p> <p>Likely effects of offshore windfarms development on coastal waters</p> <p>Possible changes of water pollution from energy sector (as a result of a reduction of energy production from fossil fuels)</p>
Land and soil	<p>Possible changes of impacts of energy sector on land and soil (as a result of a reduction of energy production from fossil fuels)</p> <p>Likely effects of solar power plants on soil</p>
Landscape	<p>Possible changes of impacts of energy sector on the landscape (as a result of a reduction of energy production from fossil fuels)</p> <p>Likely effects of new pipelines for hydrogen transport</p> <p>Likely effects of new wind farms (both onshore and offshore)</p>
Biodiversity	<p>Likely effects of new wind farms (both onshore and offshore) on sea birds, migratory birds, and bats</p> <p>Likely effects of new offshore wind farms on marine biodiversity</p> <p>Likely effects of solar plants on birds, bats, and insects</p>
Waste management	<p>Capacities to manage waste related to hydrogen production (in particular catalysts used for SMR, PEMFCs used in vehicles, and used solar panels)</p>
Human health	<p>Possible changes of impacts of energy sector (as a result of a reduction of energy production from fossil fuels) and transport sector</p> <p>Noise from hydrogen production facilities</p> <p>Disturbance by the windfarms (noise, vibrations, flick-effect)</p> <p>Likely effects of biomass use</p> <p>Implementation of safety measure for hydrogen use</p>
Livelihood	<p>Likely effects of diversification of energy resources and decentralization of energy sector, which can potentially result in improved energy supply</p> <p>Likely effects on employment rates</p> <p>Land acquisitions related to the new wind and solar farms</p>

## 7. Conclusions and recommendations

Based on the initial analysis of the linkages between the hydrogen production and use and the environmental and health issues, it can be concluded that there is a potential that the implementation of the Roadmap will result in certain positive environmental and health effects. However, such conclusion is, to a large extent, based on the assumption that the hydrogen production will use the energy from renewable energy resources i.e. the Roadmap will focus on the green hydrogen production. Although renewable energy production may also cause adverse environmental and health effects, these are most likely to be of local nature and it should be possible to effectively address them in the next steps of planning and/or during the preparation and approval procedure for specific projects.

Therefore, ***the selection of an energy source for hydrogen production represents the key strategic option, which is directly linked to the likely environmental and health effects related to the Roadmap.***

For a further analysis of the likely environmental and health effects of the Roadmap it is important – during the next steps of planning the hydrogen production and use – to more precisely specify:

- Types and expected share of the RES to be used for hydrogen production;
- To what extent the RES may replace fossil fuels for the production of hydrogen.

### 7.1. Initial recommendations to be considered in the draft Roadmap and further steps of its preparation

- 1) The main focus of the Roadmap and of the further planning steps should be placed on green hydrogen production, taking into account the ambitions of the Roadmap with regard to decarbonization of energy, industry and transport.
- 2) Even if there is clear evidence for the use of renewable sources, as already highlighted from an environmental viewpoint, the switch to a 100% renewable scheme can only be gradual, in order to satisfy both economic and environmental concerns. This process should also take into account the availability of the energy sources. Although much effort is being put to produce hydrogen from renewables, the use of fossil fuels, especially natural gas, seems to be fundamental in the short term. A clean alternative process without CO<sub>2</sub> emissions is the pyrolysis of methane, in which methane decomposes into hydrogen and solid carbon. The turquoise hydrogen is intermediate hydrogen between green hydrogen (from renewables) and gray hydrogen (from fossil fuels with CO<sub>2</sub> emission). The turquoise hydrogen is produced from natural gas (also fossil fuel), but without CO<sub>2</sub> emission (solid carbon as by-product). The turquoise hydrogen can be a temporary solution until the use of renewable sources for the production of hydrogen is sufficiently expanded. A by-product of the production of turquoise hydrogen is solid carbon black, a valuable raw material for the producing tires, plastics, paints and inks. Therefore, it can be recommended to analyze the turquoise hydrogen as a noteworthy potential option within the framework of the Roadmap.
- 3) It is important to consider the life-cycle impacts of hydrogen production (e.g. disposal of materials) on the environment, including on water supply and land use. This would be useful to inform and raise awareness of the public about the relative advantages and disadvantages of different hydrogen production pathways, such as electrolysis compared to steam methane reforming.
- 4) While hydrogen is considered an indirect greenhouse gas, a future hydrogen-based economy would not be totally free from some impact on the climate because of hydrogen leakage during its synthesis, storage and use. Therefore, careful attention should be paid to minimizing hydrogen leakage.
- 5) In order to prevent adverse effects on the landscape, the use of existing distribution systems (i.e., retrofitting existing gas pipelines) should be a preferred option (rather than constructing new pipelines).
- 6) The following technology options should be addressed in further planning hydrogen production and use:

- Electrolyzer modules require a small surface area and can be integrated into an area being used for RES production (between wind turbines, for example). In such a way, the land footprint of hydrogen production from RES can be minimized.
  - Solar-hydrogen generating units could be adapted easily to the needs of individual households, which provide a driving force for mass production.
  - Potential alternative solutions for water consumption for electrolysis include using desalination plants or recycled water.
- 7) An extensive communication between relevant governmental authorities, industries, and experts will be needed to ensure there is a regulatory framework for hydrogen industry enabling the safe hydrogen production and use.
  - 8) The different properties of hydrogen compared to petroleum, natural gas, electricity and batteries mean that those who design operate and maintain the hydrogen systems will need to take these differences into account. This will require education and community outreach to inform and raise awareness of people about the different properties of hydrogen and the relative risks compared to those of the more familiar fuels.
  - 9) The transition from fossil fuels to a hydrogen-based economy imposes the need for entirely new skills for the development and implementation of new energy-related technologies. This in turn requires new education programs in universities and other relevant institutions to train technicians and engineers who will be responsible for the practical implementation of the new technologies, as well as the researchers who will develop these.
  - 10) Concerted efforts should be used for training firefighters, police and ambulance officers to respond to incidents that involve hydrogen. This approach has a two-fold effect: first responders will know how to appropriately deal with the effects and risks of hydrogen, and communities will be reassured to feel safer knowing that first responders have adequate training.

## 7.2. General SEA procedural recommendations

1. The SEA process of the future Hydrogen Concept/Strategy needs to include a reasonable timeframe (optimally, going beyond the legal requirements, which can be considered as a minimum) and ensure mandatory public participation and consultations with the state executive authorities.
2. The consultations with the state executive authorities and public discussions should be carried out in parallel to the preparation of the Hydrogen Concept/Strategy to ensure the effective provision of comments and suggestions and ample opportunity for their integration in the draft Concept/Strategy.
3. The notification on the draft Concept/Strategy and the SEA report's public disclosure should be published in the national media, which have coverage throughout the country.
4. Given an increased interest in the production and use of hydrogen in Ukraine, it is recommended to hold public hearings as well as to use other forms of public discussions during the SEA process (round tables, open meetings, etc.) at the key stages of SEA (in particular in the scoping stage and on the draft Strategy and the SEA report).
5. The Law on SEA envisions different approaches for calculating a time frame for the procedure. The time for publishing a notification of the disclosure of the draft public planning document and publication of the approved document is calculated in working days, and public discussion can be calculated in calendar days. To prevent mistakes in using various approaches, it is recommended to calculate the schedule of the SEA procedure in terms of working days.
6. The Law on SEA does not include provisions on how to calculate the periods specified in the Law if the materials on the implementation of the SEA are sent both by official correspondence and electronically. To ensure a transparent SEA procedure, it's recommended to conduct official correspondence during the consultation process and calculate the terms of the procedure according to the date of receiving official correspondence.

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## Annex 1. Recommendations on procedural steps in the SEA process

The strategic environmental assessment procedure shall be carried in accordance with the Law of Ukraine "On Strategic Environmental Assessment" and relevant sectoral legislation.

To comply with the requirements of the Law, as well as to bring other acts into line with it, some bylaws were adopted, namely:

- Resolution of the Cabinet of Ministers of Ukraine "On Amendments and Repeal of Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, #128;
- Resolution of the Cabinet of Ministers of Ukraine "On Amendments to Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, # 45;
- "Methodological recommendations for the implementation of the strategic environmental assessment of public planning documents," approved by order of the Ministry of Ecology and Natural Resources of Ukraine dated 10.08.2018 #296.

Thus, the Resolution of the Cabinet of Ministers of Ukraine "On Amendments and Repeal of Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, № 128 brought into line with the requirements of the Law some regulations of Cabinet of Ministers, namely:

- the procedure for development and implementation of state economic programs, approved by the resolution of the Cabinet of Ministers of Ukraine of January 31, 2007, #106;
- the procedure for involving the public in the consultations of issues related to decision-making that may affect the state of the environment was approved by the Resolution of the Cabinet of Ministers of Ukraine of June 29, 2011, # 771.

Resolution of the Cabinet of Ministers of Ukraine "On Amendments to Certain Resolutions of the Cabinet of Ministers of Ukraine" of January 23, 2019, #45 amended the following:

- The procedure for developing forecast and program documents of economic and social development and drafting the state budget, approved by the Resolution of the Cabinet of Ministers of Ukraine of April 26, 2003, #621;
- Regulations of the Cabinet of Ministers of Ukraine approved by the Resolution of the Cabinet of Ministers of Ukraine of July 18, 2007, #950;
- The procedure for developing regional development strategies and action plans for their implementation, as well as monitoring and evaluating the effectiveness of the performance of these regional strategies and action plans, approved by the Cabinet of Ministers of Ukraine dated November 11, 2015, #932

Strategic environmental assessment of the draft Roadmap for production and use of hydrogen and the future Concept/Hydrogen Strategy of Ukraine must be carried out, considering the above regulations' requirements.

### Stages of strategic environmental assessment in the context of the Roadmap and further procedural steps

The draft Hydrogen Roadmap should become the basis for the Hydrogen Concept/Strategy, which will be adopted by the national authorities of Ukraine (Parliament or Government). In this regard, recommendations are provided on how to organize and carry out the strategic environmental assessment of the Hydrogen Concept/Strategy of Ukraine.

Key rules according to the national legislation	Features of SEA in the context of the Roadmap and Hydrogen Strategy
<b>SEA stage 1: Screening</b>	
The Law of Ukraine "On Strategic Environmental Assessment" does not define such a stage as screening and does not set its implementation requirements.	Ukrainian legislation does not contain a directly regulated stage of screening, but based on the content of the second article, the planner of the public planning document must determine: <ul style="list-style-type: none"> <li>• the state planning document belongs to one of the areas: agriculture, forestry, fisheries, energy, industry, transport, waste management, water use, environmental protection, telecommunications, tourism, urban planning, and land management (schemes).</li> <li>• implementation of the state planning document will provide for the performance of an activity (or which contain</li> </ul>

	<p>types of activity and projects) that under legislation require an environmental impact assessment, as well as which require an assessment in view of the likely effects on sites and objects of the nature-reserve fund or ecological network.</p> <p>The draft Hydrogen Roadmap is essentially a source document for further development of the Hydrogen Strategy, however:</p> <ul style="list-style-type: none"> <li>- is not planned for approval by a state authority or local government body, and therefore has no legal features of a public planning document;</li> <li>- although the draft Roadmap belongs to the energy sector, it still does not clearly define hydrogen production methods to be implemented in Ukraine. It does not contain provisions for the implementation of activities and facilities to be assessed for environmental impact assessment.</li> </ul> <p>Regarding the Hydrogen Strategy of Ukraine, it will be subject to SEA under the following conditions:</p> <ul style="list-style-type: none"> <li>- will be approved by public authorities (Government or Parliament);</li> <li>- the Strategy as a public planning document belongs to the field of energy;</li> <li>- if the Strategy envisages the implementation of activities and facilities subject to EIA (for example, laying pipelines or product pipelines for hydrogen transportation, hydrocarbon processing facilities, infrastructure projects, etc.)</li> </ul>
<b>SEA stage 2: Scoping</b>	
<p>Requirements are enshrined in Article 10 of the Law on SEA.</p> <p>Includes preparation declaration on scoping of the strategic environmental assessment.</p>	<p>The planner of the Strategy should be the Ministry of Energy of Ukraine. External consultants and experts may be involved in the development of the SEA documentation.</p> <p>At the preparation of the declaration of scoping of the strategic environmental assessment, the planner must already provide data on the probable effects of the implementation of the public planning document consequences (on the environment, including human health, transboundary effects), reasonable alternatives, and proposals for the SEA report's structure and content.</p> <p>You can use available research data.</p>
<b>2.1: First public consultations</b>	
<ul style="list-style-type: none"> <li>- The declaration on SEA scoping and the draft public planning document shall be published on the website and sent to the authorities referred to in Articles 6, 7, and 8 of the Law;</li> <li>- The public discussion lasts 15 days</li> </ul>	<p>Public consultations on SEA scope begins with the publication of the declaration and the draft public planning document.</p> <p>It is important to note that the planner sets the term of public discussion. During this period, any public comments may be provided.</p> <p>Notwithstanding the narrow concept of "public" (one or more natural or legal persons, their associations, organizations, or groups, registered on the territory to which the strategic planning document applies) given in the Law, the Hydrogen Strategy will apply to the whole territory of Ukraine. Therefore, anyone will be able to take part in the public discussion.</p> <p>Consultations and public discussions at the scoping stage are parallel processes.</p>
<b>SEA stage 3: Preparation of a SEA report</b>	
<p>The SEA Report is prepared by the planner of the public planning document</p> <p>Deadlines for report preparation are not set.</p> <p>Requirements for the structure of the</p>	<p>The Law does not set requirements for the developers of SEA Reports. Still, it contains only a rule that obliges the developers to sign and indicate the qualification (Article 11 of the Law), so specialists of the Ministry of Energy can develop a SEA report and have the opportunity to involve consultants, experts, etc.</p>

<p>Report are set out in part two of Article 11 of the Law</p>	<p>A more detailed approach to the Report's preparation is given in the Methodological recommendations for implementing the strategic environmental assessment of public planning documents, approved by the Ministry of Ecology and Natural Resources of Ukraine dated 10.08.2018 #296.</p> <p>The SEA Report of the Hydrogen Strategy should include a list of assessments, namely: analysis of the planning context, analysis of the current state of the environment and trends, its targeted analysis, and analysis of the environmental impact of the public planning document, including human health assessment, assessment of alternative scenarios, as well as recommendations for mitigation of environmental impact, including human health, and measures to prevent adverse effects.</p>
<p><b>3.1. Second public consultations</b></p>	
<p>The obligation to conduct a public discussion is assigned to the planner of the state planning document.</p> <p>The draft public planning document and the Report on the strategic environmental assessment shall be published on the official website of the planner.</p> <p>The notification of the disclosure of the draft public planning document and the strategic environmental assessment report shall be published in the printed mass media (at least two).</p> <p>The term of public consultations is not less than 30 days from the date of publication.</p>	<p>Following the preparation of the SEA report and the draft Hydrogen Strategy, public consultation may begin (consultations are second, as the first being held at the scoping stage).</p> <p>The Law does not set requirements for the media in which the notification of the disclosure of the draft public planning document should be published. But the Procedure for Involving the Public in Discussions on Decision-Making Issues that may affect the environment (Item 9 of the Cabinet of Ministries Regulation of 29.06.2011 #771) stipulates that the notification placed periodically until its completion in the media or published in a way that ensures its delivery to the residents of the relevant administrative-territorial unit.</p> <p>The Law does not provide for mandatory public hearings during public hearings, but the possibility of organizing them is not excluded.</p>
<p><b>SEA stage 4: Consultations with state executive authorities</b></p>	
<p>The procedure for holding consultations is determined by Article 13 of the Law.</p> <p>Consultations are held with the authorities referred to in Articles 6 and 7, 8 of the Law (publish notification of the disclosure of the draft public planning document on their own websites for comments and suggestions).</p> <p>Local governments, other specialists, scientists may be involved.</p> <p>Consultations with state executive authorities last 30 days.</p>	<p>As the draft Strategy is planned as a national document, consultations should be held with the Ministry of Environment and the Ministry of Health.</p> <p>Documents in the consultation process are submitted in paper form and on electronic media.</p> <p>Consultations with the Ministry of Environment and the Ministry of Health are conducted through official correspondence.</p>
<p><b>4.1. Transboundary consultations</b></p>	
<p>Carried out if the implementation of the public planning document is likely to have effects for the environment, including for the human health of affected countries.</p> <p>Cross-border consultations are conducted under the requirements of international treaties of Ukraine, the binding nature of which has been approved by the Verkhovna Rada of Ukraine</p> <p>Article 14 of the Law stipulates that within 30 days (minimum), the affected country</p>	<p>Depending on the production capacity for hydrogen production and their location that will be included in the draft Strategy, the assessment of probable consequences in the context of transboundary effects is carried out.</p> <p>If the strategy's implementation is likely to have effects on the affected countries, transboundary consultations are held.</p> <p>It is recommended to thoroughly investigate the likely transboundary effects on the environment, including human health, during the scoping phase.</p> <p>Public consultations and transboundary consultations may take</p>



<p>must inform about the intention to participate in consultations on the specified public planning document</p> <p>The public planning document could not be approved (not accepted) until the completion of the procedure of transboundary consultations and taking into account their results;</p> <p>The planner and the affected country agree on the duration of consultations, the procedure for their conduct, the conditions of translation of documents, measures to ensure information, and public participation of the affected state.</p> <p>The general terms of transboundary consultations are not set. They are determined according to the agreed schedule of consultations</p>	<p>place in parallel. Still, in practice, cross-border consultations may take longer than public consultations and consultations with public authorities, as they take place on a schedule agreed between the party of origin and the State concerned.</p> <p>The duration of cross-border consultations should be sufficient to ensure that the affected countries' public participates in the discussions.</p> <p>The planner ensures the preparation of all documents required for cross-border consultations, including their translation. It is necessary to allocate sufficient funds to the Ministry of Energy budget to cover the costs associated with such documents' preparation.</p>
<p><b>SEA stage 5: Decision making</b></p> <p><b>5.1. Taking into account SEA Report and results of NGOs consultations and consultations with state executive authorities</b></p> <p><b>5.2. Informing about the approval of public planning documents</b></p>	
<p>The Law does not provide a separate document certifying the completion of the SEA procedure.</p> <p>At the end of the public consultations and consultations with state executive authorities, the planner prepares a statement of consultations, which reflects the comments and suggestions received.</p> <p>The planner is obliged to consider comments and suggestions.</p> <p>The planner publishes the public planning document within 5 days from the date of its approval.</p> <p>Inform thereabout in writing the authority referred to in Article 6 of Law.</p>	<p>In the decision-making process, the main authorities are the Cabinet of Ministers or the Verkhovna Rada. Before the Strategy is approved, the Ministry of Energy should submit to the Cabinet of Ministers the draft Strategy a SEA Report, statements of public consultations, and consultations with executive bodies. Such a provision described in the Rules of Procedure of the Cabinet of Ministers of Ukraine approved by the Resolution of the Cabinet of Ministers of Ukraine of July 18, 2007, #950 (paragraph 1 of § 50), is a kind of safeguard that helps take into account the results of strategic environmental assessment when approving national documents.</p>
<p><b>SEA stage 6: Monitoring</b></p>	
<p>Monitoring requirements are set out in Article 17 of the Law and Resolution of the Cabinet of Ministers of Ukraine of December 16, 2020, #1272 "On approval of the Procedure for monitoring the consequences of implementing the public planning document for the environment, including the human health".</p> <p>The practical experience of such monitoring is insufficient.</p>	<p>According to the Law, monitoring the effects of implementing the public planning document on the environment, including human health, is mandatory.</p> <p>The frequency of its implementation is not defined. However, the results should be published once a year during the term of the Strategy and one year after its expiration.</p> <p>Therefore, the SEA Report should contain a clear list of monitoring measures, including quantitative and qualitative indicators, units of measurement, frequency of measurement of indicators, etc.</p>