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REPORT 4

PART A: POLICIES AND MEASURES

Project implemented by the Institute for Economics and Forecasting, NASU

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This Report 4, Part A: Policies and measures was prepared within the framework of the project funded by Sweden.

Section 1 of this Report describes outcomes and findings of sensitivity analyses of original GHG emission Scenarios of the Second NDC for Ukraine, presented in Report 3. Identified policy option leading to further reduction of emissions or reduction of required investments were integrated to the Combined Sensitivity Scenario described at the end of the section.

Section 2 proposes the approach and allocation of national carbon budget for the period of 2021-2030 for each NDC2 Scenarios by IPCC sectors and further specifies it by economic sector (manufacturing industries, modes of transport etc.) and energy demand (space heating, water heating etc.). It also provides an overview of available approaches to address fairness issue .

Section 3 outlines key sectoral mitigation policies and measures, including regulatory, legal, institutional, policy, investment and capacity building types. Policies and measures are grouped under the following sections - electricity and heat generation sector, fuel production and transportation, industry, transport, buildings, agriculture, waste sector, bioenergy, fiscal and market mechanisms, society covenant. Proposed policies and measures are based on scenario design, including sensitivity analysis and take into account macroeconomic, social, sectoral and regional impacts and cross-sectoral impacts of its implementation. The proposed list of policies and measures is undergoing to the process of stakeholders' consultation that includes ministries and state agencies, private and public business, civil and experts society, academia and others.

Section 4 outlines adaptation goal approach, proposes national adaptation goal and key national and sectoral policies and measures to be developed and implemented in order to achieve proposed adaptation goal, including gap analysis and recommendations on proposed policies and measures implementation.

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Ukraine's second NDC proposed policies and measures demonstrate economic and technological feasibility of Ukraine to achieve its carbon neutrality by 2070, following the analysis from the Report 3. The proposed Combined Sensitivity Scenario could be recommended to be used by the GoU to inform Ukraine's 2030 NDC target setting process. According to this scenario, Ukraine may reach up to **28% GHG emissions level by 2030 compared to the 1990 level (or -72%)**.

Under modelling scenarios results, the priority sectors that have the biggest GHG emission reduction potential for rapid economy decarbonisation are **electricity and heat generation, buildings, industry, transport and agriculture.**

The main technological drivers to decarbonise these sectors are the increase of the share of renewable energy, including bioenergy, fostering energy efficiency throughout the economy and buildings' sectors, as well as the deployment of hydrogen technologies and climate smart agriculture.

As of 2018, Ukraine stands at 269 kg oe /GDP PPP 2011 as primary energy intensity, having 7% of renewable energy in final energy consumption (with 8.9% in power generation (including big hydro, reaching 9.8% in 2019), 8% in district heating and 2% in transport). These numbers are exceeding the relevant Ukrainian Energy Strategy indicators, such as energy intensity of 100 kg oe / GDP PPP 2011, 18% of renewable energy in final energy consumption and 13% in power generation.

The scenarios modeling confirms that **energy intensity indicators** defined by the Energy Strategy **can be achieved through the decrease in use of carbon intensive energy sources**, as follows:

- **Share of RE in TPES can reach 16.1% by 2030, and share of low-carbon energy (including nuclear) in TPES will be around 41%;**
- **Primary energy carbon intensity shall decrease twice by 2030;**
- **Share of RE in Gross Final Energy Consumption shall reach 20% by 2030;**
- **Share of low-carbon electricity shall constitute about 78% in 2030.**

Recent research and innovations brought out additional competitiveness into clean energy technologies and its increasing role in support of reaching carbon neutrality, making it more robust and affordable. The estimated additional cumulative investment (including consumer expenditures of households to buy new equipment) for implementing proposed Combined Sensitivity Scenario, is Euro 87.8 billion for the period of 2021-2030 (in

comparison with Business as Usual scenario implementation costs). Also, NDC targets achievement coupled with carbon pricing revenue allocation for energy efficiency measures and cleaner technologies of domestic origin could boost the economy and bring an **additional 14%-16% increase in GDP by 2050.** Robust and ambitious climate mitigation policies and measures implementation would allow to improve the air quality, protect the environment that would also lead to enhanced social protection and improved health of Ukrainian people.

The possibility of **carbon border adjustment mechanism (EU CBAM) introduction for Ukraine's products exported to EU is estimated to cost up to 0.5 billion Euro per year to Ukrainian economy** (assuming the EU ETS carbon price of 22.5 Euro/t$CO_{2)}$. The **carbon price (marginal) in Ukraine is estimated to increase up to 16 Euro in 2030** and 95-122 Euro in 2050 per t$CO_{2,}$.

Therefore, the Combined Sensitivity Scenario provides a pathway for smooth incremental transition, as the investment costs are distributed evenly across the period of 2021-2030, while allowing the Ukrainian economy to decarbonise in line with the objectives of the Paris Agreement i.e. early peak emissions and achieving net zero emissions by the second half of century.

Unlocking the technological transformation potential for Ukrainian economy priority sectors will require channelling public and private funding and investments according to national decarbonisation needs. The following policies and measures will enable investment into climate-friendly technological solutions benefiting the country in the medium and long-term, both from climate and development perspectives:

- Electricity and heating generation: improving overall efficiency of electricity market, as well as demand-side management; ensuring **renewable energy share of 30% (including large hydro) and 23% (only wind, solar and bioenergy) by 2030 in power sector and 25% by 2030 in total heat production (30% in district heating**);
- Buildings: Increased energy efficiency and energy performance in buildings by aiming **energy savings of 23% by 2030 compared to BAU Scenario;**
- Industry: Enforce energy efficiency measures (include energy audits, energy management, procurement, incentives and access to R&D, including technology development and transfer mechanism) that target **EE on 15% by 2030 compared to BAU Scenario**;
- Agriculture and forestry: developing national agricultural strategy leading to climate smart agricultural practices, land management and afforestation that **decreases GHG emissions from agriculture sector by 49% by 2030 compared to BAU Scenario.**

In addition, there are other important sectoral policies and measures in transport and waste, that are not the highest emitters, yet are important to implement not only for climate change, but also environmental and economic reasons.

System-wide impacts are driven by fiscal and social policies and measure that are hard to quantify in terms of GHG emissions impact, but critical to introduce and enforce to unlock the market barriers and create a virtuous circle of economic growth and investments. This entails measures that would green the financial system (e.g. green finance instruments, green procurement, green taxonomy, climate risk disclosure), educational and capacity-building, public health and awareness raising type of measures.

Based on the analysis conducted in this report, extensive stakeholders' consultation meetings, including informal and bilateral dialogues took place with various ministries and private stakeholders to actively inform them on ministry's decision on climate ambition, specifically NDC target setting through implementing specific policies and measures. Some of the feedback received during this consultation process have already been reflected in the policies and measures proposed in this report. Others are still on-going dialogues. In the final report, the team will reflect the rest of the feedback received at the end of the consultation process.

SECTION 1. SENSITIVITY ANALYSIS OF SCENARIOS FOR THE SECOND NDC OF UKRAINE

1.1 OVERVIEW

Modelling results presented in Report 3 have demonstrated that proposed NDC2 target up to 2030, that is aligned with IPCC's conclusion of the desired pathway to guarantee the global warming less 1.5 °C (Scenario 3), does not substantively affect the trajectory of GHG emissions risen from the existing policies and targets (Scenario 2). **This confirms that focusing in the near-term on full implementation of existing and planned short-term policies and measures is critical**, while as expected, new innovative energy technologies became commercially available after 2030 will allow the possibility for Ukraine to enhance ambitions in a long-term.

Full implementation of existing strategies and extrapolation of correspondent targets by 2050 is already an ambitious task and will require fold increase of investments in energy sector from today's level to the volumes, comparable to the best examples of intensively developing economies. Such long-term extension of policies with current level of ambitions would still not be enough to stabilize emissions that start moderately growing after 2035.

Although Scenarios 2 and 3 are closely aligned up to 2030, thus may already provide some indicative information in the scope of the 2nd NDC preparation process, both Scenario 2 and 3 need further sensitivity analysis against longer-term variables.

For this reason, the Project team is carrying out the sensitivity analysis as outlined in this document, with the main purpose being **to test additional technological and policy options that were not taken into consideration in the original Scenarios 2 and 3 (table 1.1), while providing**:

- reduction of the overall GHG emissions with a reasonable cost increase (applied on Scenario 2);
- **reduction of required overall investments to acceptable level** (applied on Scenario 3, although such options will also cheapen Scenario 2, thus if needed for correct comparison they will be applied on Scenario 2).

In addition, the sensitivity analysis also aims **to test the robustness of original Scenarios, in case different key macroeconomic and technological assumptions are applied.**

In order to conduct the sensitivity analysis, the Project team determined the most critical factors/variables (see sensitivity scenarios matrix below) that affect future GHG emission pathways. By altering these variables to a range, the results will illustrate to what extend such changes affect the overall GHG emissions or corresponding system costs throughout the projected time-period. The results of model re-run on altered variables will inform whether certain additional policy or technological options are critical or not, and thus require more thorough policy analysis and recommendation.

The team proposed to finalize sensitivity analysis with a composition of the Combined sensitivity scenario, which included some sensitivity options with notable positive effect on emissions and required investments.

Table 1.1. Matrix Summarizing the Proposed Sensitivity Scenarios

Variable	Assumptions/Variables Tested	Sensitivity Scenario	S2*	S3
A	Optimistic macroeconomic scenario	S2A S3A	**X**	**X**
B	Carbon Tax	S2B	**X**	
C	New trajectory of GHG limits	S2C	**X**	
D	No new large nuclear power plants	S3D		**X**
E	Other nuclear options: - Higher (international) CAPEX level for new nuclear units construction - Extension of lifetime period for existing nuclear units - Lower load factor for existing and new nuclear units	S2E S3E	**X**	**X**
F	Balancing capacities: - Higher large hydro pump storage (1.7 GW) - Lower balancing capacity requirements for new variable renewable energy generation	S2F S3F	**X**	**X**
G	Limited implementation of waste sector policy inputs	S3G		**X**
H	Implications of the EU carbon border adjustment mechanism	S2H S3H	**X**	**X**
I	Combination of presented some sensitivity assumption and variables with notable positive effect on emissions and required investments	S2I	**X**	

NOTE: *For adequate comparison of sensitivity cases, original Scenario 2 described in Section 3 and 4 of Report 3 is supplemented with new technology options available in Scenario 3 ("S2*" in the matrix). Penetration of new technologies in original Scenario 2 is very limited, thus this option does not provide any notable changes there, although assumptions of sensitivity could increase the need for new technologies. Simply put, S2* is more encouraging of the model to select new technologies that it was in the original Scenario 2.*

1.2 RATIONALE OF PROPOSED SENSITIVITY SCENARIO

This section explains why the certain sensitivity analysis is run on either Scenario 2* or Scenario 3 only or both.

Scenarios S2A & S3A: Macroeconomic sensitivity analysis

Unless the economic composition of Ukraine decouples with GHG emissions in the near future, most likely higher GDP growth will result in higher GHG emissions, which will affect both Scenarios 2 and 3. For this reason, it would be important to test how sensitive both Scenario 2 and 3 will be in case Ukraine's economic trajectory significantly changes, compared to the current macroeconomic projection used for our analysis.

The October 2019 projections provided by the Ministry of Economic Development, Trade and Agriculture of Ukraine was based on more optimistic figures, therefore in order to understand how higher economic growth can alter/affect future GHG emissions, and what policy/measure considerations need to be taken into account for such possibility, it would be necessary to run the sensitivity analysis on both Scenario 2 and 3, as:

- for Scenario 2, it will test whether the GHG emission will significantly grow up to 2050 with higher GDP growth projections; whereas
- for Scenario 3, it will illustrate how more costly it would be to achieve the same level of GHG emission reduction by 2050, in case the technological options the model chooses differs.

This sensitivity will in addition inform the new indicative level of GHG emissions in 2030, which is important in the context of informing the target for the 2nd NDC.

Scenario S2B: Carbon prices and carbon markets

The model used to develop Scenario 2 and 3 is a dynamic model, but **as CO_2 constraint is not imposed in Scenario 2, it requires the carbon cost to be provided as an input.** Based on this input, the model will illustrate the GHG emissions trajectory from the time the cost is imposed until 2050. **For Scenario 3, were CO_2 cap is pre-defined, the model already estimated the marginal CO_2 price** that could be considered as Carbon Tax or carbon price based on ETS.

Thus, application of Carbon Tax/ETS on Scenario 2 is important to better inform our policy recommendation for this Report 4.

Scenario S2C: New trajectory of GHG limits, but carbon neutrality by 2070

This analysis was proposed by the Ministry of Energy and Environment of Ukraine, considering the significantly concentrated increase of investment needs projected for the last decade in Scenario 3.

Scenario S3D: No new large nuclear reactors

Current scenarios allow the option of choosing new nuclear and model calculations confirm its important role for reaching ambitious GHG targets, however due to other social environmental reasons, nuclear may not become a viable option as result of change in policy. **As Scenario 2 does not impose any policy targets after 2030, it may be underestimating the levels of GHG emissions in case new nuclear no longer becomes an option.**

For Scenario 3, GHG emissions limits are imposed, so the model already presents the cost-optimal technological options. Any new nuclear option will need to be replaced with other carbon-free technological solutions that will increase investment costs and electricity marginal price. However, a sensitivity analysis will inform whether there is enough potential of renewables and other technologies to compensate for the model rejecting to choose new cost-optimal nuclear power plants as an option.

Scenarios S2E & S3E: Other nuclear option, applying: 1) EU capex; 2) lower availability factor; 3) extension of existing nuclear units)

Combination of nuclear technology/policy options, where options 1 and 2 reduce competitiveness of nuclear, while option 3 will increase competitiveness of nuclear on power market, will effect GHG emissions in Scenario 2 and technological changes in Scenario 2 and 3.

Scenarios S2F & S3F: Balancing capacities

Combination of additional large hydro and minimization of balancing technologies (options) will effect GHG emissions in Scenario 2 and technological changes (composition of renewables) in both Scenario 2 and 3.

Scenario S3G: Limited implementation of waste sector policy

Various measures included in the National Waste Management Strategy differ by unit investments and by reduction of emissions they could achieve. Meanwhile, some of these measures could potentially lead to increase of emissions, such as: construction of new regional MSW landfills and closing of unauthorized and poorly equipped landfills, increasing the share of the population with the centralized solid waste collection system, etc.

The purpose of this sensitivity analysis is to explore whether there is a reasonable limitation of waste sector policy ambitions with respective reduction of required investments that will not sizably affect the reduction of emissions achieved in original Scenarios 3.

Scenarios S2H & S3H: Implications of the EU border carbon adjustment taxes

Economic assessment provided in Report 3 has revealed a wide uncertainty range following implementation of internal energy and environmental policies. And although investment-oriented pathway was identified to be the most attractive from the economic perspective, a number of risks and uncertainties associated with this scenario were discussed and explored. Corresponding assessment has shown that under certain conditions economic impacts of the low emission development scenario might be negative in the long run. At the same time, possible interactions with policies introduced by other countries, including Ukraine's key trading partners, were not explored so far. In this scenario we would focus on the set of policies that could be implemented by other counties and have a significant impact on Ukrainian economy.

Scenarios S2I: Combination of sensitivity assumption and variables

Combined Sensitivity Scenario will allow to assess the combined impact of existing legislation and additional policies and/or technologies or their limitations leading to higher ambition level and allowing additional flexibility for the GoU on implementing original Scenario 2 that currently foresees the implementation of existing legislation only.

1.3 ASSUMPTIONS/VARIABLES TESTED FOR SENSITIVITY

Variable A: Macroeconomic assumptions

Unless the economic composition of Ukraine decouples with GHG emissions in the near future, most likely higher GDP growth will result in higher GHG emissions, which will affect both Scenarios 2 and 3. For this reason, it would be important to test how sensitive both Scenario 2 and 3 will be in case Ukraine's economic trajectory significantly changes, compared to the current macroeconomic projection used for our analysis. The most recent projections provided by the Ministry of Economic Development, Trade and Agriculture of Ukraine is based on more optimistic figures, therefore in order to understand how higher economic growth can alter/affect future GHG emissions, and what policy/measure considerations need to be taken into account for such possibility, it would be necessary to run the sensitivity analysis on both Scenario 2 and 3, as for scenario 2, it will test whether the GHG emission will significantly grow up to 2050 with higher GDP growth projections; whereas for scenario 3, it will illustrate how more costly it would be to achieve the same level of GHG emission reduction by 2050, in case the technological options the model chooses differs.

Analysis using **macroeconomic optimistic scenario**, in line with revised GoU Decree on Macroeconomic and Social Development Scenarios from October 23, 2019 (scenario 2 of the decree), including the population growth rate change.

For sensitivity scenarios S2A & S3A project team recommends to apply Optimistic Macroeconomic Scenario projection that is based on October 2019 official governmental projections.

Table 1.2. Macroeconomic optimistic scenario of Ukraine (released by GoU in October 2019)

Indicators	2021-2030	2031-2040	2041-2050
GDP, %, average for period	6.2	4.7	4.5
Mining and quarrying, growth rate in %, average for period	3.2	1.1	0.3
Manufacturing, growth rate in%, average for period	7.2	5.7	5.6
Industry, growth rate in%, average for period	5.7	4.4	4.6
Construction, growth rate in %, average for period	11.3	2.6	2.4
Services, growth rate in %, average for period	6.6	5.3	5
Agriculture, growth rate in %, average for period	4.4	3	2.9
Population, mln, at the end of period	40.6	40.0	39.7

Variable B: Carbon prices and carbon markets

Ukrainian domestic cap and trade ETS implementation with coverage based on World Bank PMR Carbon Pricing Report (2019) and carbon tax for the sectors not covered by the ETS. The emissions cap for sectors covered by ETS will be as in the Scenario 2, which is different from that adopted in the PMR report. Therefore, the explicit carbon price for ETS will be different than that used in the PMR report.

For an in-depth study, a range of carbon tax values in Scenario 2 should used, which cover all energy users, exploring the sensitivity of the solution to GHG emission prices, but in this study we used only one trajectory of carbon tax based on value of carbon tax from PMR Report ($18 or ~€15.6 per t CO2) in 2030 and extrapolate until €100 pet tonne CO2 in 2050 (Figure 1.1).

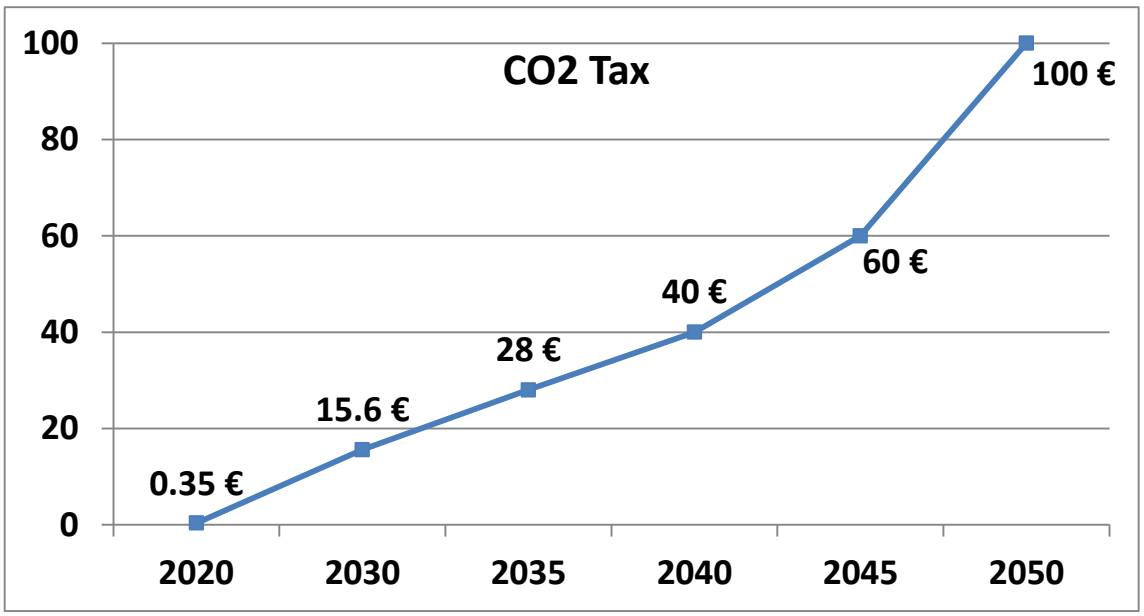

Figure 1.1. Proposed trajectory of carbon tax

Note: *Under this sensitivity analysis, we are not making policy recommendation, but only analysing the potential impact of "carbon price/tax" introduction for GHG emission reduction targets. Therefore, the term "carbon price/tax" used here means as "a policy instrument designated to assist with achieving climate change mitigation," and a range of values applied.*

Variable C: New trajectory of GHG limits, but carbon neutrality by 2070

This Sensitivity Scenario (Figure 1.2) composition was proposed by the Ministry of Energy and Environmental Protection of Ukraine, considering huge increase of investment needs in the last decade in Scenario 3.

Please note, that GHG target derived from such linear interpolation between 2035 and 2070 will be different if different macroeconomic projections applied. At the same time, 2070 timeframe was NOT modelled by Project team, thus the investments needs or other efforts required to reach net-zero emissions by 2070 is unknown.

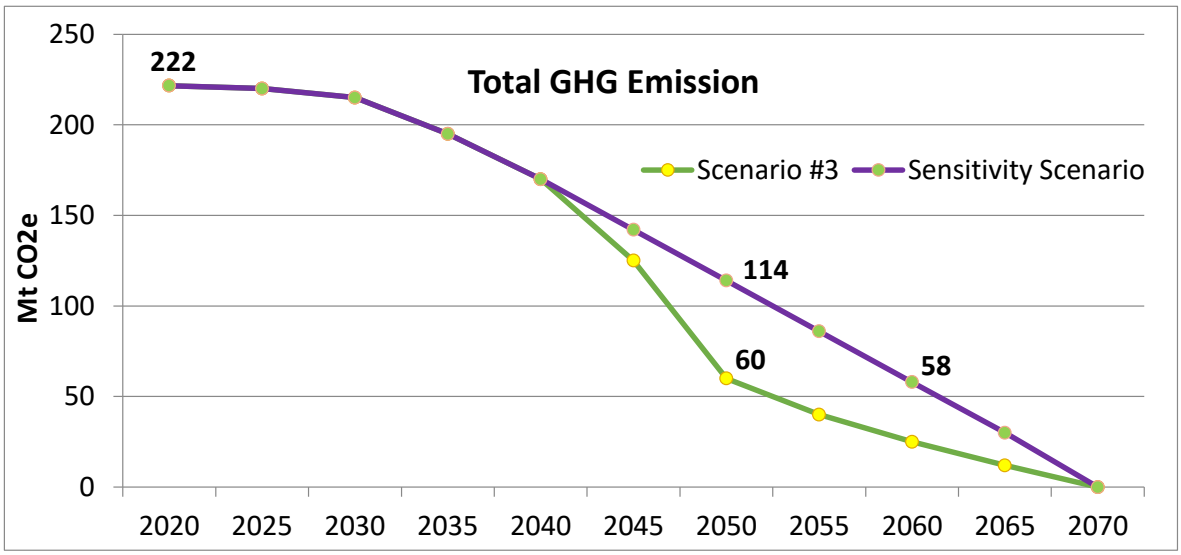

Figure 1.2. Alternative trajectory of GHG limits in Ukraine

Variables D & E: Nuclear power generation options

S3D Analysis: **Will assumes no new large nuclear reactors** (1000+ MW) are built in Ukraine during the period of 2020-2050 (as special modelling constraints).

S2E & S3E Analyses: **Other nuclear option.** Will assumes building new nuclear reactors:

- ***E.1:*** With higher CAPEX based on international benchmark:

Large size units (incl. new units #3, #4 on Khmelnyts'ka NPP) – €5922 (~$7000) per kW (EU benchmark).

- ***E.2:*** Extension of lifetime of existing nuclear reactors by additional 5-10 years.

Based on Energoatom information for some existing nuclear reactions lifetime can be extend for additional 5-10 years (Figure 1.3):

Nuclear Power Plants	# Units	Capacity, MW	Date of commissioning	Current lifetime	Extension of lifetime	Potential max. operating lifetime
Rivnens'ka	1	420	22.12.1980	22.12.2010	22.12.2030	2035
	2	415	22.12.1981	22.12.2011	22.12.2031	2036
	3	1000	21.12.1986	11.12.2017	11.12.2037	2047
	4	1000	10.10.2004	07.06.2035	*planned*	2065
Pivdenno-Ukrains'ka	1	1000	31.12.1982	02.12.2013	02.12.2023	2043
	2	1000	09.01.1985	12.05.2015	31.12.2025	2035
	3	1000	20.09.1989	10.02.2020	*on process*	2050
Zaporiz'ka	1	1000	10.12.1984	23.12.2015	23.12.2025	2045
	2	1000	22.07.1985	19.02.2016	19.02.2026	2046
	3	1000	10.12.1986	05.03.2017	05.03.2027	2037
	4	1000	18.12.1987	04.04.2018	04.04.2028	2048
	5	1000	14.08.1989	27.05.2020	*on process*	2040
	6	1000	19.10.1995	21.10.2026	*planned*	2056
Khmelnyts'ka	1	1000	22.12.1987	13.12.2018	13.12.2028	2038
	2	1000	07.08.2004	07.09.2035	*planned*	2065
	3			Not completed		
	4			Not completed		

Figure 1.3. Possible extension of lifetime of existing nuclear reactors

- ***E.3:*** With lower load factor in line with the current one in Ukraine. Based on Energoatom information to use 76% of availability factor for all new large size units of nuclear power plant (NPP) (Figure 1.4).

Variable F: Balancing capacities assumptions

Additional **large hydro pump storage** 1.7 GW and **minimum balancing** technologies for wind and solar plant size (excl. roof panels) power plants

- Additional 387 MW in 2020, 898 MW in 2025, 1222 MW in 2027 and 1675 MW in 2030. In the period 2031-2050 no new large HPP. Maximum additional capacities of large hydro pump storage in 2030-2050 is 1675 MW;
- Minimum of balancing technologies relating with variable renewables (solar and wind):
  - 1% in 2020 and 10% in 2050 of battery storages of new VRE capacity;
  - 10% in 2020 and 0% in 2050 of balancing techs (gas, hydro, fuel cells, import) of new VRE capacity, based on learning technologies and additional 1.7 GW hydro pump storage.

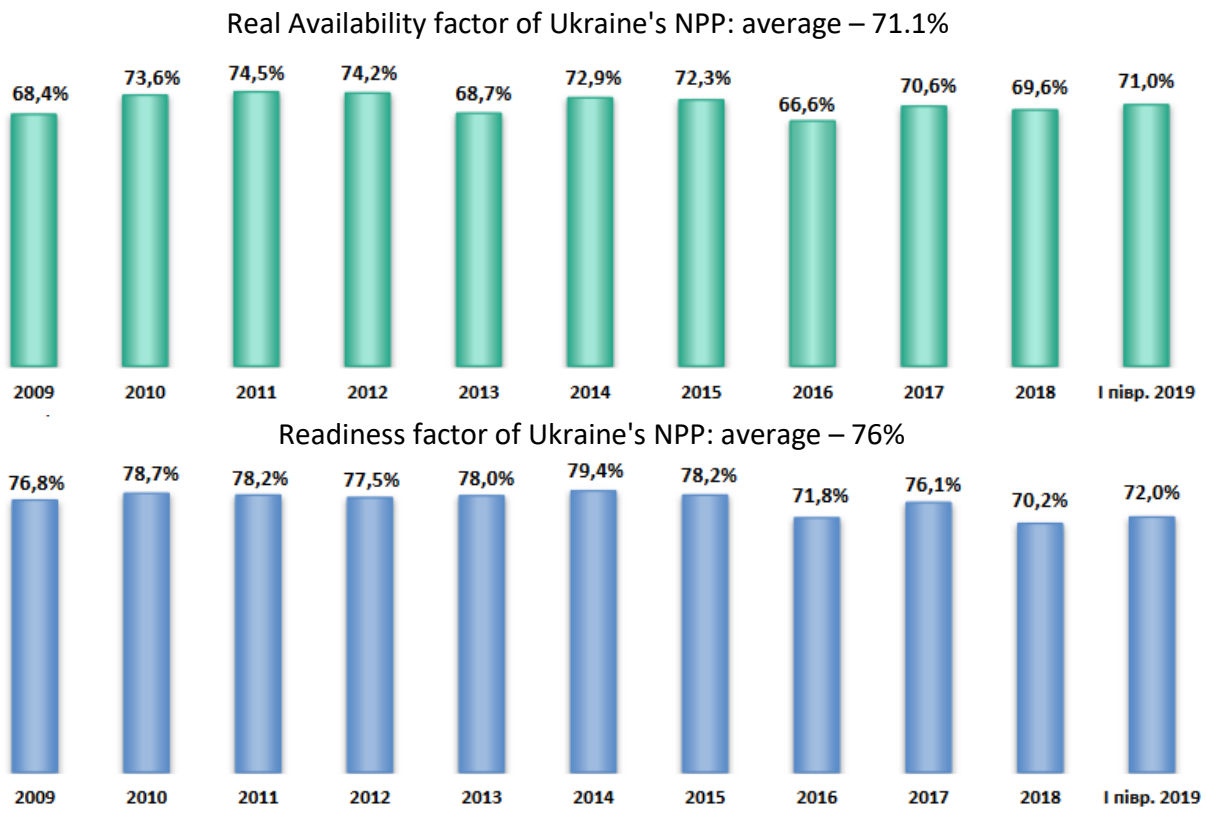

Figure 1.4. Real availability and readiness factors of Ukraine's NPP

Variable G: Limited implementation of existing legislation on waste management, applying the following assumptions for Scenario 3:

- Share of MSW landfilling in 2030, in % from generated MSW;
- Share of population covered by centralized collection MSW system in 2030, in % from total population;
- Number of new regional sanitary MSW landfills to be constructed, in units for the period of 2020-2030;
- Number of existing MSW landfills to be modernized to the level of sanitary, in units for the period of 2020-2030.

Variable H: Implications of the EU carbon border adjustment mechanism

While economic impact assessment provided in Report 3 was focused on the impacts of domestic energy and environmental policies, Ukrainian economy could be also impacted by various policy options introduced by other countries, including its key trading partners. Although at this point, there is an uncertainty around the set of environmental and climate related policy options that Ukraine might face in the future, one of the possibilities that we explore in this sensitivity scenario is imposition of the carbon border adjustment mechanism by the EU countries on imports of selected goods from Ukraine. This analysis is aimed to show possible implications of such policy for Ukrainian economy, as well as identify risks and opportunities in case such policy would be implemented. A range of possible implications of carbon border adjustment mechanism would be explored in this scenario.

1.4 MODELLING RESULTS OF SENSITIVITY SCENARIOS

1.4.1. Scenarios S2A: Macroeconomic sensitivity analysis

In the case of higher rates of economic growth, primarily due to increased industrial production without significant technological modernization, it is logical that GHG emissions will be higher. The largest increase in GHG emissions may occur in industry and the energy supply sector. The difference will not be significant - a maximum of 4-5% in 2025-2030 compared to Scenario 2 (S2) and it may decrease to 2% in 2050. As can be seen from Fig. 1.5 emissions will not exceed the level of 31% since 1990, as in scenarios S2 and S2A this is the limit of the LEDS of Ukraine.

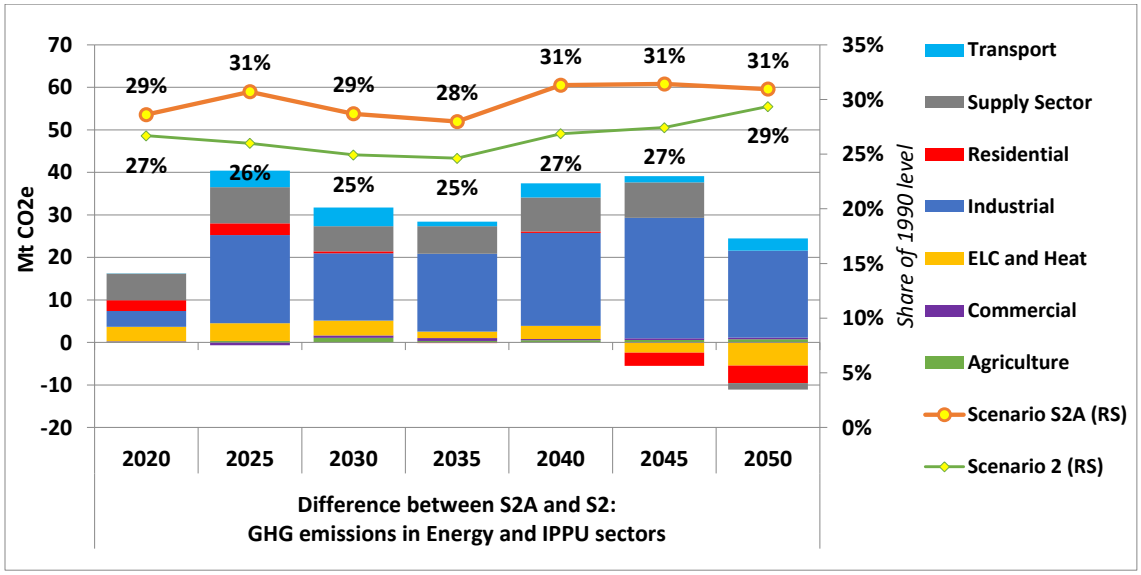

Figure 1.5. Difference between S2A and S2: GHG emissions in Energy and IPPU sectors

It is also interesting that the increase in energy needs will be primarily due to RES, natural gas and biomass (Fig. 1.6).

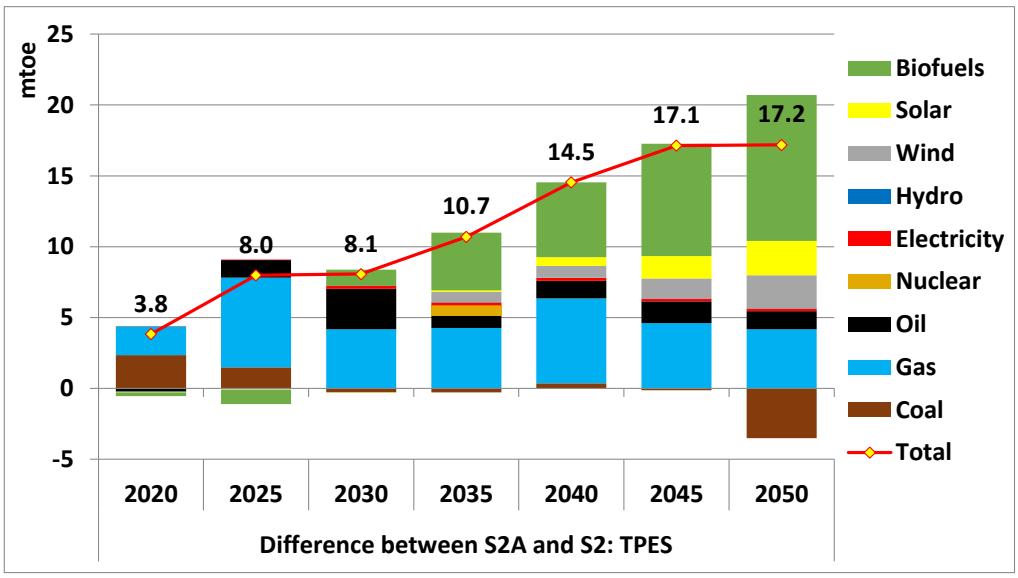

Figure 1.6. Difference between S2A and S2: Total Primary Energy Supply

Electricity production could increase by 7% in 2030 and by 27% in 2050 compared to scenario S2, also primarily due to RES (solar, wind and biomass) (Fig. 1.7).

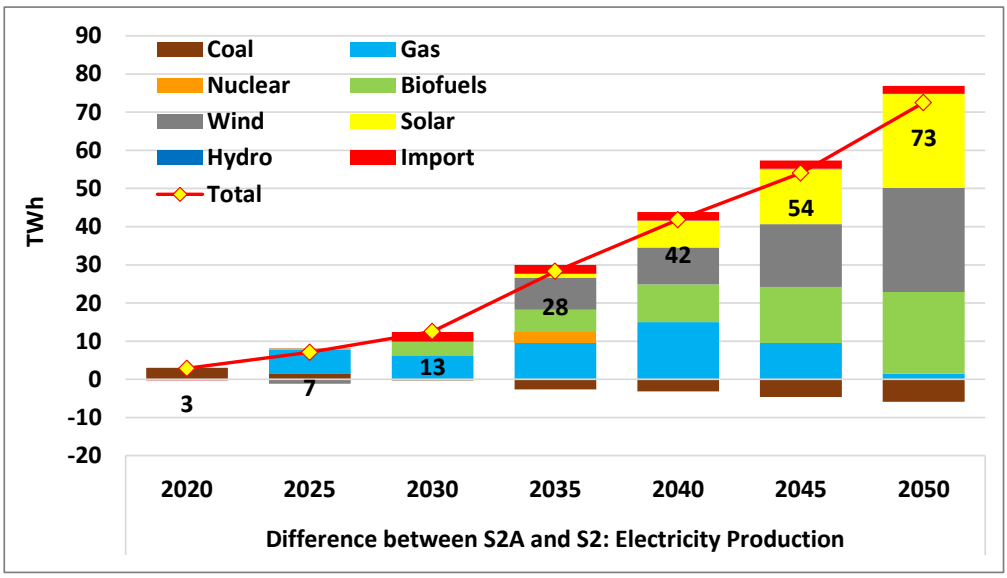

Figure 1.7. Difference between S2A and S2: Electricity production

To cover the growing demand for energy resources (based on higher economic growth rates), investment needs will increase by 308 billion Euro for the period 2020-2050. As S2 and S2A scenarios have an upper limit on GHG emissions from Low Emission Development Strategy up to 2050, the modelling results show that necessary to increase investment in transport, power and heat, and industry to reduce emission intensity of economy. In addition, under the S2A scenario, carbon capture and storage technologies may become cost-effective (Fig. 1.8).

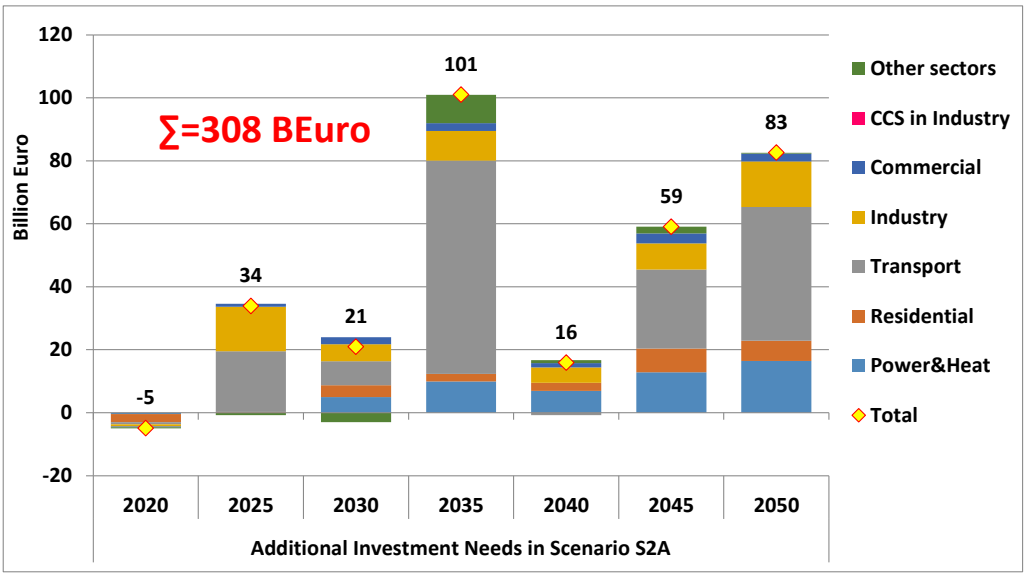

Figure 1.8. Difference between S2A and S2: Investment needs in Energy and IPPU sectors

1.4.2 Scenarios S3A: Macroeconomic sensitivity analysis

Similar to the trends and conclusions for scenario S2A, in scenario S3A emissions will also be higher than in the original scenario. Similarly, the increase will be mainly in industry, energy supply network and electricity and heat production (Fig. 1.9).

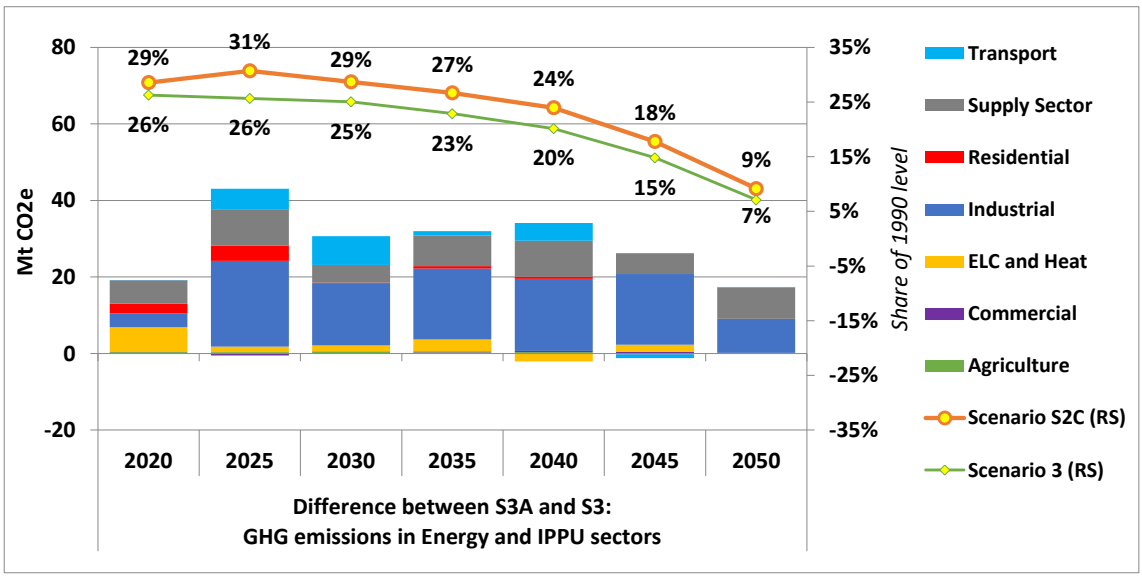

Figure 1.9. Difference between S3A and S3: GHG emissions in Energy and IPPU sectors

Similarly, Thermal Power Plants (TPPs) will grow mainly due to RES and gas, but in this case, more growth will show wind and solar energy (Fig. 1.10).

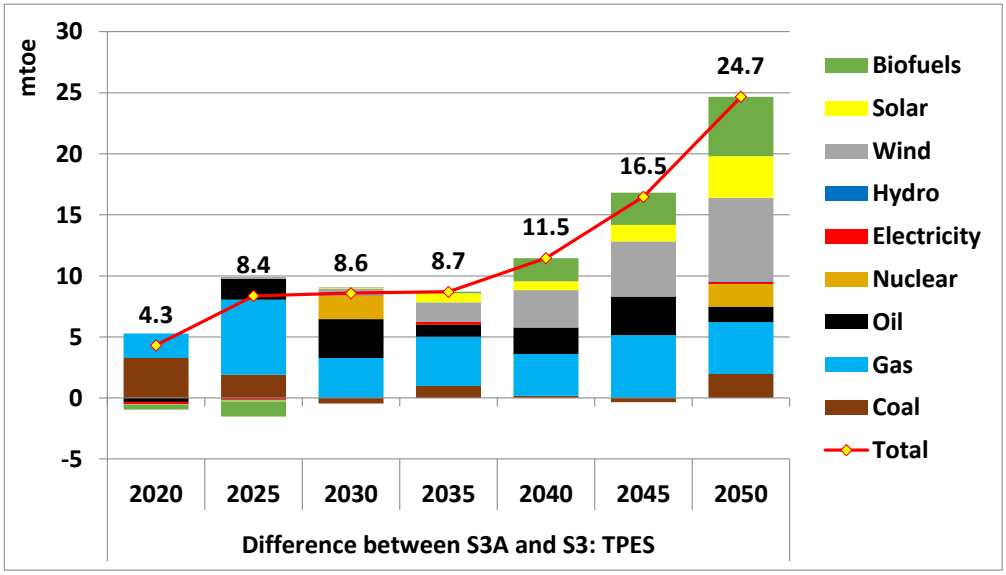

Figure 1.10. Difference between S3A and S3: Total Primary Energy Supply

Decarbonisation of the economy under the C3A scenario will require much more electricity, additional production of which can be provided by wind and solar energy.

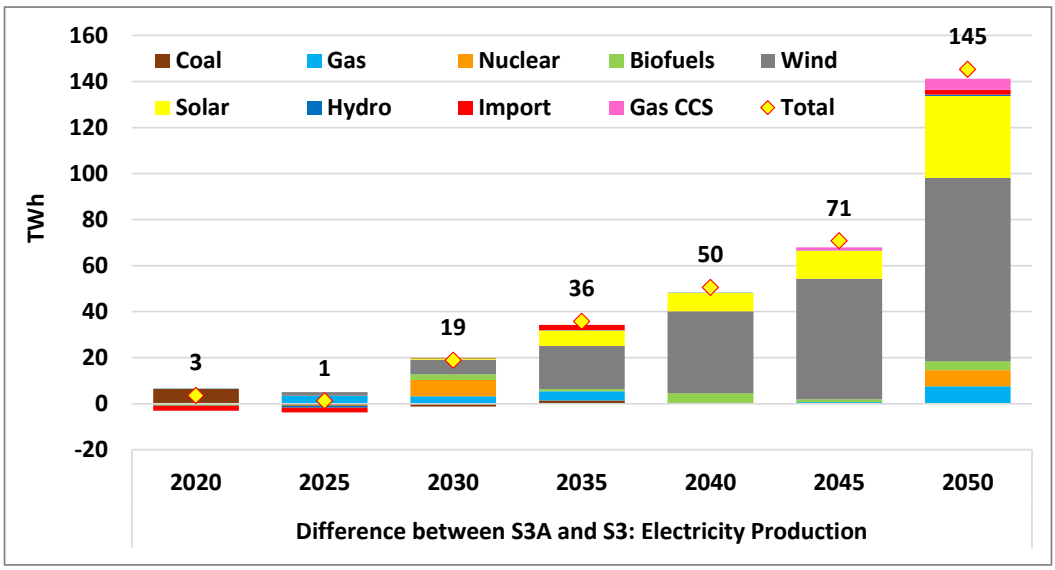

Figure 1.11. Difference between S3A and S3: Electricity production

However, level of GHG emission reductions under the C3A scenario will require extremely high investment needs in 2045-2050, which seems unlikely (Fig. 1.12).

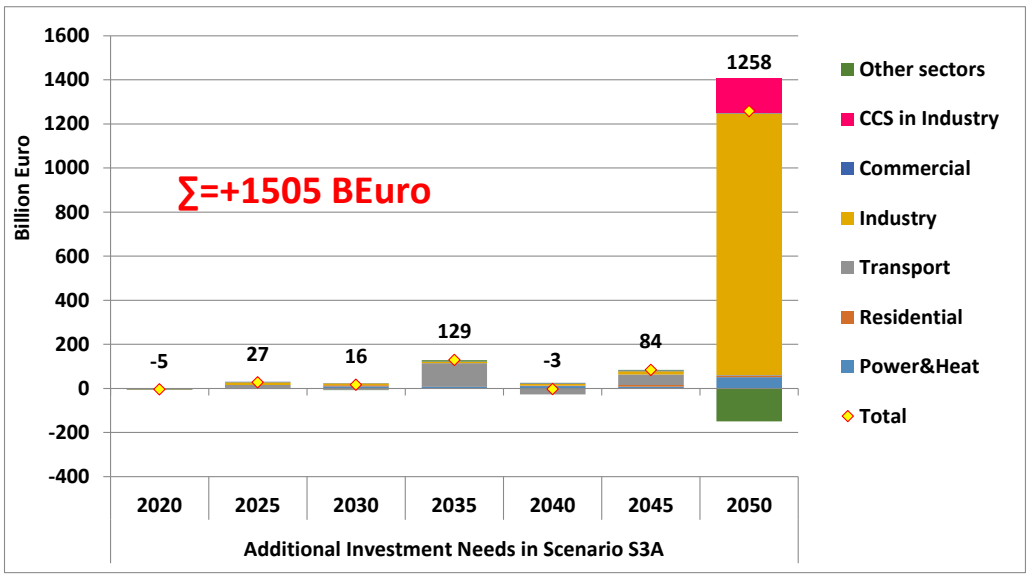

Figure 1.12. Difference between S3A and S3: Investment needs in Energy and IPPU sectors

1.4.3 Scenario S2B: Carbon prices and carbon markets

The high carbon tax in particular will have a significant impact on CO2 emissions in 2045-2050. In S2B scenario the total GHG emissions in the Energy and IPPU sectors will be 5% lower in 2040, but 21% higher in 2045 and 126% higher in 2050 compared to S3. Without strict limitation of GHG emissions as in S3, with the introduction of high CO2 tax, the share of GHG emissions in 2050 will be 16% of 1990 level, while in S3 it will be 7%, respectively. The highest increase in GHG emissions will occur in Industry, currently having the most expensive GHG reduction in the economy. GHG emissions will also increase in the Energy Supply, Transport and Residential sectors. (Fig. 1.13).

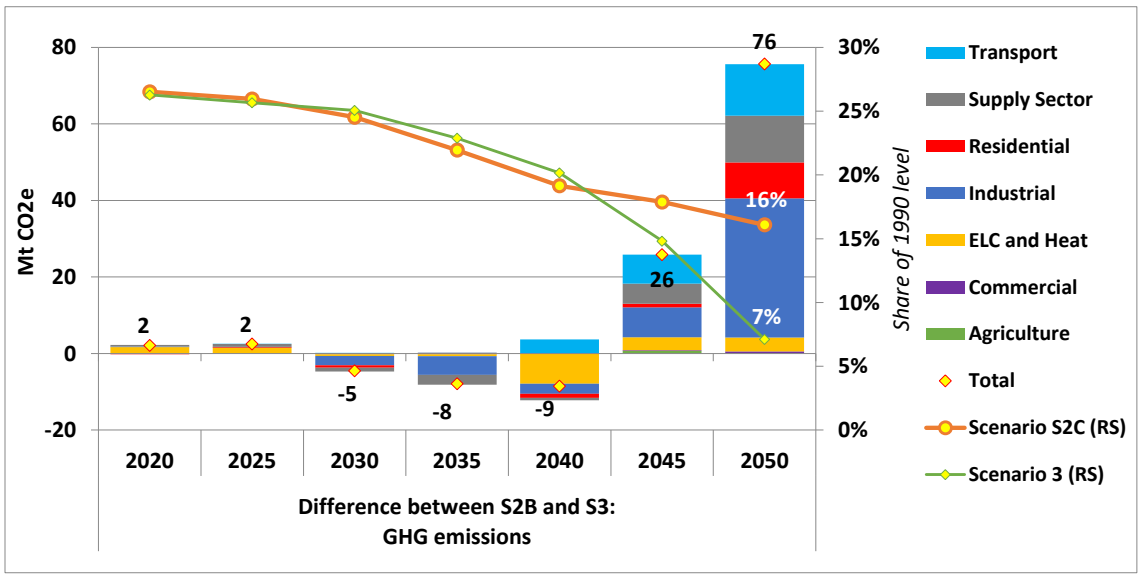

Figure 1.13. Difference between S2B and S3: GHG emissions in Energy and IPPU sectors

TPPs will increase slightly in 2040-2050 (1-3%), but its structure will somewhat change. The supply of carbon-intensive energy resources (coal, gas, oil) will increase, and renewables will decrease compared to S3 scenario.

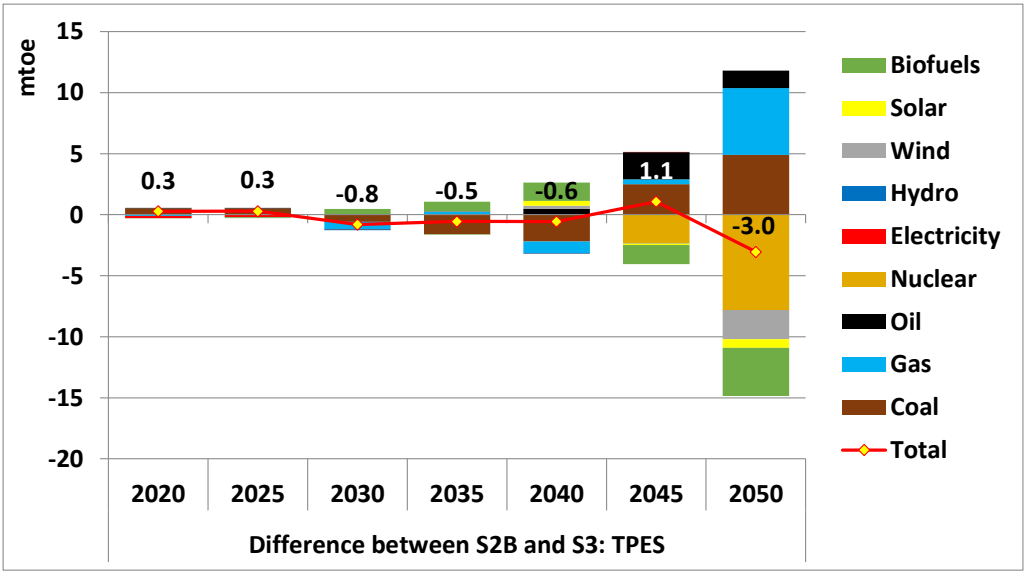

Figure 1.14. Difference between S2B and S3: Total Primary Energy Supply

In S2B scenario, electricity generation will be significantly lower than in S3. In 2050, it will be less by 21%, due to wind and partly nuclear energy (Fig. 1.15).

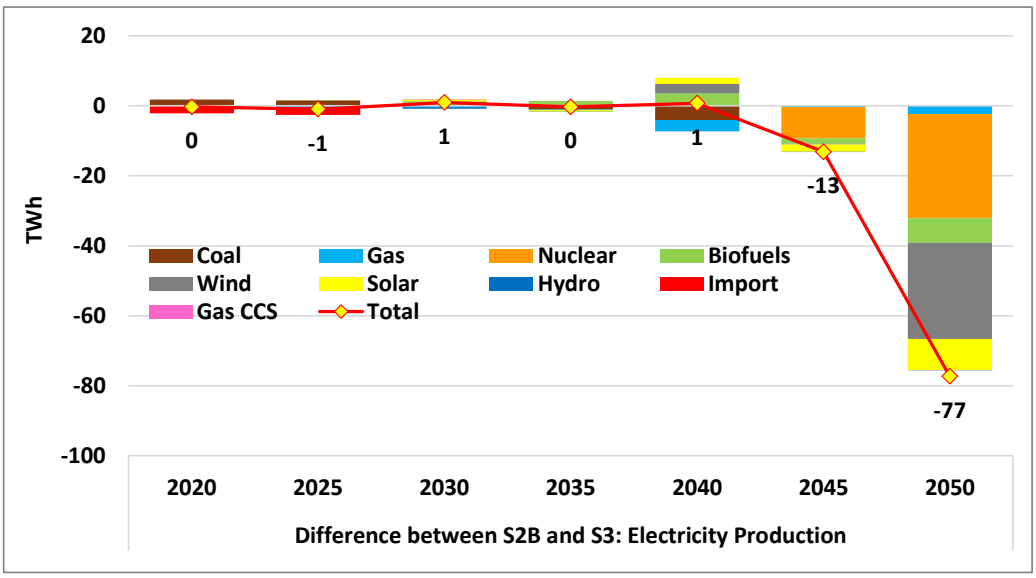

Figure 1.15. Difference between S2B and S3: Electricity production

The investment needs will be reduced by €309 Billion, primarily due to non-use a CCS technologies in Industry, which are currently quite expensive (Fig. 1.16).

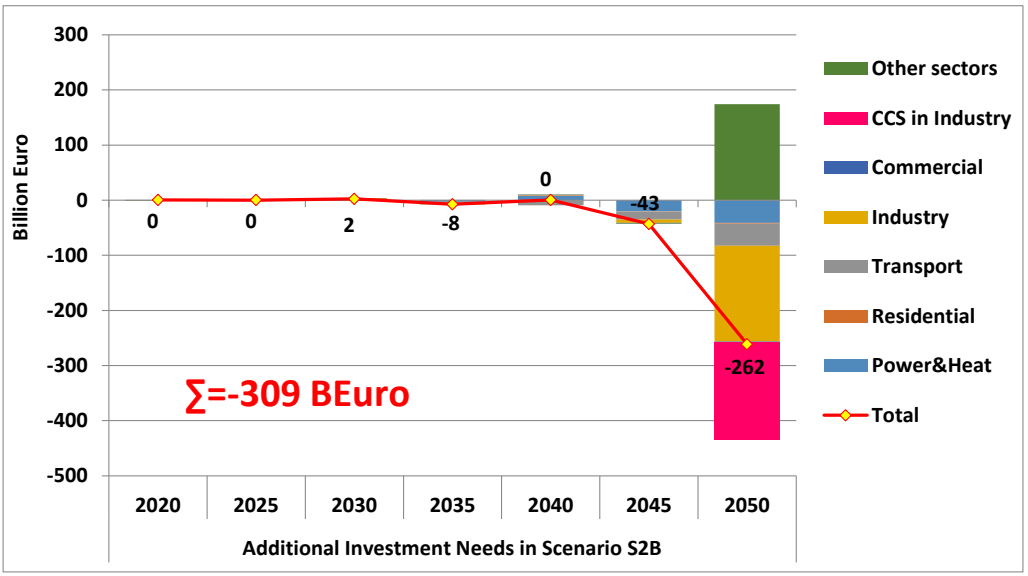

Figure 1.16. Difference between S2B and S3: Investment needs in Energy and IPPU sectors

Total System Cost (TCS) will be practically the same (+0.7%), which includes the sum of CO2 taxes (Fig. 1.17, left). The amount of CO2 taxes collected can increase from €0.1 Billion in 2020 to €12.4 Billion in 2050 (Fig. 1.17). With the introduction of these CO2 taxes, their total during 2020-2050 will be €156 Billion.

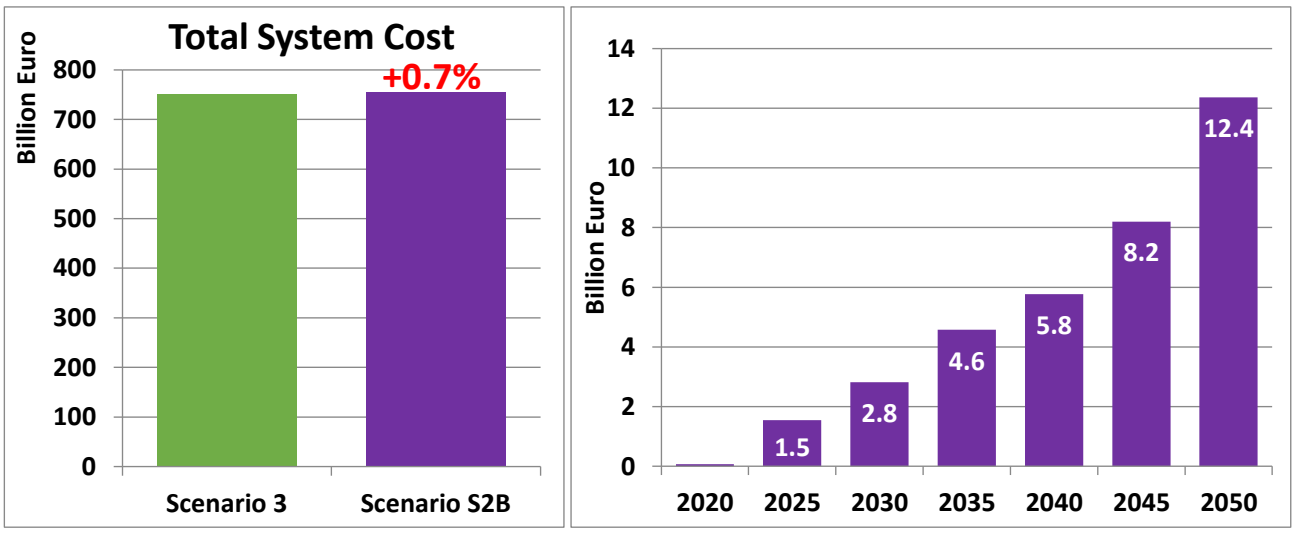

Figure 1.17. Total System Cost (left) and Amount of CO_2 Tax (right)

1.4.4 Scenario S2C: New trajectory of GHG limits, but carbon neutrality by 2070

This sensitivity scenario S2C assumes the new trajectory of GHG limits, but carbon neutrality by 2070. In scenario S3 GHG emissions per capita in 2050 is 1.5 t CO2e, but in S2C – 3.1 t CO2e per capita. This scenario is very close to the sensitivity scenario S2B, in which scenario S3 (excluding GHG emission limits) imposes high CO_2 tax.

The loosening of GHG emission restrictions in the Energy and IPPU sectors is likely to increase their level in 2045-2050, compared to scenario S3. Total GHG emissions will be the same in 2040 and 14% higher in 2045 and 90% higher in 2050 and will decreased to 14% of 1990 levels, whereas in S3 it will be 7% respectively (Fig. 1.18).

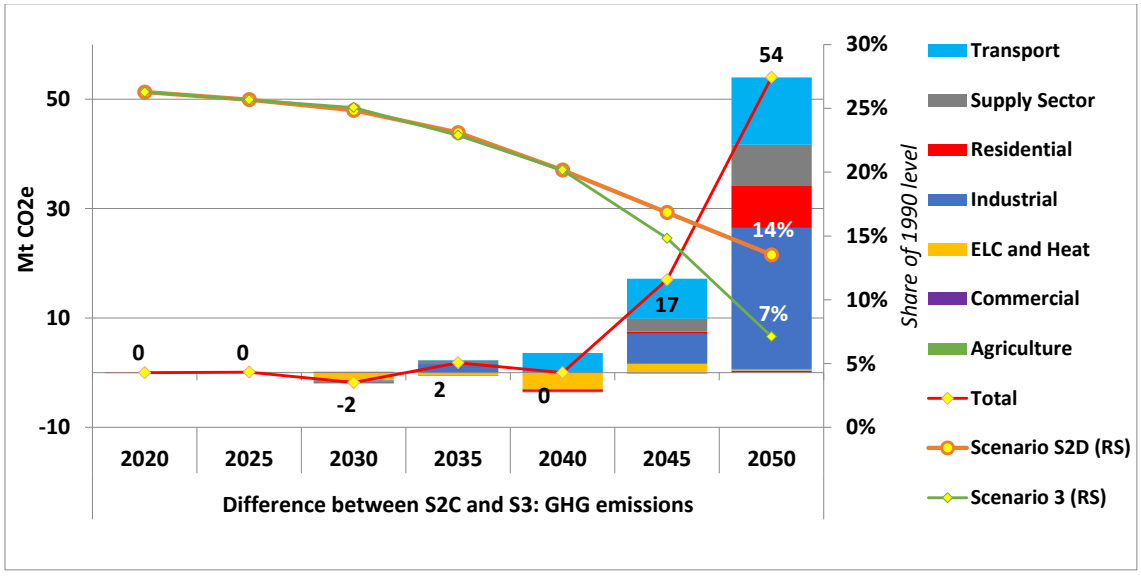

Figure 1.18. Difference between S2C and S3: GHG emissions in Energy and IPPU sectors

TPPs will not change compared to Scenario 3, but its composition of electricity mix for production will change slightly in 2045-2050. The supply of carbon-intensive energy sources (coal, gas, oil) will increase, and the supply of RES and nuclear fuel will be reduced (Fig. 1.19).

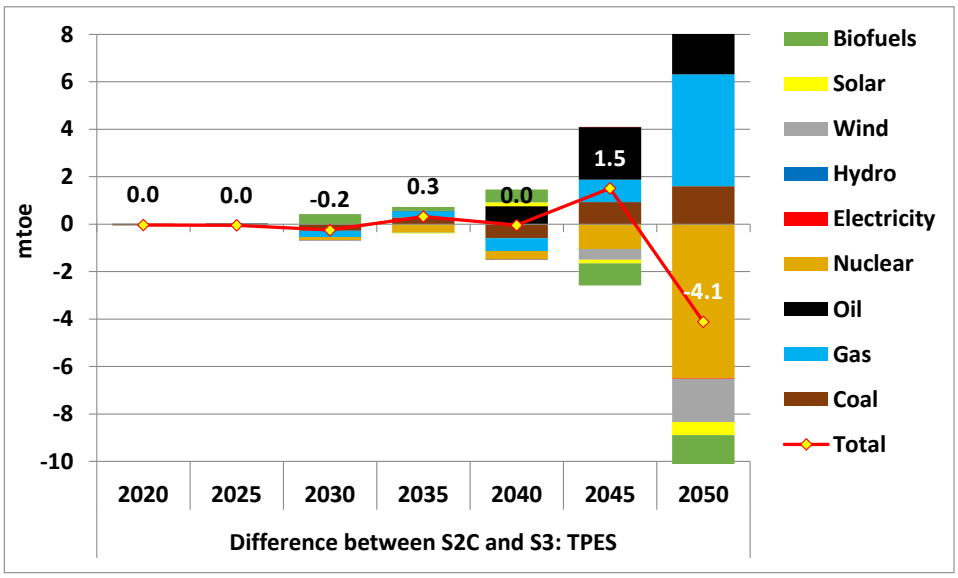

Figure 1.19. Difference between S2C and S3: Total Primary Energy Supply

Electricity generation will be significantly lower than in scenario S3 (-17% in 2050) due to nuclear and wind and partly to solar and bioenergy and gas (Fig. 1.20).

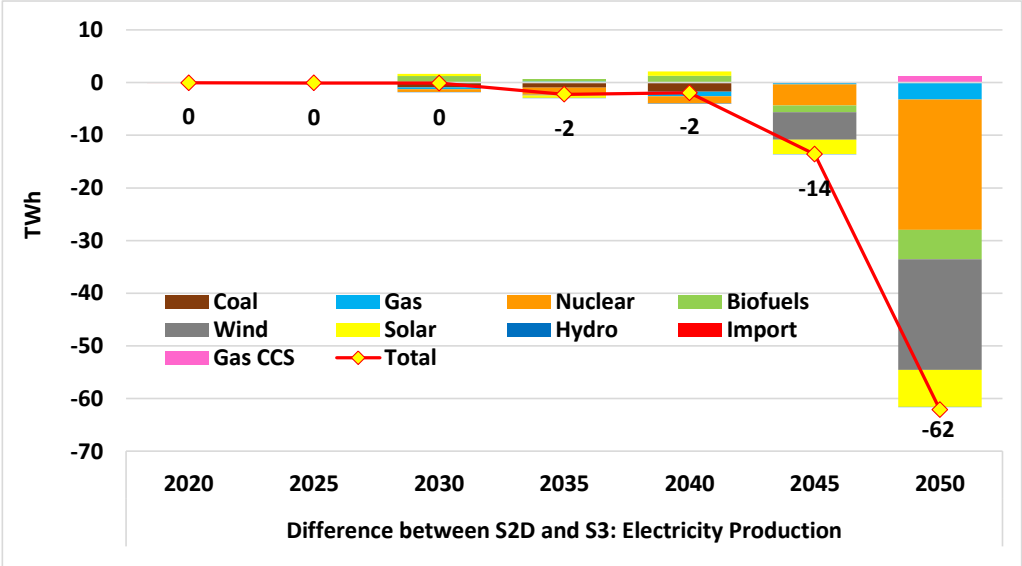

Figure 1.20. Difference between S2C and S3: Electricity production

Investment needs will be reduced by €286 Billion, mainly due to the lack of CCS technologies, which are quite expensive today. TSC will be 3.2% less (Fig. 1.21).

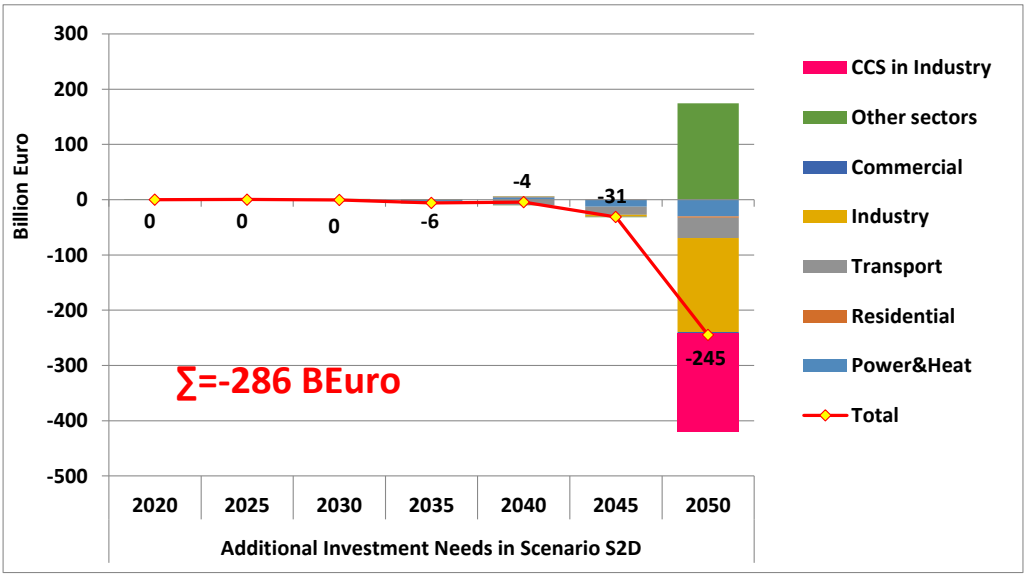

Figure 1.21. Difference between S2C and S3: Investment needs in Energy and IPPU sectors

The total system cost in the S2C scenario will be lower by 3.2%, which is quite a significant difference (Fig. 1.22).

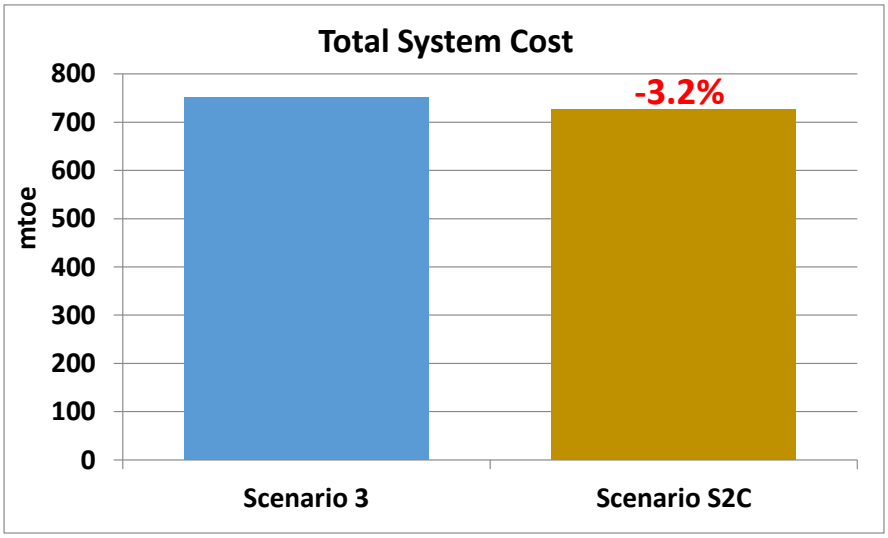

Figure 1.22. Total System Cost by Scenario 3 and Scenario S2C

Consequently, high CO2 tax are an effective tool for reducing GHG emissions, allowing to collect a substantial size budget that can be reinvested for a climate policy and measures implementations.

1.4.5 Scenario S3D: No new large nuclear reactors

This sensitivity scenario assumes that no new nuclear reactors are built in Ukraine in the period 2020-2050.

The total GHG emissions will not change, but their structure will change somewhat due to the increase in the cost of electricity. GHG emissions in the Power and Heat sector will decrease and in the industry will increase (Fig. 1.23).

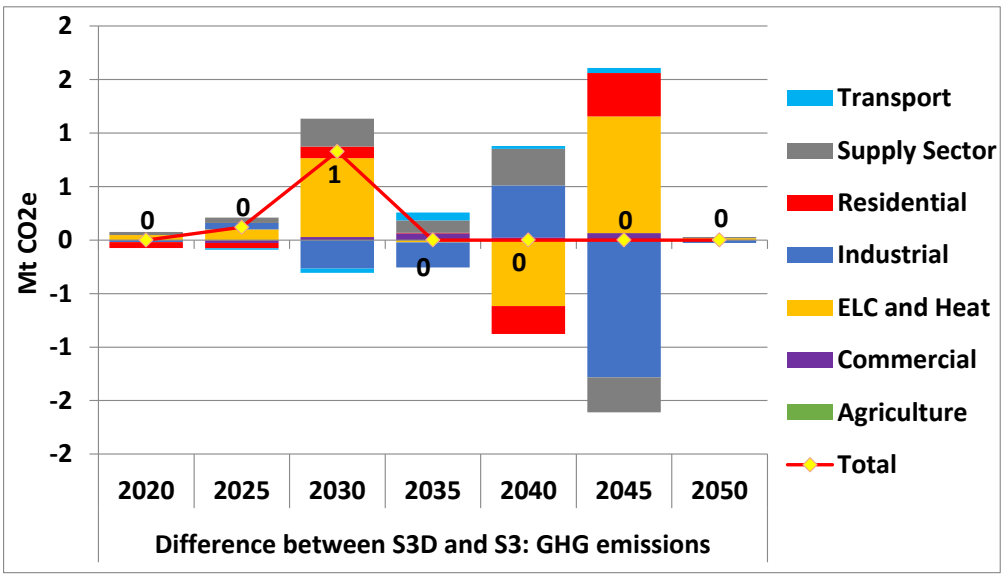

Figure 1.23. Difference between S3D and S3: GHG emissions in Energy and IPPU sectors

In the composition of electricity generation mix, the potentially generated electricity by new nuclear units in scenario S3 will be replaced by wind and solar power plants. However, more balancing capacity will be needed to increase wind and solar power generation, possibly even with CCS (Fig. 1.24).

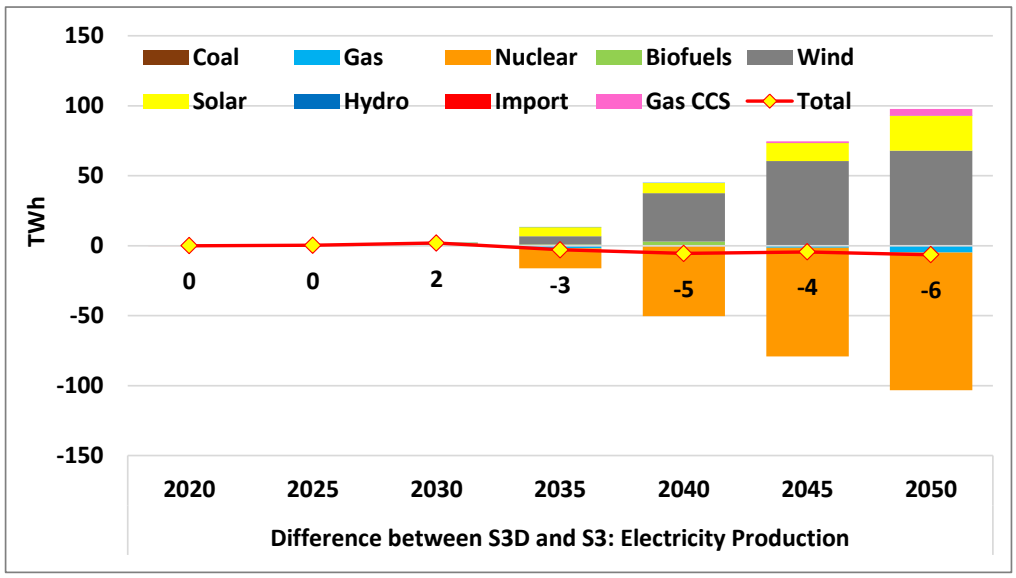

Figure 1.24. Difference between S3D and S3: Electricity production

The investment needs will increase by €3.7 Billion, with Total System Cost increasing by only 0.2%. Investments will mainly increase in final energy consumption and other sectors, and in the power and heat sector, they might be even slightly lower due to a slight decrease in electricity generation (Fig. 1.25).

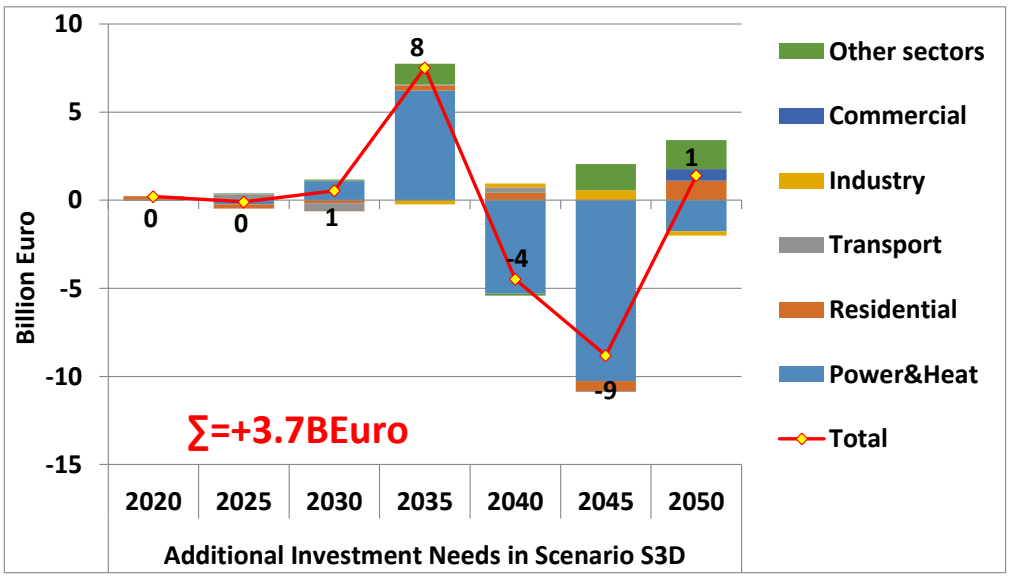

Figure 1.25. Difference between S3D and S3: Investment needs in Energy and IPPU sectors

1.4.6 Scenarios S2E: Other nuclear option

This Sensitivity Scenario assumes that the CAPEX of new nuclear reactors that will be built is based on international benchmark of - $7000 per kW; extension of existing nuclear reactions by additional 5-10 years; and availability factor for all new and existing large size units of NPP - 76%.

Total GHG emissions will not change, but the structure of emissions will change in 2030-2045, due to higher electricity price. GHG emissions in Agriculture and Power and heat sectors will decrease and in Industry, Energy Supply and Transport will increase (Fig. 1.26).

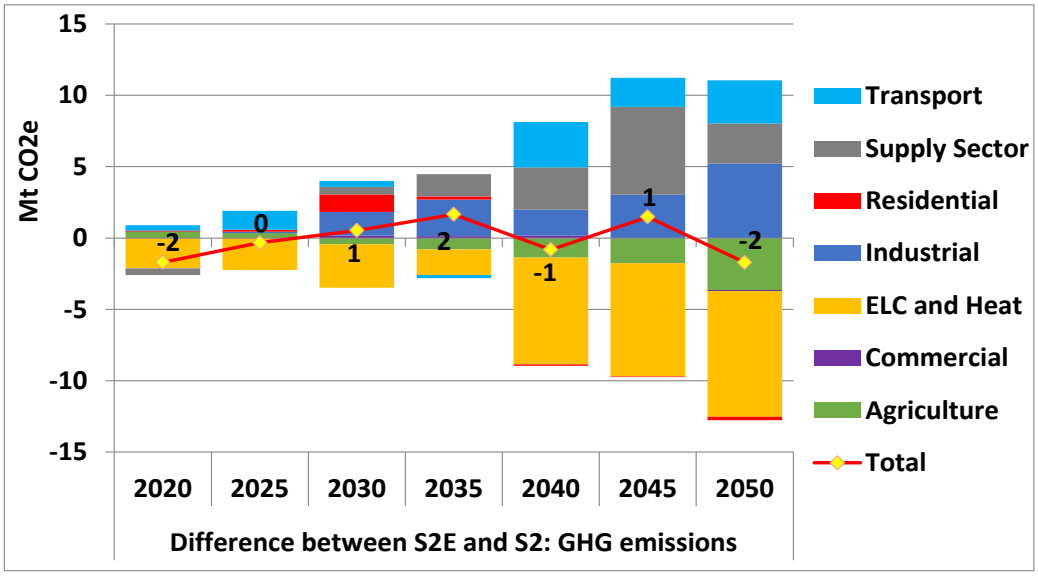

Figure 1.26. Difference between S2E and S2: GHG emissions in Energy and IPPU sectors

The potentially electricity generated by the new nuclear units in scenario S2, will be replaced by wind and solar electricity (Fig. 1.27).

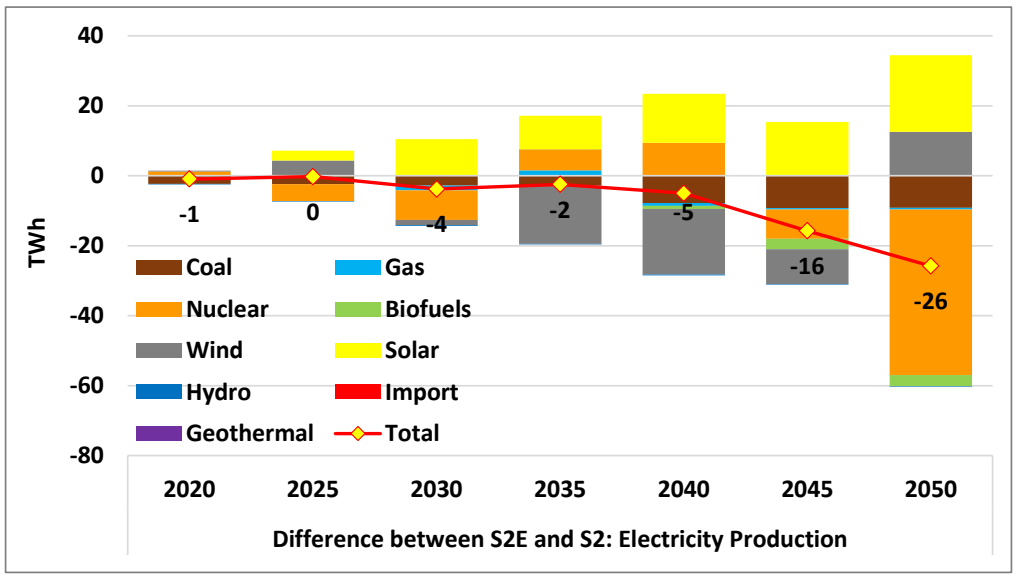

Figure 1.27. Difference between S2E and S2: Electricity production

Due to the possibility of existing nuclear units use, which involves small investments, total investment needs can be significantly reduced compared to scenario S2, especially in 2040. During this time in S2 a large number of nuclear units are expected to be decommissioned due to their expiration (Fig. 1.28).

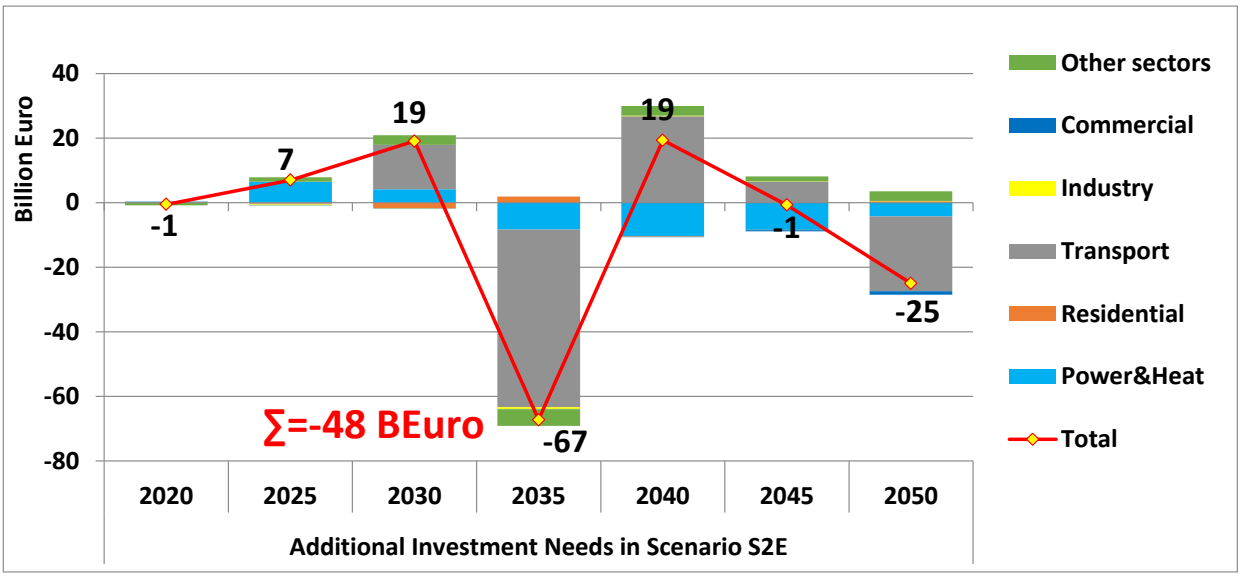

Figure 1.28. Difference between S2E and S2: Investment needs in Energy and IPPU sectors

1.4.7 Scenarios S3E: Other nuclear option

As in scenario S2E, the total GHG emissions will not change, but the structure of emissions will change slightly in 2030 and 2045-2050 (Fig. 1.29).

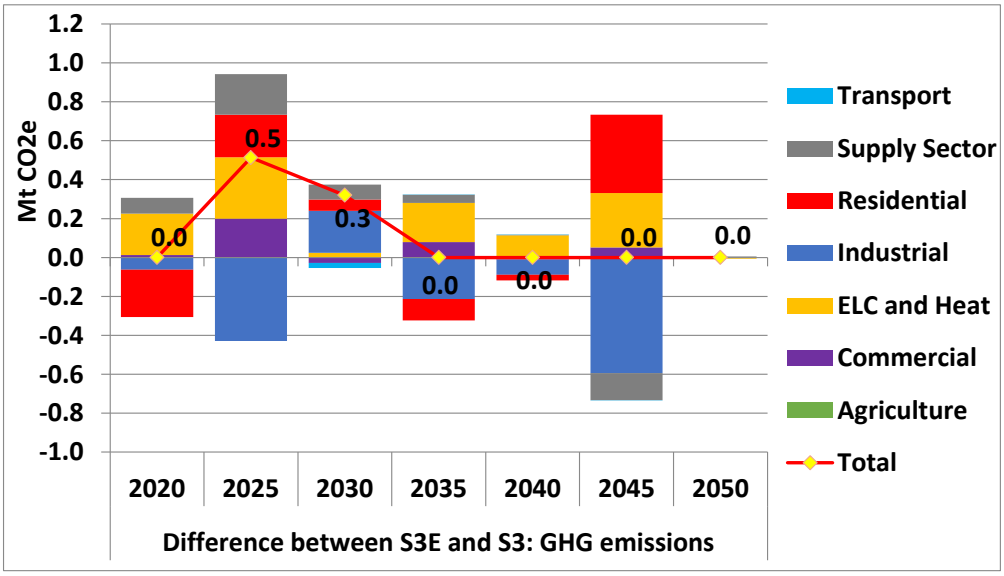

Figure 1.29. Difference between S3E and S3: GHG emissions in Energy and IPPU sectors

The potential electricity generated by the new nuclear units in scenario S3, will be replaced first of all by wind and solar electricity. CCS technologies may also be economically feasible, but the share of power plants with CCS in electricity generation will still be quite small (Fig. 1.30).

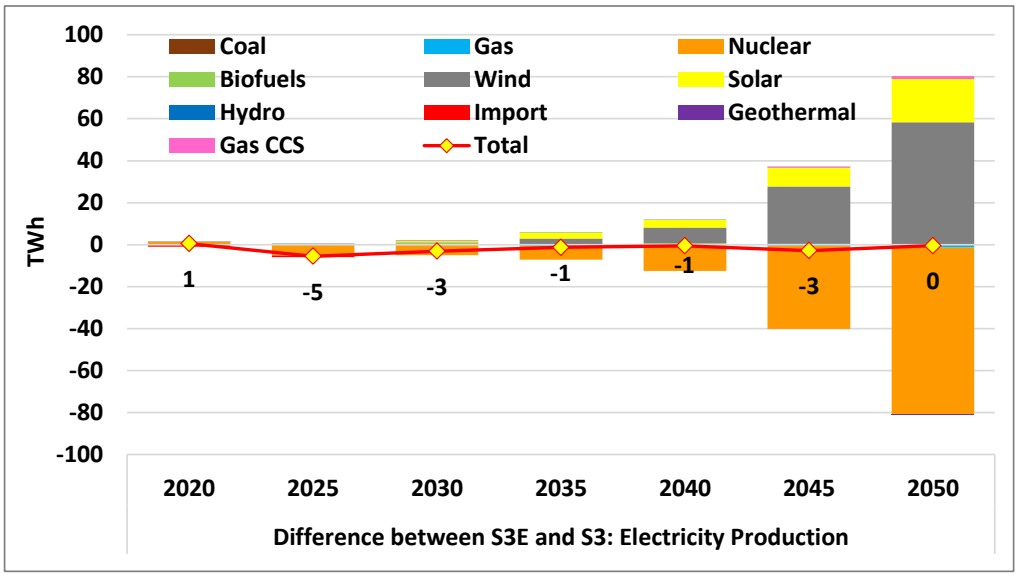

Figure 1.30. Difference between S3E and S3: Electricity production

The total investment needs can be significantly reduced, compared to scenario S3, especially in 2040. In scenario S3 until 2040, a large number of nuclear units are expected to be decommissioned due to their expiration. Continuation of operation of existing NPP units will allow to pass this process more stable, at the same time reducing investment needs (Fig. 1.31).

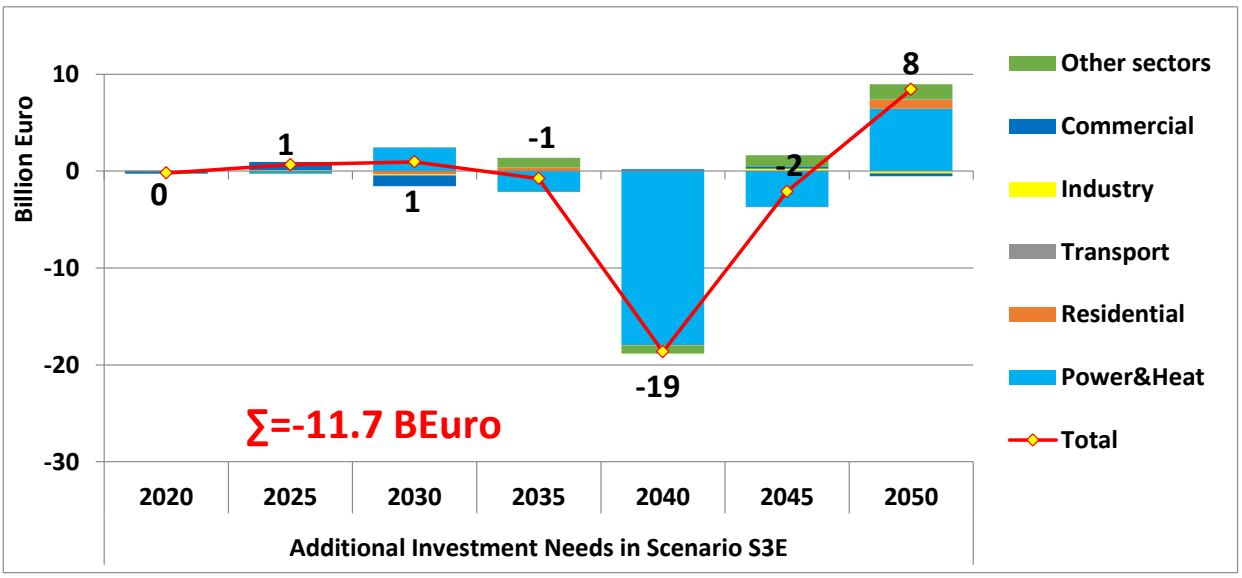

Figure 1.31. Difference between S3E and S3: Investment needs in Energy and IPPU sectors

1.4.8 Scenarios S2F: Balancing capacities

Additional balancing capacity and minimization of their support for wind and solar power plants will not have a significant impact on total GHG emissions (Fig. 1.32).

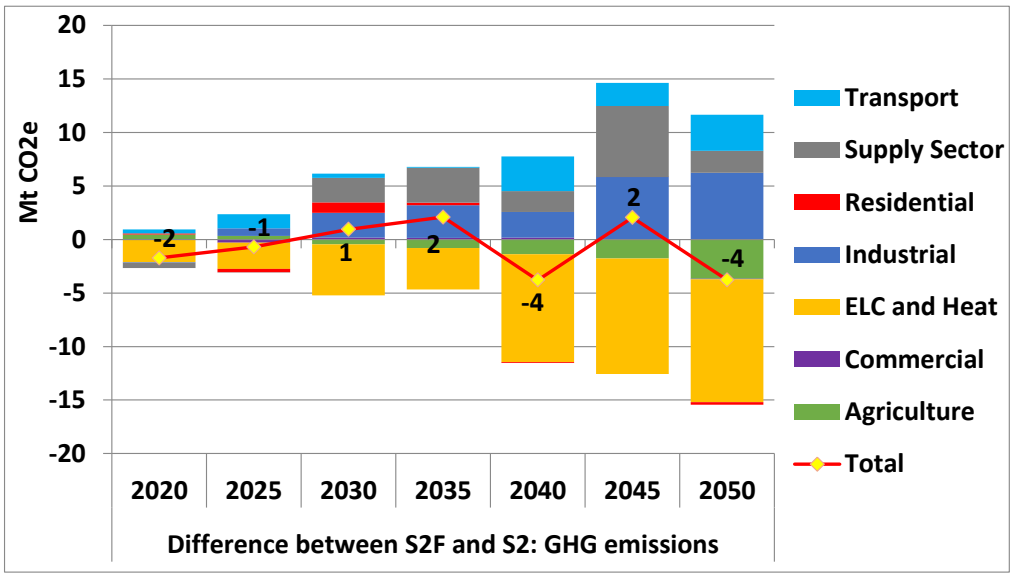

Figure 1.32. Difference between S2F and S2: GHG emissions in Energy and IPPU sectors

Due to reduced need in balancing technologies (hard link), the cost of solar electricity will decrease and it will compete the wind electricity, for which the balancing requirements in scenario S3 are softer. It also will contribute to greater use of solar energy instead of coal and nuclear in electricity production (Fig. 1.33).

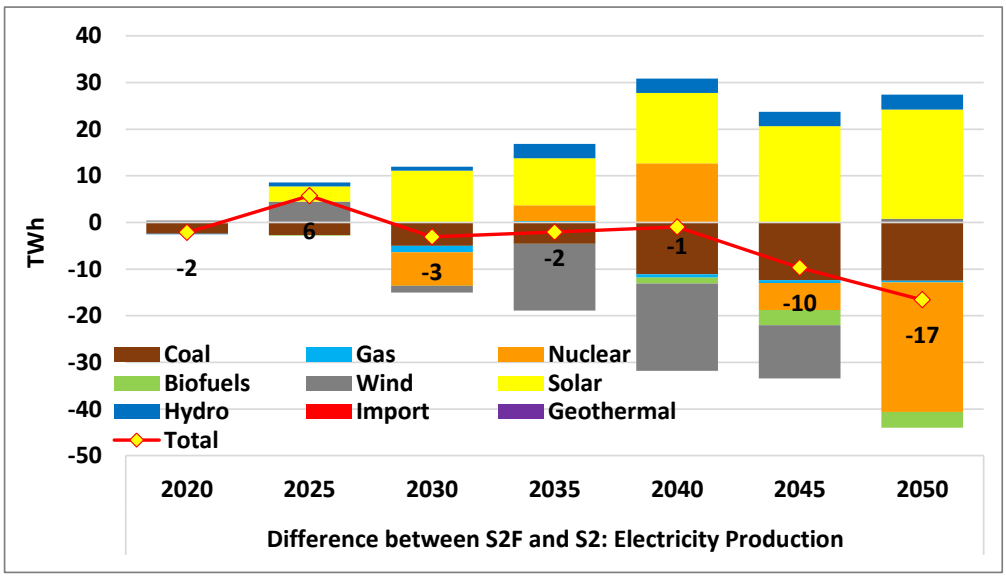

Figure 1.33. Difference between S2F and S2: Electricity production

At the same time, reducing the consumption of carbon-intensive energy resources in the electricity and heat production sector will reduce the need for full decarbonization of the transport sector, and thus investment in the transport sector may be significantly lower. Due to the lower cost of electricity, hydrogen-powered cars may be economically viable after 2030. The investment needs will be reduced by €47 Billion (Fig. 1.34).

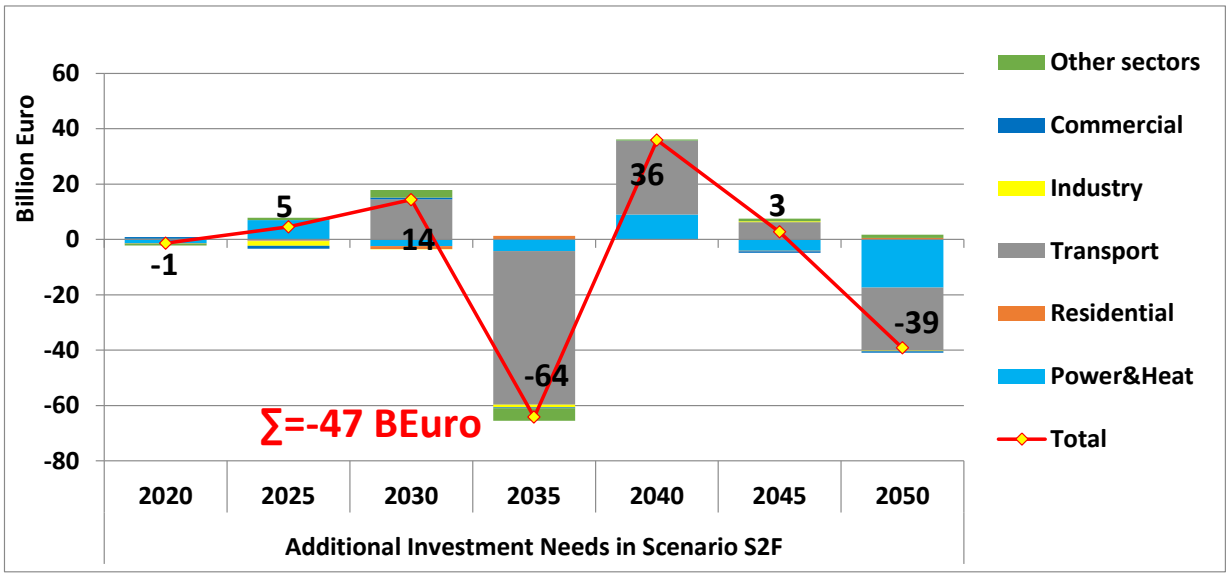

Figure 1.34. Difference between S2F and S2: Investment needs in Energy and IPPU sectors

1.4.9 Scenarios S3F: Balancing capacities

As in scenario S2F, additional balancing capacity and minimization of their support for wind and solar power plants will not have a significant impact on total GHG emissions (Fig. 1.35).

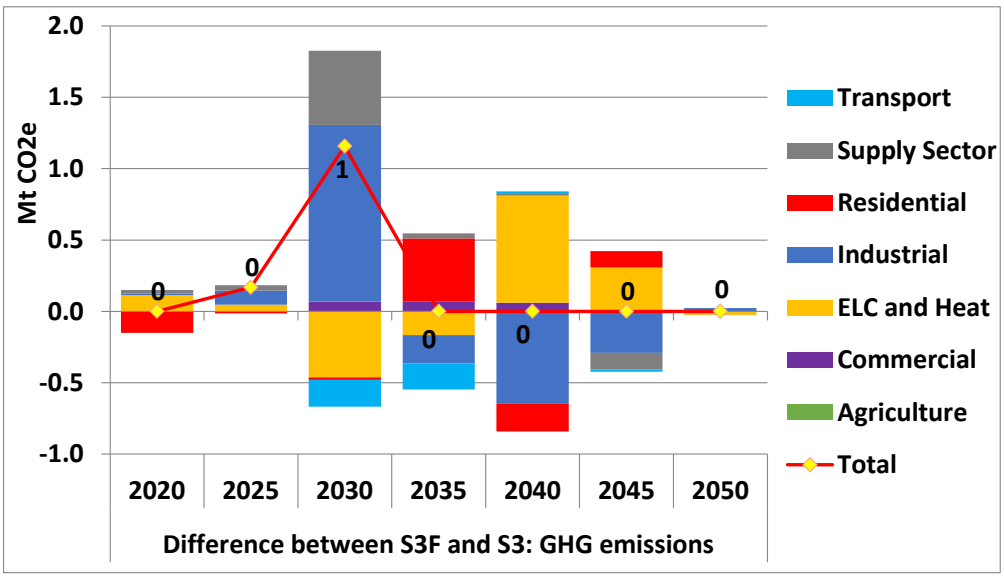

Figure 1.35. Difference between S3F and S3: GHG emissions in Energy and IPPU sectors

Decarbonisation of the energy sector under scenarios S3 and S3F will require a significant increase in electricity production compared to the S1 (Business As Usual) and S2 scenarios, so increasing the balancing capacity and minimizing the requirements for their use for solar and wind energy will not have a significant impact on overall electricity production (Fig. 1.36), but investment needs will decrease (Fig. 1.37).

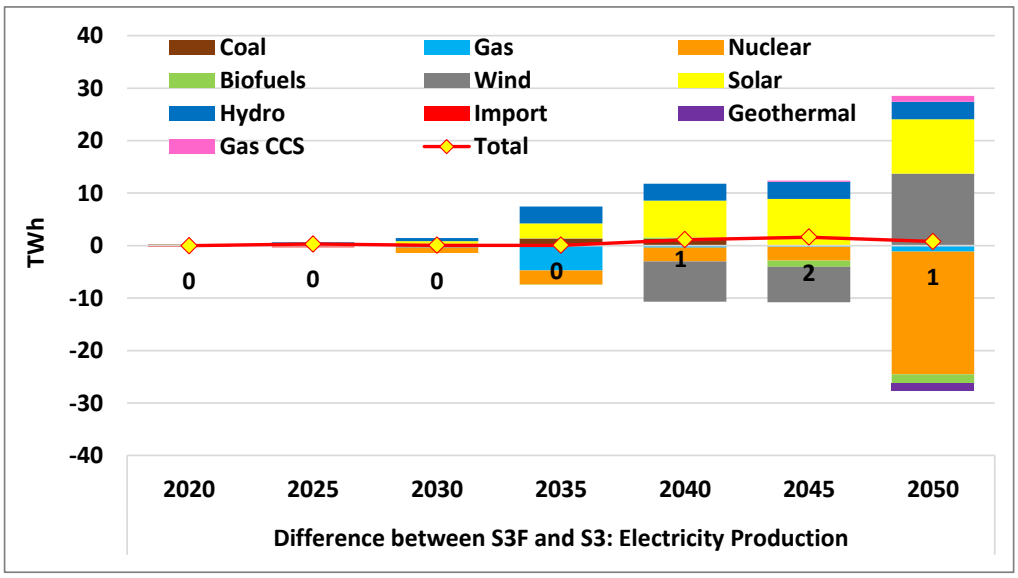

Figure 1.36. Difference between S3F and S3: Electricity production

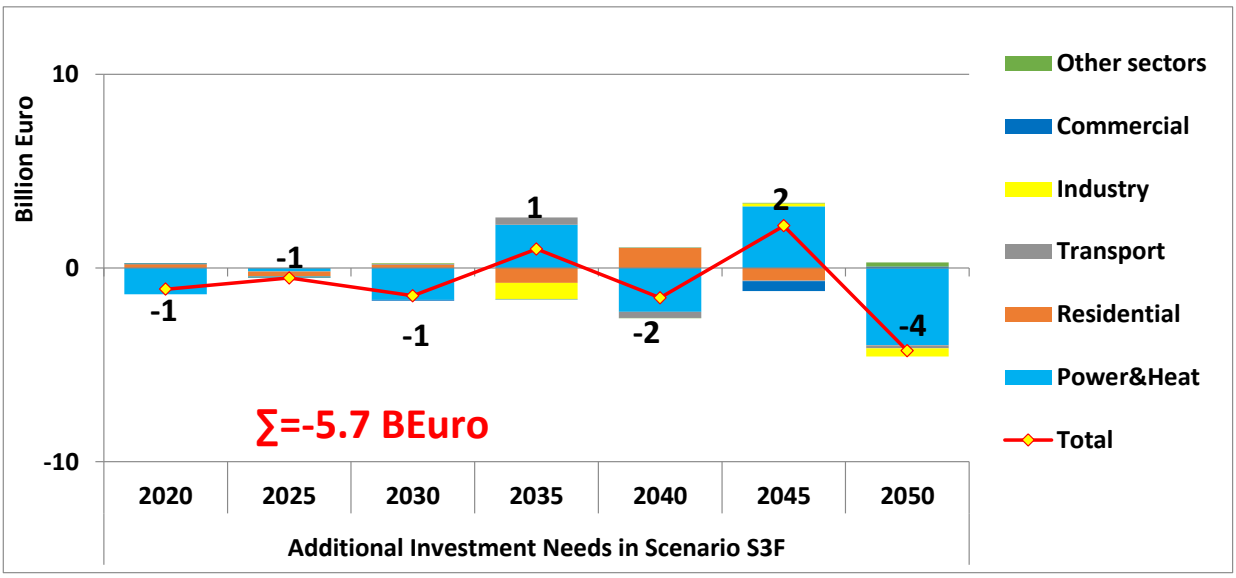

Figure 1.37. Difference between S3F and S3: Investment needs in Energy and IPPU sectors

1.4.10 Scenario S3G: Limited implementation of waste sector policy

Detailed GHG emission modelling results by each scenario are presented in Table 1.3 and also illustrated in absolute units in Fig. 1.38, as well as relative ones in Fig. 1.39.

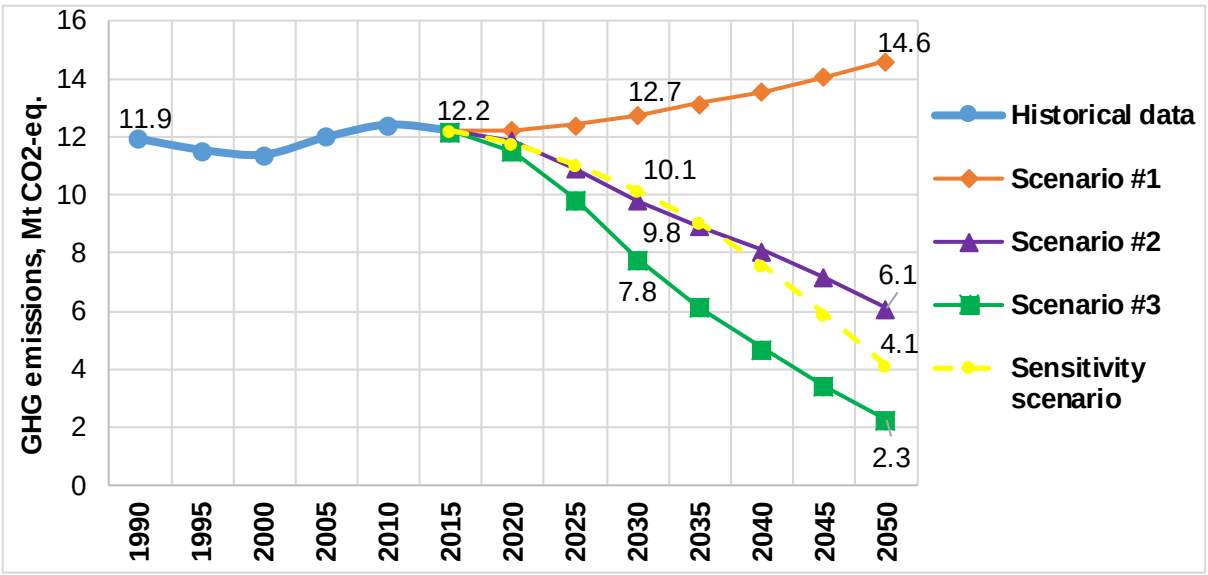

Figure 1.38. Total GHG emissions in Waste sector up to 2050

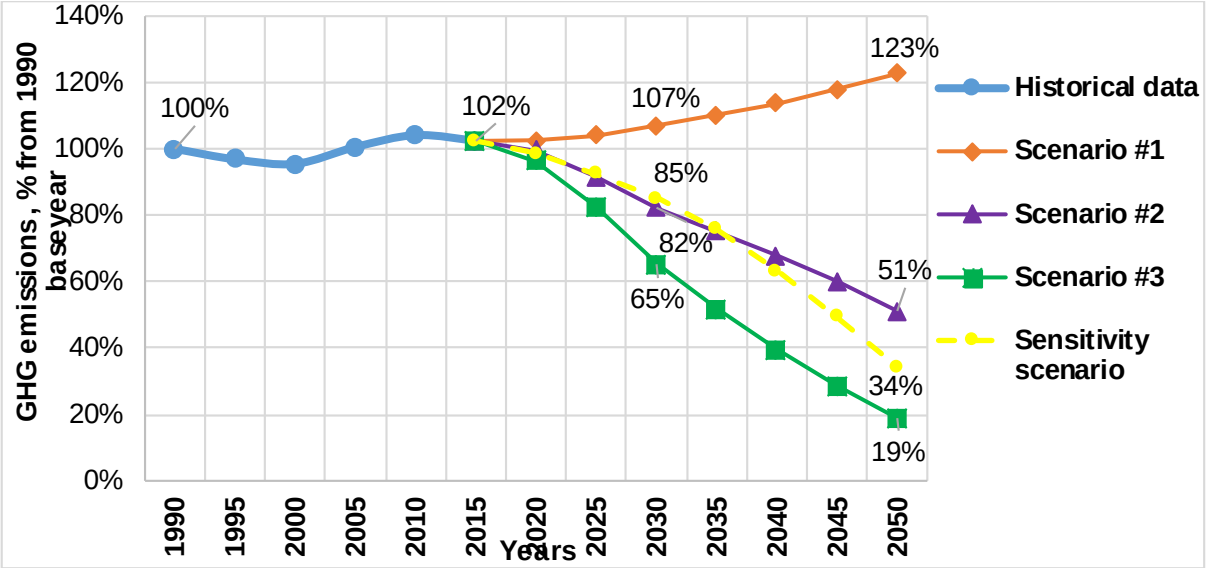

Figure 1.39. Total GHG emissions changes in Waste sector up to 2050, compared to 1990 base year

Table 1.3. GHG emissions in Waste sector by categories, 1990-2050

Emissions (+) and removals (-), kt CO_2 eq.	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Solid Waste Disposal													
Scenario #1	6535	7279	7377	7639	8035	8142	8137	8229	8365	8529	8709	8900	9098
Scenario #2							7883	7125	6235	5651	5121	4626	4153
Scenario #3							7744	6741	5427	4178	3154	2297	1577
Sensitivity S3G							8082	8023	7877	7116	6053	4798	3428
Biological Treatment of Solid Waste													
Scenario #1	34	23	10	5	3	39	28	31	36	42	47	52	59
Scenario #2							107	213	268	256	238	215	185
Scenario #3							108	176	124	118	110	101	90
Sensitivity S3G							46	57	37	56	72	83	90
Incineration and Open Burning of Waste													
Scenario #1	36	31	40	57	59	12	12	14	16	19	22	23	29
Scenario #2							11	13	17	20	23	26	28
Scenario #3							11	13	17	20	23	26	28
Sensitivity S3G							11	13	17	20	23	26	28
Wastewater Treatment and Discharge													
Scenario #1	5318	4215	3963	4293	4323	4017	4044	4135	4325	4549	4783	5076	5436
Scenario #2							3855	3558	3291	3016	2680	2293	1736
Scenario #3							3630	2929	2214	1828	1410	984	558
Sensitivity S3G							3630	2929	2214	1828	1410	984	558
Total Waste sector													
Scenario #1	**11924**	**11548**	**11389**	**11995**	**12420**	**12210**	**12220**	**12409**	**12743**	**13139**	**13560**	**14052**	**14622**
Scenario #2							**11856**	**10910**	**9811**	**8943**	**8063**	**7159**	**6103**
Scenario #3							**11493**	**9858**	**7782**	**6143**	**4697**	**3408**	**2254**
Sensitivity S3G							**11769**	**11023**	**10145**	**9020**	**7557**	**5892**	**4105**

In Table 1.4 presented capital cost needed to implement all scenarios in Waste sector, including data for sensitivity scenario S3G for Waste sector.

Table 1.4. Capital cost needed to implement all scenarios in Waste sector, MEuro

Scenarios	2020*	2025	2030	2035	2040	2045	2050	TOTAL
Scenario #1	37	206	229	251	273	295	316	1,606
Scenario #2	408	2,056	2,080	2,093	2,099	2,104	2,107	12,947
Scenario #3	564	2,845	2,881	2,900	2,910	2,914	2,912	17,925
Sensitivity S3G	222	1,131	1,155	2,925	2,933	2,936	2,934	14,237

* for 2020

1.4.11 Potential implication of the EU border carbon adjustment tax for Ukraine export industries

One of the policy initiatives identified in the European Green Deal, as a possible policy to help with the transition to a more sustainable economy is a Carbon Border Adjustment Mechanism (CBAM)[1]. The main idea behind the CBAM, is to protect domestic (in the particular case, EU) energy-intensive trade-exposed industries by eliminating the competitive advantage enjoyed by exports from countries that do not tax carbon emissions or impose lower carbon taxes compared to the EU. Such tariffs would also create incentives for non-carbon taxing countries to adopt carbon taxes, avoid carbon leakage and limit the reallocation of the EU-based industries to the countries with less stringent climate regulations. Carbon border adjustment mechanism (CBAM) could be implemented in the form of import fees levied by EU on goods manufactured in non-carbon-taxing countries.

CBAM can be implemented in several different ways and as of March of 2021 details of such implementation are not available. These include sectoral/commodity coverage and specifics of the approach for carbon content accounting. Compatibility of the CBAM with the World Trade Organization (WTO) rules could be considered as one of the major potential obstacles. Several studies suggest that theoretically it is possible to design the WTO-compatible CBAM, but a number of complications could arise and lead to the WTO disputes (Eichenberg, 2010[2]; Hillman, 2013[3]; Krenek, 2020[4]).

Ukraine, as one of the countries with less stringent climate regulations than the EU, faces a real perspective that the CBAM would be imposed on country's exports to EU. As of the 2020, Ukrainian enterprises that emit over 500 tCO_2-eq. are facing the tax of around \$0.4/ton of CO_2 (SFSU, 2020[5]), which is much lower than the 2019 EU average carbon tax of \$28/ton (Osterloh, 2020[6]). As of 2019, EU accounted for over 41% of Ukraine's total commodity exports. EU is the major destination for the exports of selected Ukraine's energy and carbon intensive commodities, such as ferrous metals (36%

[1] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-EU-Green-Deal-carbon-border-adjustment-mechanism-

[2] Eichenberg. M.B. 2010. Greenhouse gas regulation and border tax adjustments: the carrot and the stick. Golden Gate Univ. Environ. Law J., 3 (2).

[3] Hillman, J. 2013. Changing Climate for Carbon Taxes: Who's Afraid of the WTO? Climate & Energy Policy Paper Series. The German Marshall Fund of the United States. https://www.scribd.com/document/155956625/Changing-Climate-for-Carbon-Taxes-Who-s-Afraid-of-the-WTO#download

[4] Krenek, A. 2020. How to implement a WTO-compatible full border carbon adjustment as an important part of the European Green Deal. ÖGfE Policy Brief 02'2020. https://www.scribd.com/document/155956625/Changing-Climate-for-Carbon-Taxes-Who-s-Afraid-of-the-WTO#download

[5] State Fiscal Service of Ukraine (SFSU). 2020. Tax Code of Ukraine. Section VIII. Ecological tax. http://sfs.gov.ua/nk/rozdil-viii--ekologichniy-poda/

[6] Osterloh, S. 2020. The implications of fiscal measures to address climate change. ECB Economic Bulletin, Issue 2/2020. https://www.ecb.europa.eu/pub/economic-bulletin/focus/2020/html/ecb.ebbox202002_04~a7d137cb35.en.html

of total exports), preparations of ferrous metals (42%), aluminum (57%), mineral products (55%), chemical products (29%), machines and equipment (63%), etc.

Methodological framework. To provide an assessment of the possible implications of the EU CBAM tax on Ukrainian economy, we employ the Global Trade Analysis Project (GTAP) 10 Data Base model (Aguiar et al., 2019[7]). The GTAP 10 Data Base presents a snapshot of the world economy for the 121 countries and 20 aggregate regions for each of the four benchmark years: 2004, 2007, 2011, and 2014 (Annex A). Economy of each region is represented with 65 sectors (Annex B). All regions in the GTAP Data Base are linked with bilateral trade flows, including trade in goods and services. Ukraine is represented as a separate country in the GTAP Data Base. In terms of energy and emission accounting, the GTAP 10 Data Base incorporates extended energy balances from the International Energy Agency (IEA) for each country/region and reference year. GTAP also reports CO_2 emissions from the fossil fuels combustion. Non-CO_2 greenhouse gas emissions, as well as air pollution accounts are also available in the GTAP 10 Data Base format (Aguiar et al., 2019), but those were not used in the current assessment.

For the assessment of the impact of BCA tax we rely on the GTAP-E model, which is a static multi-region computable general equilibrium (CGE) model (McDougal and Golub, 2007[8]). As an extension of the standard GTAP model it introduces capital-energy and energy-energy substitution to the modelling framework. The GTAP-E model also provides a carbon accounting and allows introduction of carbon taxes, quotas and emission trading.

To provide an accounting of the CO_2 emissions embodied into bilateral trade, we follow an approach outline in Peters (2008) and applied to GTAP 10 Data Base in Aguiar et al. (2019). Country-specific CO_2 emissions per unit of output by sectors are used to estimate emissions associated with bilateral trade flows, including exports from Ukraine to the EU. This method assumes that in a given sector and country, the same production technology is used to produce domestic and exported commodities. This allows to decompose emissions from domestic output into components associated with the domestic demand and exports. For every commodity, the total CO_2 emissions associated with fossil-fuels combustion and embodied in trade flows from region r to region s (f_{rs}) are estimated as:

$$f_{rs} = F_r(E - A_r)^{-1}e_{rs},$$

where F_r is a vector of region-specific CO_2 emissions per unit of output by industries, E is an identity matrix, A_r is the technological matrix, which represents the industry requirements of domestically produced products in region r and e_{rs} corresponds to the bilateral trade flow from region r to region s.

CO_2 emissions embodied into trade flows are further aggregated to 20 regions and 22 sectors used in the policy simulation. Annex A provide corresponding regional and sectoral mappings. In such a way we estimate emissions embodied into commodities exported from Ukraine to EU (as well as other regions) through the whole value chain. For instance, CO_2 emitted by the coal power plant to produce electricity, which was further used to produce iron and steel for exports would be embodied into the exports of iron and steel.

[7] Aguiar, A., Chepeliev, M., Corong, E., McDougall, R., and van der Mensbrugghe, D. 2019b. The GTAP Data Base: Version 10. Journal of Global Economic Analysis. v. 4, n. 1, p. 1-27, June 2019. ISSN 2377-2999. https://jgea.org/resources/jgea/ojs/index.php/jgea/article/view/77

[8] McDougal, R. and Golub, A. 2007. GTAP-E: A Revised Energy-Environmental Version of the GTAP Model. GTAP Research Memorandum No. 15. https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2959

Overview of the EU-Ukraine trade and embodied emissions. For the CBAM impacts assessment, we assume that the sectors that are covered by the EU emissions trading system (ETS) are those that would face the tax (EU, 2015[9]). In our sectoral aggregation (Annex A), there are seven sectors that correspond to the EU ETS industries. As of 2014, which is the latest available reference year in the GTAP 10 Data Base, Ukraine exported over 5.6 bn USD of commodities corresponding to the EU ETS sectors (Figure 1). Around 70% of this value is coming from the exports of ferrous metals. Furthermore, ferrous metals also have the largest share of exports to EU in the total Ukraine's output among analyzed commodity groups, as over 20% of metal and steel produced in Ukraine was exported to EU. Chemical products is the second largest category of Ukraine's exports to EU and accounts for over 15% of the ETS commodities export (Fig. 1.40).

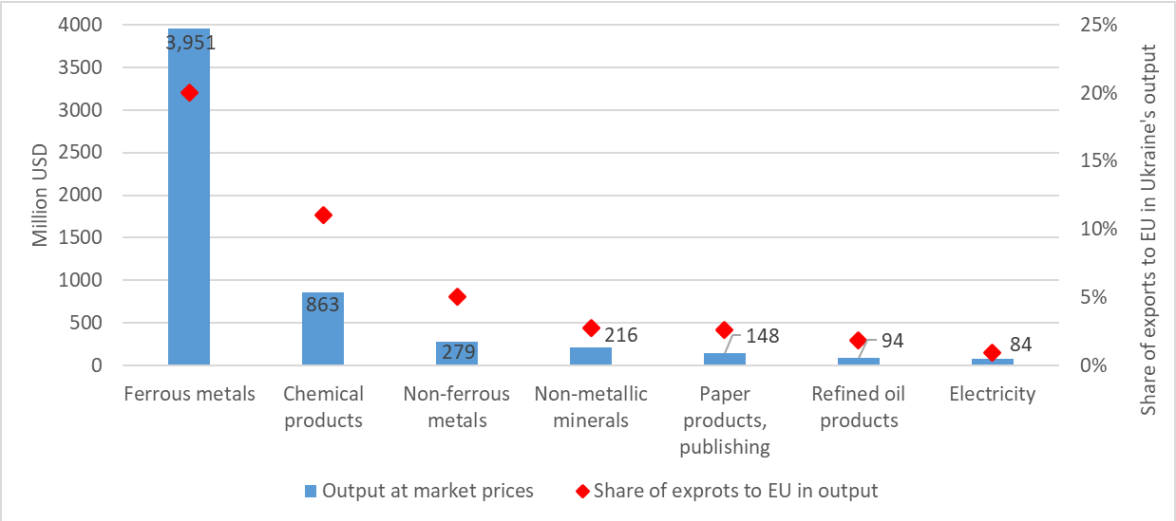

Figure 1.40. Exports from Ukraine to EU in 2014 for EU ETS sectors, mln USD

Source: estimated by authors based on Aguiar et al. (2019).

In terms of emissions embodied into exports ferrous metals also represents by far the largest group, with almost 10.6 million tons of CO_2 exported to EU (Figure 2). Although the value of electricity exports is the lowest among analyzed commodity groups (Fig. 1.40), due to the high carbon intensity of electricity generation, it is the second largest commodity group in terms of emissions embodied into Ukraine's exports to the EU (Fig. 1.41). Due to the differences in technologies and composition of the analyzed commodity groups in the Ukraine and EU, carbon intensities of production largely differ between these two regions. And while in the case of electricity Ukraine's carbon intensity is only two times higher than in the EU, in the case of ferrous metals the difference is almost nine times (Fig. 1.41). This fact could significantly impact the assessment of the possible implications of the BCA tax. Depending on whether Ukraine's or EU's carbon intensity is used to impose the CBAM tax, corresponding ad valorem equivalent rates would largely vary – by nine times in the case of ferrous metals, thus leading to different changes in consumer prices. In the next section both these options are discussed and modelled. It should be noted that the aggregation bias might impact carbon intensity estimates and comparisons, as each of the considered sectors includes a set of commodities characterized by different carbon intensities. The commodity composition of each sector differs by countries and regions.

[9] European Union. 2015. EU ETS Handbook. https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf

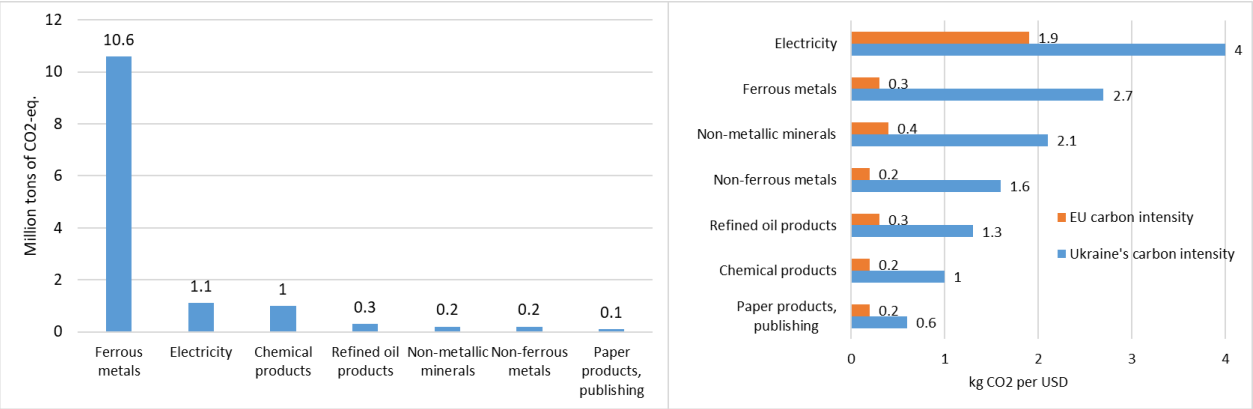

Figure 1.41. Emissions embodied into trade and carbon intensity of the selected commodities

Source: estimated by authors based on Aguiar et al. (2019).

Policy scenarios and simulation results. For the CBAM policy assessment, we assume that the EU27 imposes CBAM on imports from all countries and regions, including Ukraine. UK and the European Free Trade Association (EFTA) countries (Norway, Iceland, Liechtenstein and Switzerland) do not impose or face CBAM. The mechanism is planned to be imposed in the form of ad valorem equivalent on imports of commodities that belong to the EU ETS sectors. To calculate the corresponding tax rate average ETS tax for 2019 was estimated and then converted to the $2014 to match the latest reference year of the GTAP 10 Data Base. Thus, the tax rate is $26/t$CO_2$-eq. Equivalent import tax is estimated based on the emissions embodied into exports. We consider two options of the carbon content:

a) Based on the emissions intensity of the exporting country;

b) Based on the emissions intensity of the EU27.

Depending on whether Ukraine's or EU's content is used to estimate the ad valorem equivalent, corresponding import taxes vary significantly (Fig. 1.42). For instance in the case of ferrous metals under the Ukraine's carbon intensity CBAM tax is estimated to be 6.6%, while under EU carbon content the tax is 0.7% – more than nine times lower.

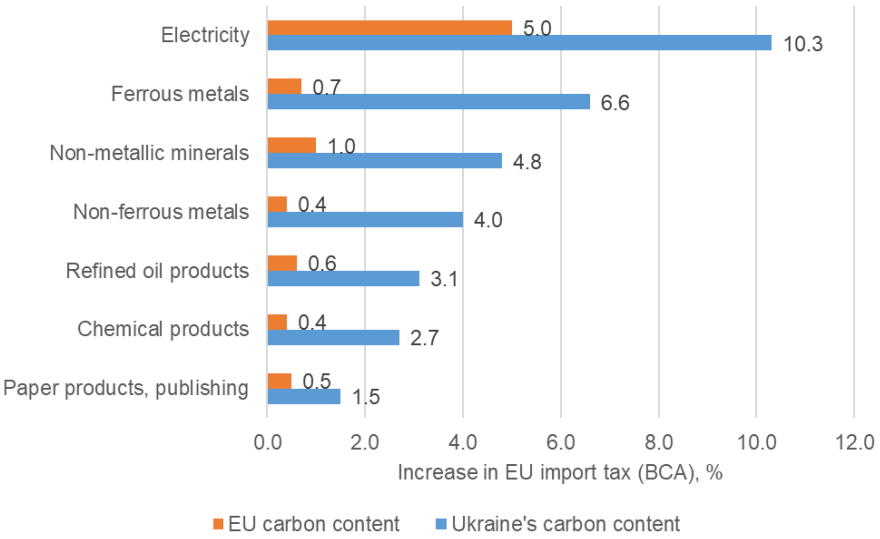

Figure 1.42. Ad valorem equivalents of the CBAM tax under EU and Ukraine's carbon content assumptions

Source: estimated by authors.

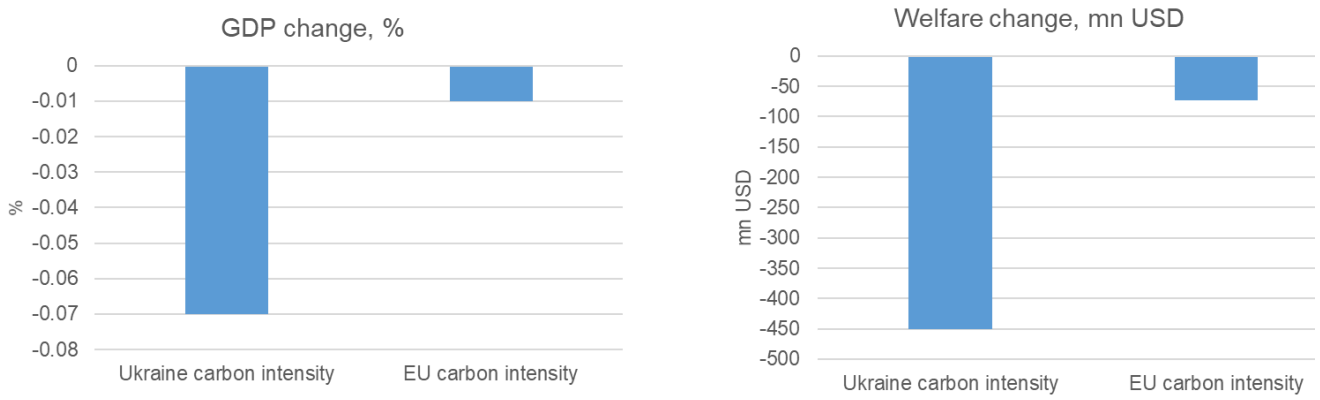

Figure 1.43. Macroeconomic impacts of EU's CBAM on Ukraine

Source: estimated by authors.

In terms of macro implications of the CBAM tax, estimates suggest that there are no significant negative impacts, as even under Ukraine's carbon intensity assumption GDP falls by less than 0.1%, while welfare reduces by 450 mn USD (Fig. 1.43). Much smaller impacts are observed under EU's carbon content assumption, as Ukraine's GDP barely changes.

Aggregate output also almost does not suffer with total change of around -0.002% under both carbon intensity cases. At the sectoral level ferrous metals suffer the most with output volumes reduction reaching almost 4% under the Ukraine's carbon content case, this reduces to only 0.3% reduction under EU's carbon intensity assumption (Fig. 1.44). Refined oil production and electricity are two other sectors that suffer the most in terms of output behind the ferrous metals. At the same time, reduction in output in these energy intensity and trade exposed sectors are almost fully compensated by increasing output in some other manufacturing activities that do not face CBAM, such as motor vehicles, other machinery and other manufacturing (Fig. 1.44). The magnitude of impacts is on average 5-6 times lower under the EU's carbon content case than under the Ukraine's carbon intensity assumption.

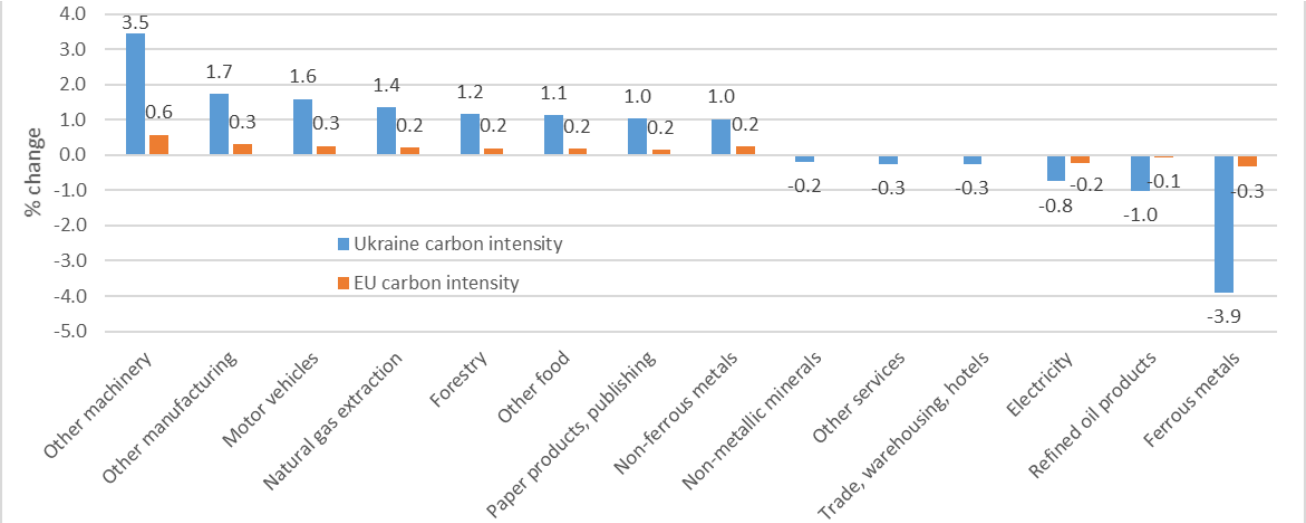

Figure 1.44. Changes in Ukraine's sectoral output due to the EU's BCA tax imposition

Source: estimated by authors.

On the trade side, electricity, ferrous metals, refined oil products and chemical products suffer the most (Fig. 1.45). And while in the case of electricity exports falls by almost 12% (under Ukraine's carbon content

case), this does not significantly impact electricity producers, as the share of electricity exports in total output is relatively low (Fig. 1.44). Ferrous metals on the contrary is a major category of Ukraine's exports with a potential of significant adverse impacts on domestic producers.

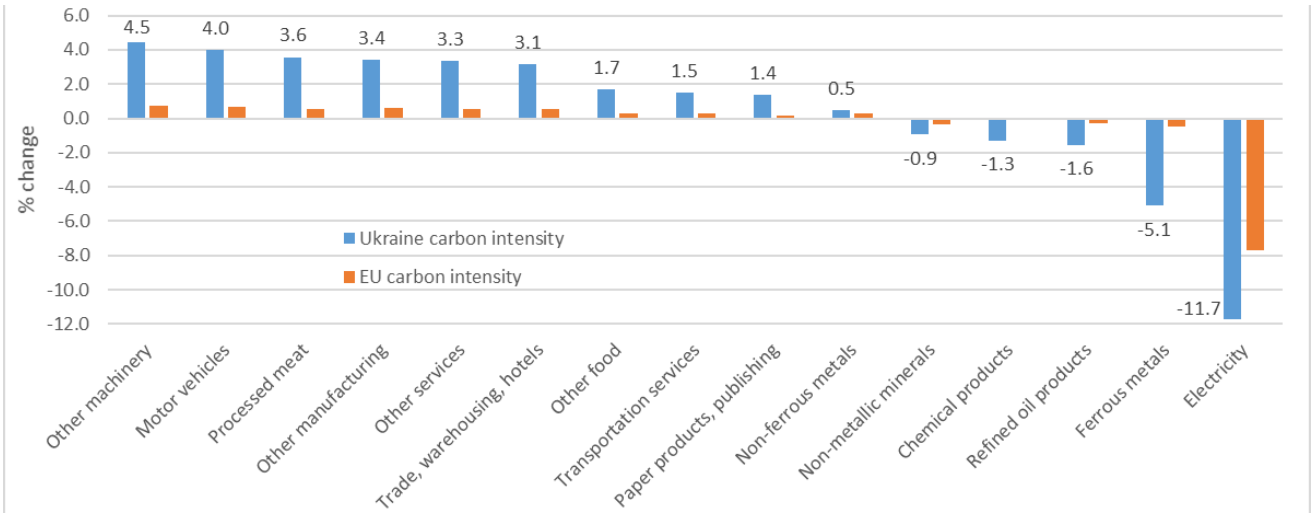

Figure 1.45. Changes in Ukraine's exports due to the EU's BCA tax imposition

Source: estimated by authors.

But while the exports of ferrous metals to EU indeed suffers substantially – reduction of 25.8% under the Ukraine's carbon content case, a significant redirection of the ferrous metals exports is observed (Fig. 1.44). Depending on the trading partner, exports of the ferrous metals increase by 2.2%-4.4%. As a result, under the case of Ukraine's carbon intensity, around 29% of exports lost to EU is reallocated to other destinations, meaning that while ferrous metals exports to EU fall by around $1020 mln, exports to other regions increases by $296 mln. The reallocation share is even higher under the EU's carbon intensity case, where it reaches 42%. Impacts on export volumes are much lower under the EU's carbon intensity case (compared to the Ukraine's carbon content assumption), as the aggregate Ukraine's ferrous metals export falls by only 0.5%, with a reduction in exports to EU of around 2.9%.

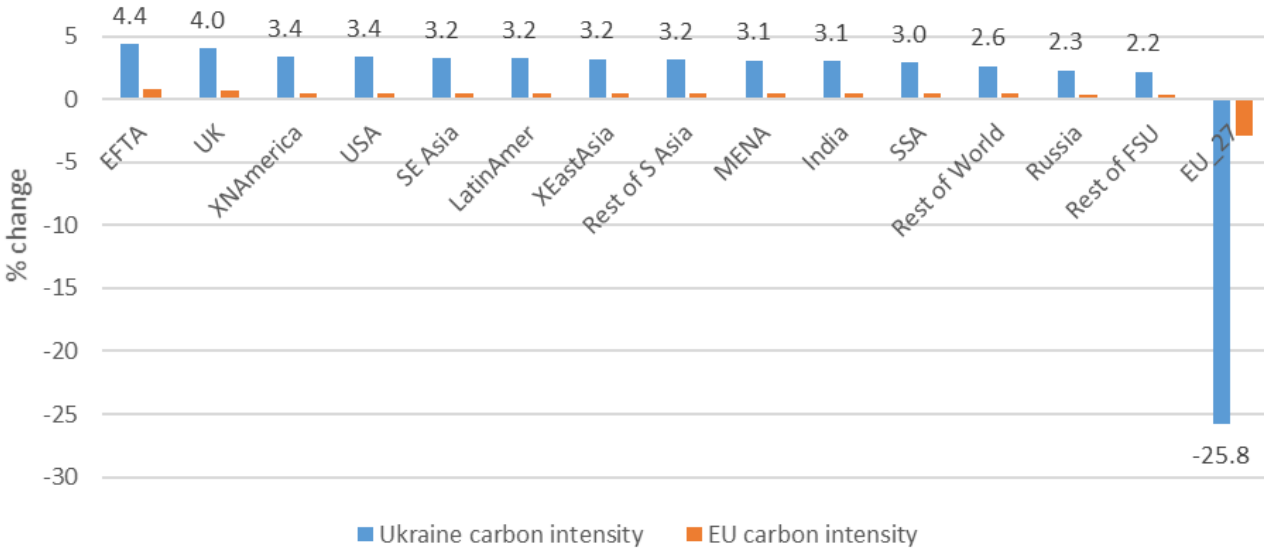

Figure 1.46. Changes in Ukraine's exports of ferrous metals by destinations due to the EU's CBAM tax imposition

Source: estimated by authors.

Conclusions. Although there is still high uncertainty regarding the possible implementation of the Carbon Border Adjustment Mechanism by the European Union, in this Chapter we made some plausible assumptions and provided a preliminary assessment of the possible implications of such measures on Ukrainian economy. In particular, we considered an imposition of the \$26/tCO_2-eq., equivalent to the average 2019 EU ETS carbon price.[10] We explored impacts of such CBAM on Ukrainian economy under two carbon content assumptions – Ukraine's and EU's – and the CBAM was imposed on the commodities belonging to the EU ETS sectors only.

Simulations suggest that the ***imposition of the CBAM does not have any major negative impacts on Ukrainian economy***, as the reduction in GDP is between -0.07% and -0.01%, while welfare reduces between -\$451 mn and -\$74 mn, depending on the carbon content assumption. ***Results*** though ***significantly vary depending on whether EU's or Ukraine's carbon intensities are considered*** to determine CBAM various indicators. As the EU's carbon intensities are on average 5-6 times lower than the Ukraine's ones, negative impacts are also much lower in the former case. ***Iron and steel sector*** is associated with 80% off all CO_2 emissions exported from Ukraine to EU (in the ETS sectors) and ***suffers the most*** from CBAM introduction. At the same time, as other non-EU countries (except UK and EFTA) also face CBAM, there is a ***redirection of exports*** from EU to these other destinations, which ***reduces potential export losses***. Aggregate Iron and Steel exports from Ukraine fall between -5.1% and -0.5%, while exports to EU fall between (-2.9% and -25.8%).

While in the current assessment we tried to incorporate the best available information on the possible set up of the CBAM, a number of uncertainties underlie our analysis, which could impact the simulation results. ***First,*** there is an uncertainty regarding sectoral/commodity coverage of the CBAM . While we assumed that the tax is imposed on sectors covered by the EU ETS, it might not be the case. ***Second,*** it is not clear what would be an approach to the carbon content estimation and whether it would be implemented at the commodity level, averaged over different producers or made produced-specific. In our analysis, we estimated emissions embodied into trade at the sectoral level. Sectors that we use include many individual commodities with potentially different carbon content. Assessment of the CBAM policies at the commodity level might provide additional insights into the impact of this policy. ***Third,*** there is an uncertainty regarding the regional source of the carbon content estimates, as either exporting or importing country can be used to estimate the carbon intensity. On average EU's carbon intensity for the considered sectors is much lower than the one in Ukraine. As a result equivalent CBAM is from 2 to 10 times lower under the EU's carbon content assumption, which significantly impacts the magnitude of the results. ***Finally,*** in the model we make some specific assumptions regarding substitution possibilities, in particular, possibilities to switch from one export destination (EU) to other destinations. Additional sensitivity analysis regarding values of these parameters might provide additional insights into the possible implications of the CBAM on Ukrainian economy.

While this report has been developing, there are other assessments and reports of potential implications of CBAM introduction on Ukrainian economy that have been conducted and presented, including the assessment conducted by Ukrainian consulting company "GMK Center" that was

[10] This tax is equivalent to the average EU ETS 2019 carbon price, converted to the \$2014.

presented and discussed during number of governmental and industry and business association strategic events. Based on the assessment of GMK Center "*as a result of CBAM introduction, additional payments of Ukrainian companies exporting to EU may increase by EURO 566.3 million per annum. Almost 94% of that amount will be a burden of steelmaking and power companies*"[11].

1.5 COMBINED SENSITIVITY SCENARIO

The combined sensitivity scenario was developed on the basis of key scenarios with the addition of sensitivity options (see Section 1.3 above), which help to minimize investment needs and optimize them, increase the share of renewable energy, maintain the long-term goal of climate policy - achieving a carbon-neutral economy until 2070 in line with the Paris Agreement.

The combined scenario was modelled on the baseline economic development scenario, including the conditions of Scenarios 2 for the sectors of agriculture and land use, land use change and forestry (LULUCF), as well as the sensitivity options, such as:

- Carbon tax
- New trajectory of greenhouse gas emissions limits until 2050
- Higher (global, European) capital investments for the construction of new nuclear power plants units
- Extension of the lifetime of existing nuclear power plants units
- Current availability factor for existing and new nuclear power plants units
- Lower balancing capacity requirements
- Limited implementation of waste sector policy inputs

1.5.1 General modelling results

Combined sensitivity scenario forecasts that GHG emissions (including LULUCF sector) will be relatively the same as in Scenario 3 during the period of 2020-2040 and less in 2045-2050 according to the input assumptions, reaching 14-15% of the 1990 level in 2050. This GHG emission pathway in the Combined Sensitivity Scenario corresponds to the IEA scenario (Fig. 1.47).

[11] https://gmk.center/wp-content/uploads/2020/09/Assessed_impact_of_the_carbon_border_adjustment_mechanism_on_Ukrainian_compressed.pdf

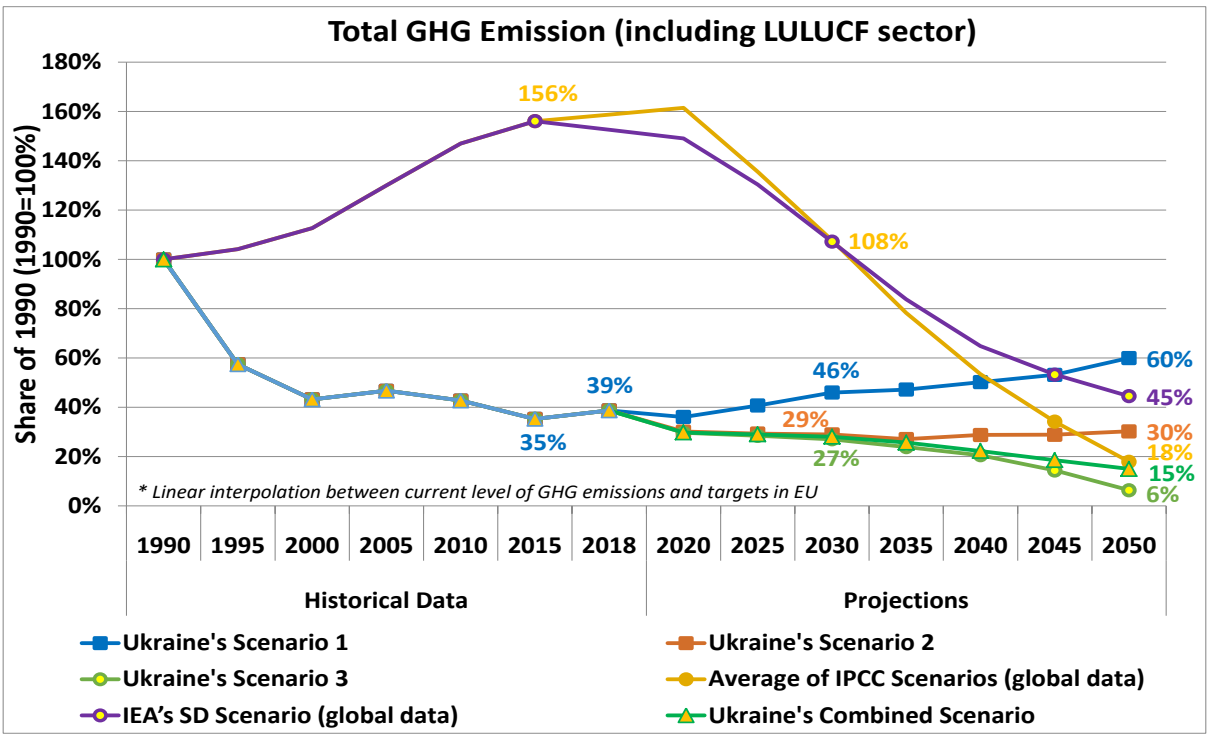

Figure 1.47. Total Ukraine's GHG Emissions Pathways

Fig. 1.48 shows how Ukraine's previous climate commitments (presented in 1st and 2nd periods of Kyoto Protocol, the first NDC, Energy Strategy of Ukraine until 2035 and Low Emission Development Strategy until 2050) corresponded to GHG emission statistics and how the Combined Sensitivity scenario corresponds to the trajectory of carbon neutrality in 2070. In addition, Fig. 1.48 shows how much more the EU and Poland need to do in particular to achieve their new goals and that the goal of achieving carbon neutrality is an easier task for Ukraine.

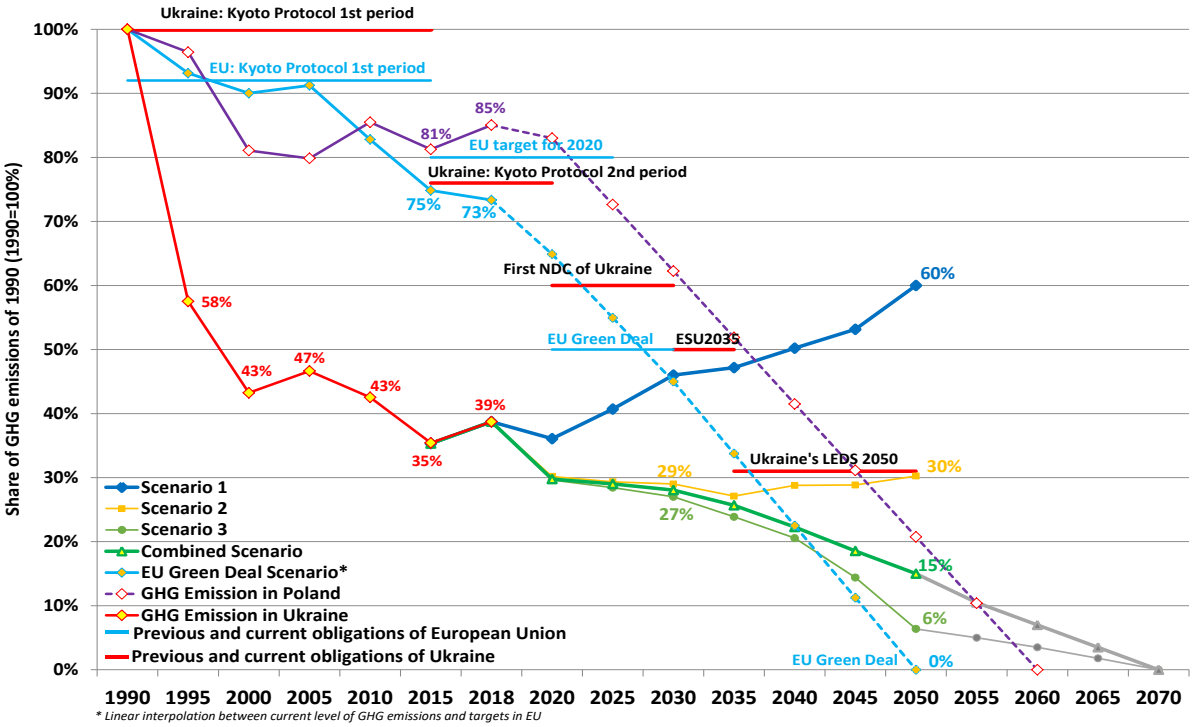

Figure 1.48. GHG Emissions Scenarios and Targets in Ukraine, EU and Poland

As shown in Fig. 1.49 investment needs excluding consumer spending (top left) in the Combined sensitivity scenario will be approximately at the level of Scenario 2, while in Scenario 3 they are significantly higher, and particularly high investment needs in 2050 in Scenario 3 (top right), which was one of the reasons for developing the Combined sensitivity scenario. Total system cost (excluding the cumulative amounts of CO_2 tax) for the period 2020-2050 more-less the same for each four scenarios (bottom left). Moreover, the total system costs of the Combined sensitivity scenario are lower than in Scenario 2 and only by 0.3% higher than in Scenario 1 (bottom right), which means that the implementation of a climate-neutral policy may be about the same as business as usual policy.

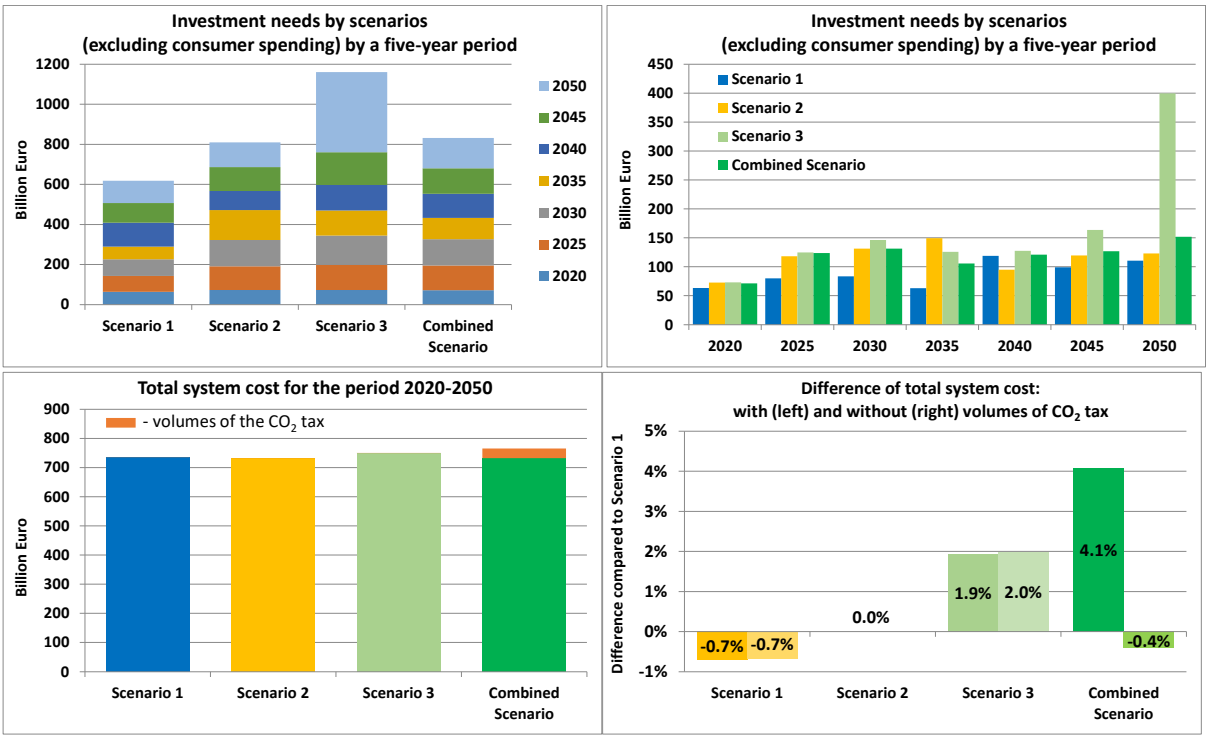

Figure 1.49. Ukraine's NDC2 Scenarios: Investment Needs Assessment[12]

Table 1.5 presents GHG emissions and investment needs (including consumer spending) in 2030 and 2050 by key IPCC sectors and economic subsectors.

Table 1.5. GHG Emissions and Investment Needs in Combined scenario

	Historical Data			Combined Sensitivity Scenario			
	GHG emissions, Mt CO2e			GHG emissions, Mt CO2e		Investment Needs, Billion Euro	
	1990	2015	2018	2030	2050	2021-2030	2021-2050
TOTAL (Net Emissions)	**883**	**313**	**342**	**247**	**130**	**379**	**1164**
1+2. Energy + Industrial processes and product use	843	267	282	210.7	114.0	370.3	1143.1
*Electricity and Heat**	*273*	*90*	*99*	*52.9*	*2.4*	*26.0*	*138.5*

[12] Investment here includes only the cost of energy production and use technologies, some of which can be interpreted as final consumer costs, production or other costs. The total cost of energy system operation is the sum of discounted annual capital investment (including service life), operational costs, costs of production and supply (import) of energy resources, taxes and subsidies (e.g. CO2 tax and "green tariffs"), etc. but it does not include population utilities or coal mines state support.

	Historical Data			Combined Sensitivity Scenario			
	GHG emissions, Mt CO2e			GHG emissions, Mt CO2e		Investment Needs, Billion Euro	
	1990	2015	2018	2030	2050	2021-2030	2021-2050
*Industry**	*229*	*75*	*75*	*81.3*	*79.4*	*37.3*	*130.7*
Buildings, ***	*98*	*29*	*28*	*21.5*	*7.5*	*85.7*	*266.2*
Transport, ***	*112*	*31*	*35*	*20.1*	*12.2*	*208.3*	*578.1*
*Supply Sector**	*127*	*41*	*46*	*31.8*	*12.2*	*10.8*	*23.7*
*Agriculture**	*3.8*	*0.3*	*0.4*	*3.1*	*0.3*	*2.2*	*5.9*
3. Agriculture	87	39	44	38	36	4.0	3.6
4. Land Use, Land-Use Change and Forestry	-59	-6	3	-12	-24	2.9	2.6
5. Waste	12	12	12	10	4	2.3	14.2
Others	0.1	0.4	0.5	0	0	0	0

** Economic sectors, ** Investment Needs include the cost of consumers spending to buying private vehicles, advanced efficiency equipment's (washing machines, refrigerators, individual heat boilers etc.) and others.*

Although GHG emission reductions under the Combined Scenario are greater than under the Scenario, the investment needs (with consumers spending) are approximately the same (Fig. 1.50-1.51), at the same time the share of RES in the electricity production in 2050 is almost twice as high (86% vs. 45%), and in TPPs – more than 2.5 times (53% vs. 20%).

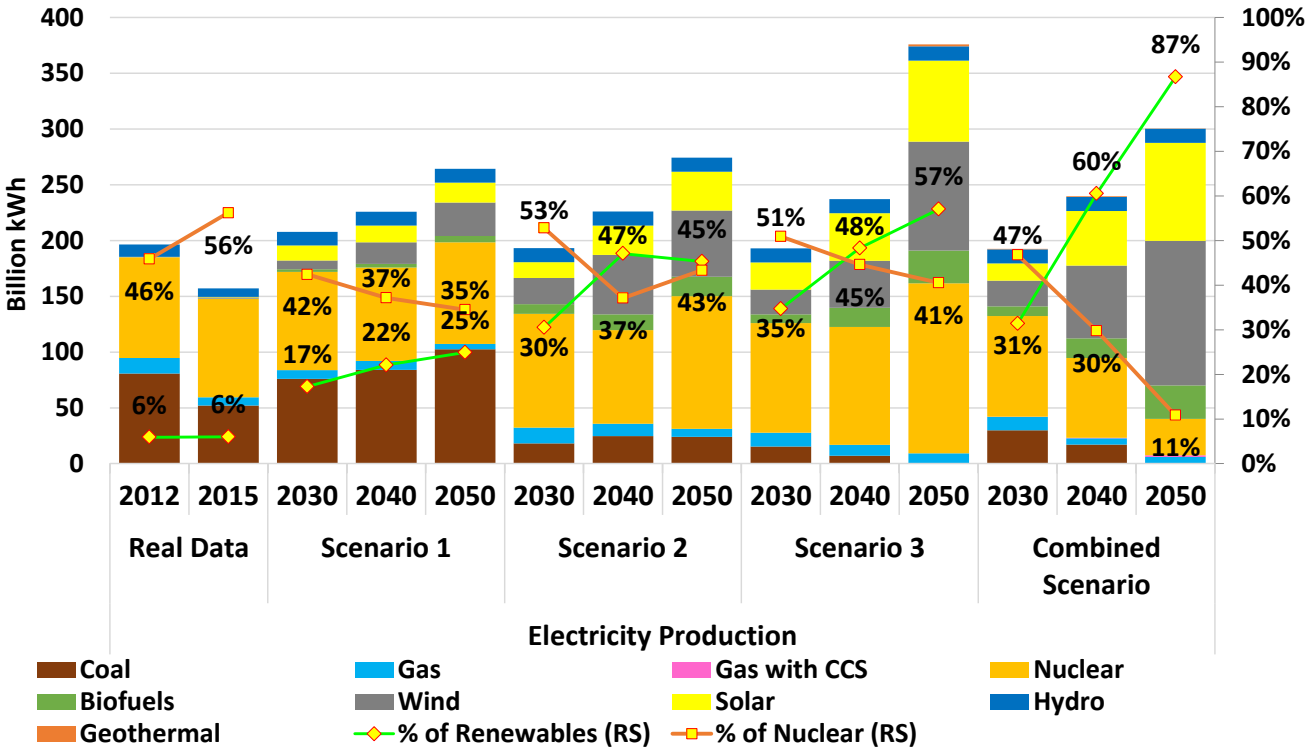

Figure 1.50. Electricity Production by Key Scenario

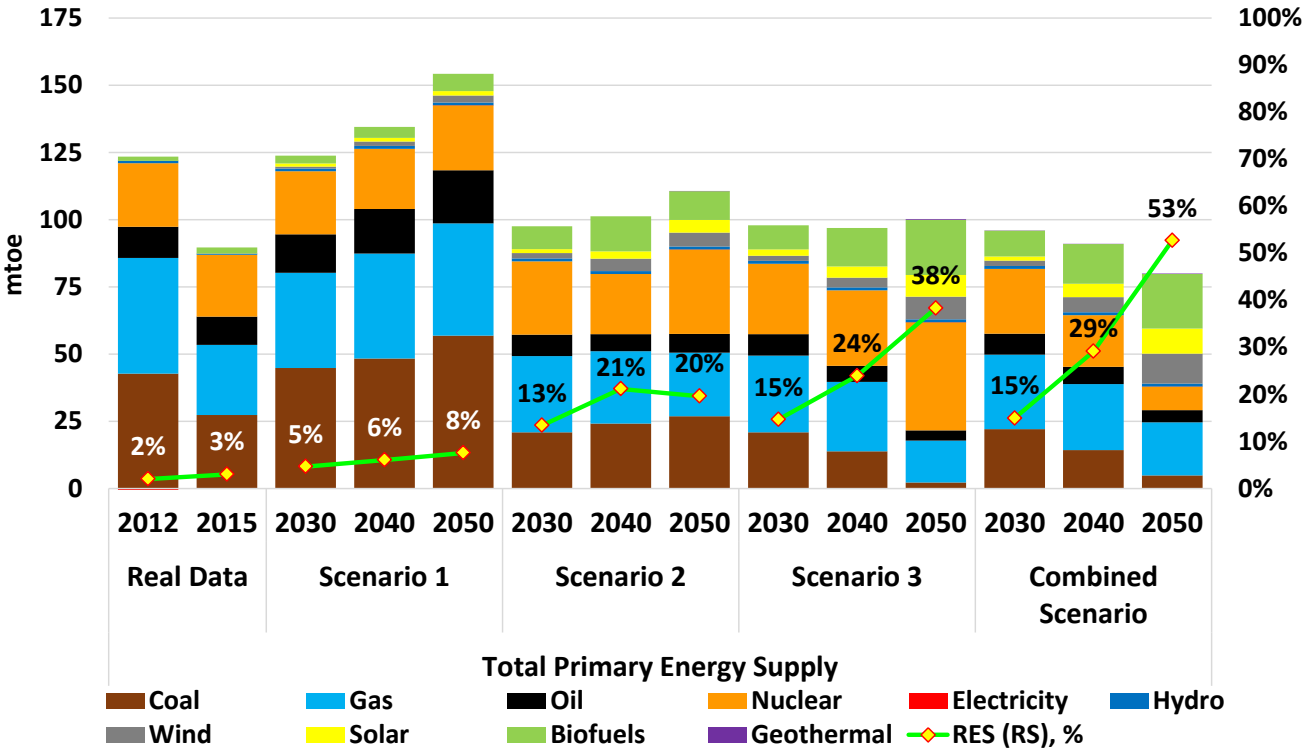

Figure 1.51. Total Primary Energy Supply by Key Scenario

In table 1.6 aggregated key indicators by key four scenarios.

Table 1.6. GHG Emissions and Investment Needs

Scenario Name	GHG emissions reduction compared to 1990 level		Investment needs for period (without consumers spending), billion Euro		Renewable Energy Share			
					Electricity production		TPES	
	2030	2050	2020-2030	2020-2050	2030	2050	2030	2050
Business As Usual	-54%	-40%	168	548	17%	24%	5%	8%
Reference	-71%	-70%	241	731	30%	45%	13%	20%
Climate Neutral Economy	-73%	-94%	256	971	34%	56%	15%	38%
Combined Sensitivity	-72%	-85%	245	743	31%	86%	15%	53%

The implementation of the combined sensitivity scenario requires attracting 22-23 billion Euro annually in the decarbonization of Ukraine's economy, which is approximately 70-80% of all capital investments. That is, **the average capital investment in 2020-2030 should be 28-33 billion Euro annually, which is 40-65% more than the level of capital investment in 2019, but corresponds to the data of 2007-2008** (Fig. 1.52).

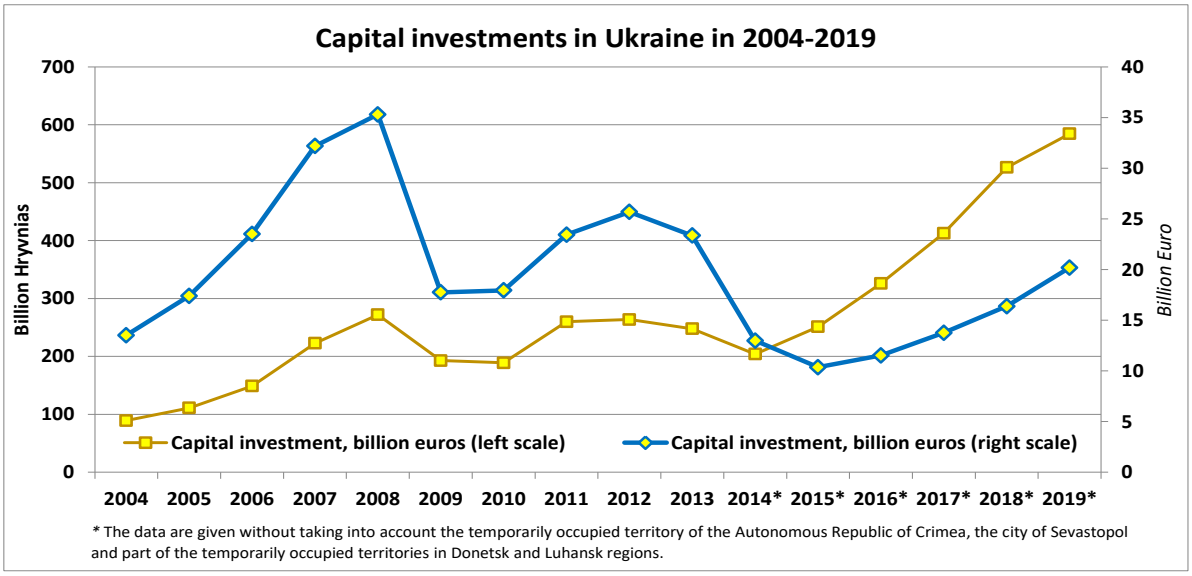

Figure 1.52. Capital investments in Ukraine in 2004-2019

According to 2019 statistics, in **Ukraine 5% of capital investments came from the state budget, 10% from local budgets and 68% are investments of private enterprises and organizations own funds** (Fig. 1.53). Such a distribution of financing for the decarbonisation of the economy seems quite reasonable and may be maintained in the future.

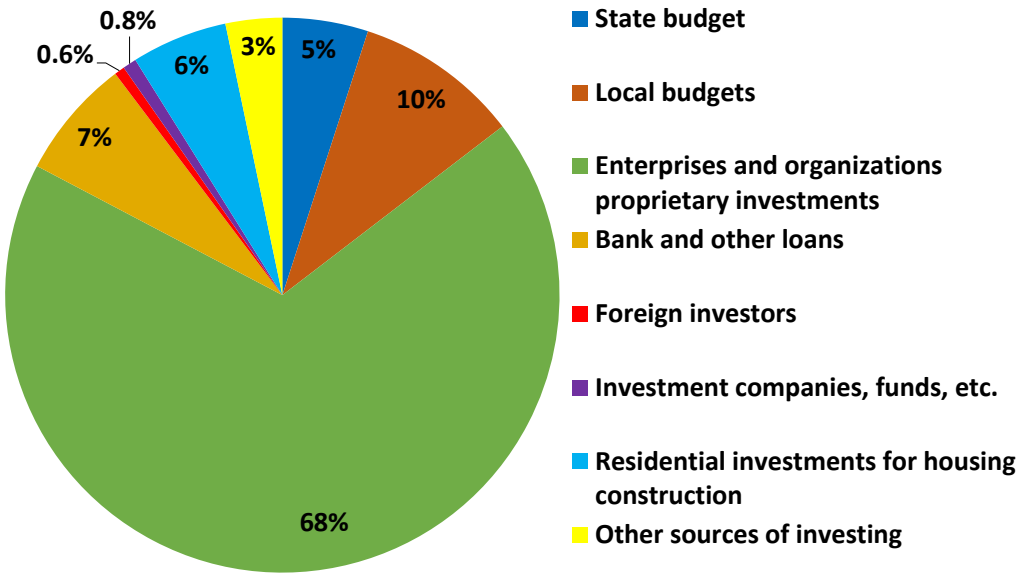

Figure 1.53. Capital investments in Ukraine by sources in 2019[13]

Source: State statistic services of Ukraine

1.5.2 Sectoral modelling results

In tables 1.5-1.11 presented detailed information about net and average annual GHG emissions and investment needs (including consumers spending) for 2021-2030.

[13] The data are given without taking into account 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 regions.

The key conclusion drawn from the analysis on **Electricity and Heat sector** (table 1.7) are:

- Electricity (power) and heat sector is considered to be the core sector in reducing GHG emissions potential (**-450 Mt CO2e** for 2021-2030).
- In order to achieve the above mentioned GHG emission reductions potential, requires **21 billion Euro** of investment in wind and solar generation and low-carbon and efficient co-generation and district heating.

Table 1.7. GHG Emissions and Investment Needs in Power and Heat Sector

	Net GHG emissions for 2021-2030, Mt CO2e			Average annual GHG emissions for 2021-2030, Mt CO2e			Investment needs[14] for 2021-2030, Billion Euro		
	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
1+2. Energy + Industrial processes and product use	**3119**	**2160**	**-959**	**312**	**216**	**-96**	**291**	**370**	**79.2**
Electricity and Heat	***995***	***545***	***-450***	***99***	***54***	***-45***	***14.3***	***26.0***	***11.7***
Main activity producer electricity plants	*612*	*239*	*-373*	*61*	*24*	*-37*	*11.4*	*20.1*	*8.7*
Wind power plants							*2.3*	*7.9*	*5.6*
Solar power plants							*6.5*	*8.4*	*2.0*
Bio power plants							*0.2*	*0.8*	*0.6*
Main activity producer CHP plants	*124*	*120*	*-4*	*12*	*12*	*-0.4*	*1.0*	*2.4*	*1.3*
Bio CHP plants							*0.0*	*1.8*	*1.8*
Autoproducer CHP plants							*0.3*	*1.9*	*1.5*
Bio autoproducer CHP							*0.0*	*1.8*	*1.8*
Producer heat only plants	*109*	*68*	*-42*	*11*	*7*	*-4*	*0.8*	*0.5*	*-0.3*
Bio heat only plants							*0.1*	*0.3*	*0.2*
Autoproducer heat only							*0.4*	*0.6*	*0.2*
Others	*149*	*118*	*-31*	*15*	*12*	*-3*	*1.1*	*3.0*	*2.0*

Regarding the **Industry sector** (table 1.8):

- Iron and steel production are the key sub-sector of the industry that need to reduce GHG emissions, which accounts for 88% of the total GHG reduction in industry.
- In order to achieve this, investment needs in metallurgy is only 22% of the total in industry investment needs, while 40% of it is needed in other industries (incl. SMEs) to de carbonize.

Table 1.8. GHG Emissions and Investment Needs in Industry

	Net GHG emissions for 2021-2030, Mt CO2e	Average annual GHG emissions for 2021-2030, Mt CO2e	Investment needs[15] for 2021-2030, Billion Euro

[14] Investment needs are including consumers spending
[15] Investment needs are including consumers spending

	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
1+2. Energy + Industrial processes and product use	**3119**	**2160**	**-959**	**312**	**216**	**-96**	**291**	**370**	**79.2**
Industry	***876.0***	***763.6***	***-112.5***	***87.6***	***76.4***	***-11.2***	***29.8***	***37.3***	***7.5***
Iron and steel	*497.9*	*398.8*	*-99.1*	*49.8*	*39.9*	*-9.9*	*7.7*	*8.3*	*0.6*
Non-ferrous metals	*3.3*	*3.2*	*-0.1*	*0.3*	*0.3*	*0.0*	*0.9*	*1.0*	*0.1*
Non-metallic minerals	*169.8*	*166.0*	*-3.8*	*17.0*	*16.6*	*-0.4*	*5.7*	*6.3*	*0.5*
Chemical	*127.9*	*124.6*	*-3.2*	*12.8*	*12.5*	*-0.3*	*3.1*	*5.5*	*2.5*
Paper, pulp and print	*0.6*	*0.6*	*0.0*	*0.1*	*0.1*	*0.0*	*1.1*	*1.2*	*0.1*
Other industries	*76.5*	*70.4*	*-6.1*	*7.6*	*7.0*	*-0.6*	*11.4*	*15.1*	*3.7*

Regarding, **Energy Supply and Agriculture sector** (fuel combustion only) (table 1.9):

- In Energy Supply sector, there is high GHG emissions reduction potential, estimated to be **218 Mt CO2e** for the period of 2021-2030.
- The GHG emissions in primarily associated with oil and gas pipelines that requires modernization of existing infrastructure and investment in new biofuel infrastructure (e.g. logistics, biofuel stations etc).
- In Agriculture (fuel combustion only) investment needs are relatively high, but they lead to a more sustainable development of agriculture.

Table 1.9. GHG Emissions and Investment Needs in Energy Supply and Agriculture

	Net GHG emissions for 2021-2030, Mt CO2e			Average annual GHG emissions for 2021-2030, Mt CO2e			Investment needs[16] for 2021-2030, Billion Euro		
	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
1+2. Energy + Industrial processes and product use	**3119**	**2160**	**-959**	**312**	**216**	**-96**	**291**	**370**	**79.2**
Supply Sector	***528.8***	***311.1***	***-217.7***	***52.9***	***31.1***	***-21.8***	***2.1***	***10.8***	***8.7***
Oil&Gas Pipelines							*0.9*	*2.8*	*1.9*
Liquid Biofuels Infrastructure							*0.4*	*4.6*	*4.2*
Others							*0.8*	*3.4*	*2.6*
Agriculture	***40***	***37***	***-3***	***4***	***4***	***0***	***0.6***	***2.2***	***1.6***

Regarding **Buildings** sector (Commercial and Residential sectors) (table 1.10):

- Energy savings (retrofitting) will play a big role in reducing GHG emissions (**-96 Mt CO2e**) in buildings (residential + commercial) sector, including reducing cooling demands.

[16] Investment needs are including consumers spending

- Decarbonisation of the buildings sector will not only lead to energy savings in energy production, but also create social co-benefits (e.g. health and welfare, safety)

Table 1.10. GHG Emissions and Investment Needs in Buildings

	Net GHG emissions for 2021-2030, Mt CO2e			Average annual GHG emissions for 2021-2030, Mt CO2e			Investment needs for 2021-2030, Billion Euro		
	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
1+2. Energy + Industrial processes and product use	**3119**	**2160**	**-959**	**312**	**216**	**-96**	**291**	**370**	**79.2**
Commercial	***20***	***15***	***-6***	***2***	***1***	***-1***	***9.7***	***11.8***	***2.1***
Space Heating	*9*	*4*	*-5*	*1*	*0*	*0*	*3.2*	*5.7*	*2.5*
Retrofitting							*2.7*	*4.5*	*1.8*
Cooling							*4.7*	*3.9*	*-0.9*
Water Heating	*2*	*3*	*0.7*	*0.2*	*0.3*	*0.1*	*0.4*	*0.6*	*0.2*
Public Lighting							*0.5*	*0.5*	*0.0*
Others	*9*	*8*	*-1.4*	*0.9*	*0.8*	*-0.1*	*1.3*	*1.6*	*0.4*
Residential	***328.6***	***238.6***	***-90.0***	***32.9***	***23.9***	***-9.0***	***60.7***	***73.9***	***13.2***
Space Heating	*197.4*	*122.5*	*-74.9*	*19.7*	*12.3*	*-7.5*	*7.8*	*22.1*	*14.3*
Retrofitting							*5.4*	*19.8*	*14.4*
Cooling							*12.7*	*10.5*	*-2.2*
Water Heating	*100.7*	*92.0*	*-8.7*	*10.1*	*9.2*	*-0.9*	*1.7*	*2.6*	*0.8*
Others	*30.4*	*24.0*	*-6.4*	*3.0*	*2.4*	*-0.6*	*38.6*	*38.9*	*0.3*

Regarding **Transport sector** (table 1.11):

- Within the energy subsector, road transport is a large GHG emitting subsector (**-48.7 Mt CO2e** for 2021-2030) – more than 60% of the total GHG reduction in transport. In order to achieve this, the investment in road transport fleet is about 84% of the total investment needs in transport sector.

- Important benefit of investment in this sector the significant reduction of pollutants and related improvements of living conditions and health in large cities.

Table 1.11. GHG Emissions and Investment Needs in Transport

	Net GHG emissions for 2021-2030, Mt CO2e			Average annual GHG emissions for 2021-2030, Mt CO2e			Investment needs[17] for 2021-2030, Billion Euro		
	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
1+2. Energy + Industrial processes and product use	**3119**	**2160**	**-959**	**312**	**216**	**-96**	**291**	**370**	**79.2**
Transport*	***330.6***	***250.4***	***-80.2***	***33.1***	***25.0***	***-8.0***	***173.8***	***208.3***	***34.4***
Private cars	*101.5*	*79.2*	*-22.4*	*10.2*	*7.9*	*-2.2*	*81.7*	*91.7*	*10.0*

[17] Investment needs are including consumers spending

Trucks	*86.4*	*68.2*	*-18.2*	*8.6*	*6.8*	*-1.8*	*43.3*	*58.0*	*14.8*
Buses	*26.6*	*18.5*	*-8.1*	*2.7*	*1.8*	*-0.8*	*18.5*	*24.3*	*5.8*
Rail	*1.4*	*1.3*	*-0.1*	*0.1*	*0.1*	*0.0*	*19.5*	*19.4*	*-0.1*
Others	*114.6*	*83.2*	*-31.4*	*11.5*	*8.3*	*-3.1*	*10.8*	*14.8*	*4.0*

* *Investment Needs include the cost of consumers spending to buying private vehicles.*

Regarding the **Agriculture and LULUCF sector** (table 1.12):

- The biggest GHG emissions reductions and removals potential can be achieved in crop production (**-33.8 Mt CO2e**) and forestry (**+20.4 Mt CO2e**) with moderate rates of investment.
- While investment needs in the sector are relatively high, there are numerous co-benefits of implementing policies and measures, including SDGs, improvement of living environment beyond climate dimension, soil and water protection, biodiversity and others that go beyond GHG emissions reduction and removals increase.

Table 1.12. GHG Emissions and Investment Needs in Agriculture and LULUCF

	Net GHG emissions for 2021-2030, Mt CO2e			Average annual GHG emissions for 2021-2030, Mt CO2e			Investment needs[18] for 2021-2030, Billion Euro		
	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
3. Agriculture	**396.2**	**384.7**	**-11.5**	**39.6**	**38.5**	**-1.1**	**0.0**	**4.0**	**4.0**
Enteric Fermentation	*83.6*	*77.1*	*-6.5*	*8.4*	*7.7*	*-0.7*	*0.0*	*0.0*	*0.0*
Manure Management	*20.7*	*18.7*	*-2.0*	*2.1*	*1.9*	*-0.2*	*0.0*	*1.4*	*1.4*
Agricultural Soils	*291.9*	*288.9*	*-3.0*	*29.2*	*28.9*	*-0.3*	*0.0*	*2.6*	*2.6*
4. Land use, land-use change and forestry	**-57.6**	**-109.8**	**-52.2**	**-5.8**	**-11.0**	**-5.2**	**0.1**	**2.9**	**2.9**
Forest Land	*-499.2*	*-519.5*	*-20.4*	*-49.9*	*-52.0*	*-2.0*	*0.1*	*0.3*	*0.3*
Cropland and Grassland	*415.8*	*384.0*	*-31.8*	*41.6*	*38.4*	*-3.2*	*0.0*	*2.6*	*2.6*
Wetlands	*2.3*	*2.3*	*0.0*	*0.2*	*0.2*	*0.0*	*0.0*	*0.0*	*0.0*
Other emissions	*23.5*	*23.5*	*0.0*	*2.3*	*2.3*	*0.0*	*0.0*	*0.0*	*0.0*

Regarding **Waste sector** (table 1.13):

- Solid waste disposal sub-sector has the highest potential for GHG reduction in the Waste sector.

Key policies to reduce GHG emissions in the waste sector, include waste water treatment, prevention of municipal solid waste disposal, stimulation of electricity and CHP production on the landfills and others. Thus, in many cases, investments needs are comparatively high due to the need to create new waste management practices and facilities. The most cost-effective GHG emissions reductions are those from wastewater treatment.

Table 1.13. GHG Emissions and Investment Needs in Waste

	Net GHG emissions for 2021-2030, Mt CO2e	Average annual GHG emissions for 2021-2030, Mt CO2e	Investment needs[19] for 2021-2030, Billion Euro

[18] Investment needs are including consumers spending
[19] Investment needs are including consumers spending

	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.	Scen 1	Comb. Scen	Diff.
Total	**3582**	**2545**	**-1037**	**358**	**254**	**-104**	**292**	**379**	**88**
5. Waste	**124.6**	**109.2**	**-15.4**	**12.5**	**10.9**	**-1.5**	**0.4**	**2.3**	**1.8**
Solid Waste Disposal	*82.5*	*80.0*	*-2.5*	*8.2*	*8.0*	*-0.3*	*0.2*	*0.8*	*0.6*
Biological Treatment of Solid Waste	*0.3*	*0.5*	*0.2*	*0.0*	*0.1*	*0.0*	*0.0*	*0.1*	*0.1*
Incineration and Open Burning of Waste	*0.1*	*0.1*	*0.0*	*0.0*	*0.0*	*0.0*	*0.1*	*0.3*	*0.2*
Wastewater Treatment and Discharge	*41.7*	*28.6*	*-13.1*	*4.2*	*2.9*	*-1.3*	*0.2*	*1.0*	*0.8*

SECTION 2. UKRAINE'S SECOND NDC CARBON BUDGET

2.1 CARBON BUDGET ESTIMATION

The carbon budget term is used in this report as a cumulative amount of GHG emissions budgeted to be emitted over a period of time. Graphically, carbon budget could be presented as the area of the figure outlined below the emission curve, as shown in Figure 2.1 and the area highlighted.

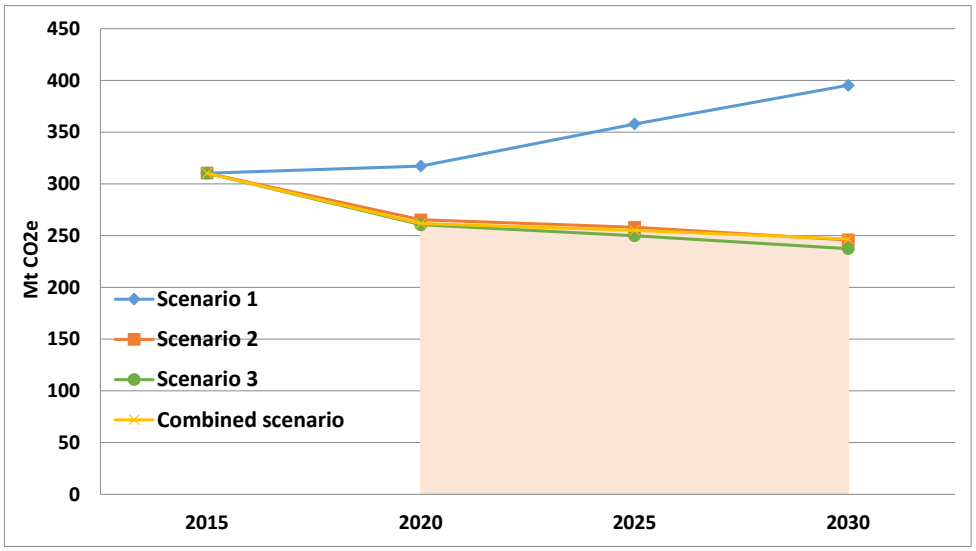

Figure 2.1. Total GHG emissions

Except in Scenario 1, all NDC2 scenarios follow similar trajectory until 2030, and the estimated carbon budget or cumulative GHG emissions for these scenarios result similar to one another (Table 2.1). Difference between Scenario 1 and other scenarios (Table 2.2), or alternatively – difference between average annual emissions and 2015 level (Table 2.3) and the same difference of emissions in 2030 (Table 2.4) - reflect the level of ambitions and expected contribution of each sector to meet policy assumptions.[20] **Fuel combustion, fugitive emissions and industrial processes (according to IPCC definition) remain the biggest GHG emitters of about 86%**.

On the other hand, structure of emissions by sub-sector differs among scenarios. Extensive economic/energy system development upon **Scenario 1 provides no radical changes in the structure of energy consumption or emissions by sector within 2021-2030** (see Report 3). This brings to conclusion that sectoral allocation of carbon budget in Scenario 1 estimated for 10 years is likely to reflect today's structure of emissions throughout the timeframe, i.e. without notable distortion at the beginning or end of the period. **In other NDC2 scenarios, where decarbonisation of the energy sector plays crucial role for reaching emissions reduction target, the composition of emissions from fuel use by sector in 2030 and respective breakdown of carbon budget differ from those of today** (Fig. 2.2)[21]. Expected decrease of emissions in electricity and heat production and buildings sector by almost 40%

[20] Definitions of sectors is provided in Annex B.

[21] In TIMES-Ukraine model GHG emissions are counted by economic activities, thus allocation of GHG emissions in *Energy and Industrial Processes sectors* (IPCC categories) presented here is also made by **economic activities** that is consistent to the European environmental economic accounts used by Eurostat. In Ukraine GHG emissions are normally not reported by economic activities, so assessment of GHG emissions by economic sector for 2015 were taken from TIMES model just *for comparison purpose*.

in 2030, comparing to 2015, explains a drop in the share of these sectors from 26% to 20% and from 12% to 10% respectively. Meanwhile, owing to optimistic assumptions as for agriculture and industrial production (manufacturing) that should double by 2030, the share of Industry (as economic sector) increases from 21% to 28% and Agriculture (as IPCC category) – from 12% to 15%.

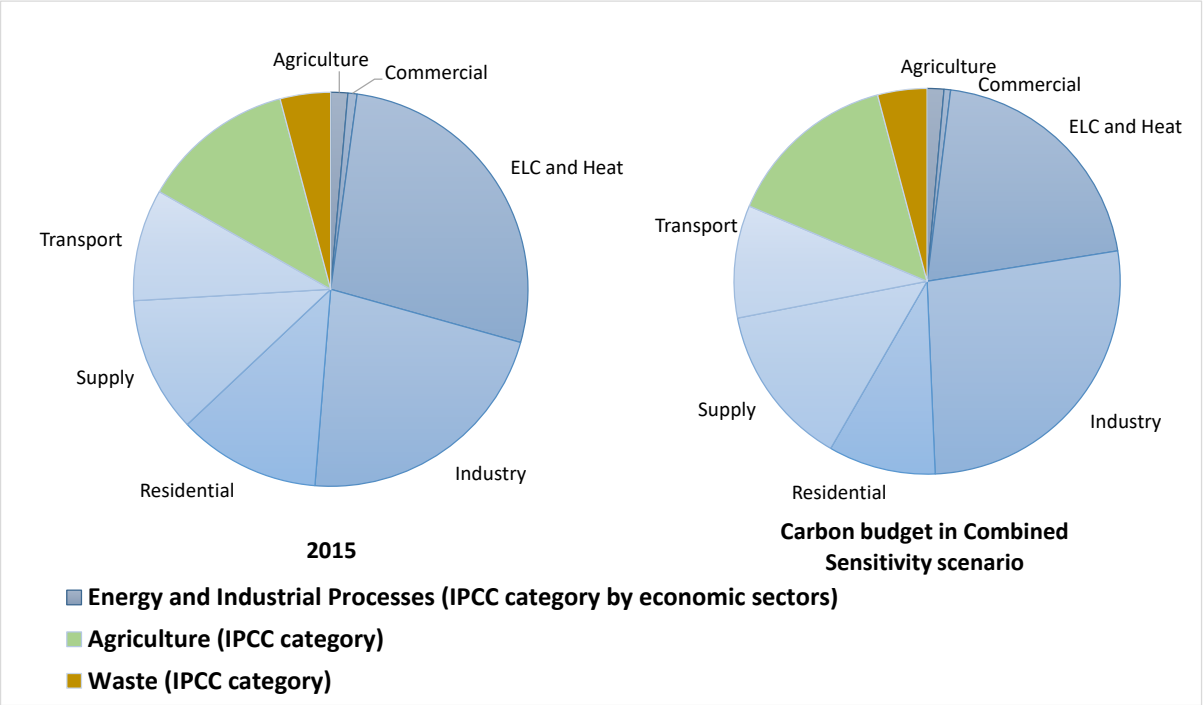

Figure 2.2. GHG emissions by Sector

Table 2.1. Modelled carbon budget distribution (Mt CO_2e) with investments (bln EUR) for 2021-2030 by sector by scenario

	Net GHG emissions for 2021-2030, Mt CO2e			Investment needs for 2021-2030, Billion Euro		
	Scenario 1	Combined Scenario	Difference	Scenario 1	Combined Scenario	Difference
Total	**3582.1**	**2544.8**	**-1037.3**	**291.6**	**379.4**	**87.8**
1+2. Energy + Industrial processes and product use	3119.0	2160.3	-958.7	291	370	79.2
Agriculture*	***40.1***	***37.3***	***-2.8***	***0.6***	***2.2***	***1.6***
Commercial*	***20.1***	***14.6***	***-5.6***	***9.7***	***11.8***	***2.1***
Space Heating	*8.6*	*3.7*	*-4.9*	*3.2*	*5.7*	*2.5*
Retrofiting				*2.7*	*4.5*	*1.8*
Cooling				*4.7*	*3.9*	*-0.9*
Water Heating	*2.1*	*2.9*	*0.7*	*0.4*	*0.6*	*0.2*
Public Lighting				*0.5*	*0.5*	*0.0*
Others	*9.4*	*8.0*	*-1.4*	*1.3*	*1.6*	*0.4*
ELC and Heat*	***994.9***	***544.8***	***-450.1***	***14.3***	***26.0***	***11.7***
Main activity producer electricity plants	*611.9*	*238.6*	*-373.3*	*11.4*	*20.1*	*8.7*
Wind power plants				*2.3*	*7.9*	*5.6*
Solar power plants				*6.5*	*8.4*	*2.0*
Bio power plants				*0.2*	*0.8*	*0.6*
Main activity producer CHP plants	*124.3*	*119.9*	*-4.4*	*1.0*	*2.4*	*1.3*
Bio CHP plants				*0.0*	*1.8*	*1.8*
Autoproducer CHP plants				*0.3*	*1.9*	*1.5*
Bio autoproducer CHP plants				*0.0*	*1.8*	*1.8*
Producer heat only plants	*109.4*	*67.8*	*-41.6*	*0.8*	*0.5*	*-0.3*
Bio heat only plants				*0.1*	*0.3*	*0.2*
Autoproducer heat only plants				*0.4*	*0.6*	*0.2*
Others	*149.2*	*118.4*	*-30.8*	*1.1*	*3.0*	*2.0*
Industry*	***824.4***	***713.0***	***-111.4***	***29.8***	***37.3***	***7.5***
Iron and steel	*497.9*	*398.8*	*-99.1*	*7.7*	*8.3*	*0.6*
Non-ferrous metals	*3.3*	*3.2*	*-0.1*	*0.9*	*1.0*	*0.1*
Non-metallic minerals	*118.2*	*115.4*	*-2.8*	*5.7*	*6.3*	*0.5*
Chemical	*127.9*	*124.6*	*-3.2*	*3.1*	*5.5*	*2.5*
Paper, pulp and print	*0.6*	*0.6*	*0.0*	*1.1*	*1.2*	*0.1*
Other industries	*76.5*	*70.4*	*-6.1*	*11.4*	*15.1*	*3.7*
Residential*	***328.6***	***238.6***	***-90.0***	***60.7***	***73.9***	***13.2***
Space Heating	*197.4*	*122.5*	*-74.9*	*7.8*	*22.1*	*14.3*

Retrofitting				*5.4*	*19.8*	*14.4*
Cooling				*12.7*	*10.5*	*-2.2*
Water Heating	*100.7*	*92.0*	*-8.7*	*1.7*	*2.6*	*0.8*
Others	*30.4*	*24.0*	*-6.4*	*38.6*	*38.9*	*0.3*
Supply Sector*	***580.4***	***361.7***	***-218.7***	***2.1***	***10.8***	***8.7***
Oil&Gas Pipelines				*0.9*	*2.8*	*1.9*
Liquid Biofuels Infrastructure				*0.4*	*4.6*	*4.2*
Others				*0.8*	*3.4*	*2.6*
Transport*	***330.6***	***250.4***	***-80.2***	***173.8***	***208.3***	***34.4***
Private cars	*101.5*	*79.2*	*-22.4*	*81.7*	*91.7*	*10.0*
Trucks	*86.4*	*68.2*	*-18.2*	*43.3*	*58.0*	*14.8*
Buses	*26.6*	*18.5*	*-8.1*	*18.5*	*24.3*	*5.8*
Rail	*1.4*	*1.3*	*-0.1*	*19.5*	*19.4*	*-0.1*
Other	*114.6*	*83.2*	*-31.4*	*10.8*	*14.8*	*4.0*
3. Agriculture	**396.2**	**384.7**	**-11.5**	**0.0**	**4.0**	**4.0**
Entheric Fermentation	*83.6*	*77.1*	*-6.5*	*0.0*	*0.0*	*0.0*
Manure Management	*20.7*	*18.7*	*-2.0*	*0.0*	*1.4*	*1.4*
Agricultural Soils	*291.9*	*288.9*	*-3.0*	*0.0*	*2.6*	*2.6*
4. Land use, land-use change and forestry(1)	**-57.6**	**-109.8**	**-52.2**	**0.1**	**2.9**	**2.9**
Forest Land	*-499.2*	*-519.5*	*-20.4*	*0.1*	*0.3*	*0.3*
Cropland and Grassland	*415.8*	*384.0*	*-31.8*	*0.0*	*2.6*	*2.6*
Wetlands	*2.3*	*2.3*	*0.0*	*0.0*	*0.0*	*0.0*
Other emissions	*23.5*	*23.5*	*0.0*	*0.0*	*0.0*	*0.0*
5. Waste	**124.5**	**109.7**	**-14.9**	**0.4**	**2.2**	**1.8**
Solid Waste Disposal	*82.4*	*80.0*	*-2.4*	*0.2*	*0.8*	*0.6*
Biological Treatment of Solid Waste	*0.3*	*0.5*	*0.2*	*0.0*	*0.1*	*0.1*
Incineration and Open Burning of Waste	*0.1*	*0.1*	*0.0*	*0.1*	*0.3*	*0.2*
Wastewater Treatment and Discharge	*41.6*	*29.1*	*-12.6*	*0.2*	*1.0*	*0.8*

** economic sectors*

Table 2.2. Carbon budget for 2021-2030 by sector, difference with Scenario 1, %

	Scenario 2	Scenario 3	Combined Scenario
Total (net emissions)	**-28.4**	**-30.5**	**-29.0**
1+2. Energy + Industrial processes and product use	**-30.0**	**-30.6**	**-30.7**
*Agriculture**	*-9.7*	*-7.0*	*-7.0*
*Commercial sector**	*-27.4*	*-26.9*	*-27.4*
*Production of electricity and heat **	*-45.6*	*-49.0*	*-45.2*
*Industry (manufacturing)**	*-10.1*	*-10.0*	*-13.5*
*Residential sector**	*-26.3*	*-25.5*	*-27.4*
*Supply sector**	*-36.7*	*-36.8*	*-37.7*
*Transport**	*-27.4*	*-24.2*	*-24.3*
3. Agriculture	**-2.9**	**-4.9**	**-2.9**
Enteric Fermentation	*-7.8*	*-7.8*	*-7.8*
Manure Management	*-9.7*	*-24.2*	*-9.7*
Agricultural Soils	*-1.0*	*-2.7*	*-1.0*
4. Land use, land-use change and forestry(1)	**90.5**	**152.1**	**90.5**
Forest Land	*4.1*	*5.1*	*4.1*
Cropland and Grassland	*-7.6*	*-15.0*	*-7.6*
Wetlands	*0.0*	*0.0*	*0.0*
Other emissions	*0.0*	*0.0*	*0.0*
5. Waste	**-13.4**	**-22.9**	**-12.4**
Solid Waste Disposal	*-14.8*	*-20.2*	*-3.0*
Biological Treatment of Solid Waste	*600.0*	*433.3*	*66.7*
Incineration and Open Burning of Waste	*0.0*	*0.0*	*0.0*
Wastewater Treatment and Discharge	*-15.1*	*-31.4*	*-31.4*

** - economic sectors*

Table 2.3. Average annual GHG emissions for 2021-2030 by sector, difference with 2015, %

	Scenario 1	Scenario 2	Scenario 3	Combined Scenario
Total (net emissions)	**15.4**	**-17.4**	**-19.8**	**-18.0**
1+2. Energy + Industrial processes and product use	**16.7**	**-18.3**	**-19.1**	**-19.2**
*Agriculture**	*-2.6*	*-12.1*	*-9.4*	*-9.4*
*Commercial sector**	*-9.2*	*-34.1*	*-33.6*	*-34.1*
*Production of electricity and heat **	*23.7*	*-32.7*	*-36.9*	*-32.3*
*Industry (manufacturing)**	*27.2*	*14.4*	*14.5*	*10.0*
*Residential sector**	*-4.9*	*-29.9*	*-29.1*	*-30.9*
*Supply sector**	*76.7*	*11.8*	*11.7*	*10.1*
*Transport**	*21.9*	*-11.6*	*-7.7*	*-7.7*
3. Agriculture	**6.3**	**3.2**	**1.1**	**3.2**
Enteric Fermentation	*-4.4*	*-11.9*	*-11.9*	*-11.9*
Manure Management	*6.9*	*-3.4*	*-18.9*	*-3.4*
Agricultural Soils	*10.1*	*9.0*	*7.1*	*9.0*
4. Land use, land-use change and forestry(1)	**-8.3**	**74.6**	**131.2**	**74.6**
Forest Land	*-3.1*	*0.8*	*1.8*	*0.8*
Cropland and Grassland	*-0.5*	*-8.1*	*-15.4*	*-8.1*
Wetlands	*-34.1*	*-34.1*	*-34.1*	*-34.1*
Other emissions	*-24.6*	*-24.6*	*-24.6*	*-24.6*
5. Waste	**2.0**	**-11.6**	**-21.3**	**-10.6**
Solid Waste Disposal	*1.3*	*-13.7*	*-19.2*	*-1.7*
Biological Treatment of Solid Waste	*-23.0*	*439.1*	*310.8*	*28.4*
Incineration and Open Burning of Waste	*-16.9*	*-16.9*	*-16.9*	*-16.9*
Wastewater Treatment and Discharge	*3.8*	*-11.9*	*-28.8*	*-28.8*

** - economic sectors*

Table 2.4. GHG emissions in 2030 by sector, difference with 2015, %

	Scenario 1	Scenario 2	Scenario 3	Combined Scenario
Total (net emissions)	**27.3**	**-20.8**	**-23.5**	**-20.5**
1+2. Energy + Industrial processes and product use	**29.4**	**-21.3**	**-20.9**	**-21.2**
*Agriculture**	*1.5*	*-13.1*	*-24.2*	*-24.2*
*Commercial sector**	*-13.5*	*-45.1*	*-43.3*	*-44.6*
*Production of electricity and heat **	*34.3*	*-47.0*	*-50.5*	*-34.2*
*Industry (manufacturing)**	*53.7*	*31.6*	*31.5*	*15.4*
*Residential sector**	*-9.8*	*-40.9*	*-36.4*	*-41.2*
*Supply sector**	*98.7*	*15.5*	*21.9*	*16.5*
*Transport**	*31.6*	*-29.2*	*-26.3*	*-26.0*
3. Agriculture	**7.3**	**2.1**	**-1.8**	**2.1**
Enteric Fermentation	*-4.0*	*-15.9*	*-15.9*	*-15.9*
Manure Management	*8.7*	*-8.1*	*-32.8*	*-8.1*
Agricultural Soils	*11.2*	*9.1*	*5.4*	*9.1*
4. Land use, land-use change and forestry(1)	**-48.5**	**93.9**	**191.1**	**93.9**
Forest Land	*-7.0*	*1.3*	*2.8*	*1.3*
Cropland and Grassland	*0.8*	*-10.5*	*-23.2*	*-10.5*
Wetlands	*-24.7*	*-24.7*	*-24.7*	*-24.7*
Other emissions	*-24.7*	*-24.7*	*-24.7*	*-24.7*
5. Waste	**4.4**	**-19.6**	**-36.3**	**-16.9**
Solid Waste Disposal	*2.7*	*-23.4*	*-33.3*	*-3.3*
Biological Treatment of Solid Waste	*-7.6*	*588.0*	*218.3*	*-5.0*
Incineration and Open Burning of Waste	*32.9*	*41.2*	*41.2*	*41.2*
Wastewater Treatment and Discharge	*7.7*	*-18.1*	*-44.9*	*-44.9*

** - economic sectors*

Table 2.5. Structure of investment needs by scenario, %

	Scenario 1	Scenario 2	Scenario 3	Combined Scenario
Total, billion Euro	**291.6**	**371.5**	**391.2**	**379.4**
Total, %	**100**	**100**	**100**	**100**
1+2. Energy + Industrial processes and product use	**99.8**	**97.0**	**96.2**	**97.6**
*Agriculture**	*0.2*	*0.3*	*0.6*	*0.6*
*Commercial sector**	*3.3*	*3.1*	*3.0*	*3.1*
*Production of electricity and heat **	*4.9*	*7.3*	*9.0*	*6.9*
*Industry (manufacturing)**	*10.2*	*9.7*	*9.0*	*9.8*
*Residential sector**	*20.8*	*19.8*	*18.5*	*19.5*
*Supply sector**	*0.7*	*2.6*	*2.8*	*2.8*
*Transport**	*59.6*	*54.0*	*53.4*	*54.9*
3. Agriculture	**0.0**	**1.1**	**1.5**	**1.1**
Enteric Fermentation	-	*0.003*	*0.0*	*0.0*
Manure Management	-	*0.4*	*0.7*	*0.4*
Agricultural Soils	-	*0.7*	*0.8*	*0.7*
4. Land use, land-use change and forestry(1)	**0.02**	**0.8**	**0.8**	**0.8**
Forest Land	*0.02*	*0.1*	*0.1*	*0.1*
Cropland and Grassland	-	*1*	*0.8*	*0.7*
Wetlands	-	-	-	-
Other emissions	-	-	-	-
5. Waste	**0.1**	**1.1**	**1.5**	**0.6**
Solid Waste Disposal	*0.1*	*0.4*	*0.5*	*0.2*
Biological Treatment of Solid Waste	*0.01*	*0.1*	*0.1*	*0.0*
Incineration and Open Burning of Waste	*0.02*	*0.1*	*0.2*	*0.1*
Wastewater Treatment and Discharge	*0.1*	*0.5*	*0.6*	*0.3*

** - economic sectors*

2.2 FAIRNESS OF THE UKRAINE'S NDC COMMITMENT

The main goal of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature increase well below 2°C by the end of the century relative to pre-industrial level[22]. The Paris Agreement architecture of Parties contributions is based on the bottom up approach that foresees regular submissions of such contributions by each Party that are self-determined by that Party. At the same time, each nationally determined contribution should address the fairness of its contribution and this fairness is not defined by the Paris Agreement.

There are numerous research papers and reports on the issue of addressing fairness and equity concepts and its principles. Several studies have modelled allocation of the 2°C and 1.5°C-consistent global carbon budgets by countries using different equity principles[23] [24]. Different concepts of fairness have been proposed and discussed, showing high variation in efforts sharing between different approaches [5] [25] [26].

To access the mitigation targets for Ukraine proposed under Scenarios 2 and 3, we compare them with the fair share of Ukraine's mitigation effort under five equity approaches, which follow five IPCC-AR5 equity categories [5] [27]. Table 4 below provides an overview of such principles.

Table 2.6. Approaches to the allocation of the global carbon budget by countries

Allocation code	Allocation name	IPCC category	Allocation characteristics
CAP	Capability	Capability	High mitigation for countries with high GDP per capita.
EPC	Equal per capita	Equality	Convergence towards equal annual emissions per person.
GDR	Greenhouse development rights	Responsibility–capability–need	High mitigation for countries with high GDP per capita and high historical per capita emissions.
CPC	Equal cumulative per capita	Equal cumulative per capita	High mitigation for countries with high historical per capita emissions.
CER	Constant emissions ratio	Staged approaches	Maintains current emissions ratios.

Source: Robiou du Pont et al., 2017.

Robiou du Pont et al. (2017) provide estimates of the emission reduction targets for 174 countries of the world, including Ukraine, under each of the carbon budget allocation approaches listed in the Table 4. Table 5 compares estimates of the emission reduction targets for Ukraine sourced from Robiou du Pont et al. (2017) and estimates developed for the 2nd Ukrainian NDC. We also add estimates of the

[22] UNFCCC. 2020. The Paris Agreement. Paris Agreement: essential elements. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[23] Robiou du Pont, Y., Jeffery, M., Gütschow, J. et al. 2017. Equitable mitigation to achieve the Paris Agreement goals. Nature Clim Change 7, 38–43 (2017). https://doi.org/10.1038/nclimate3186

[24] Peters, G. P., Andrew, R. M., Solomon, S. & Friedlingstein, P. 2015. Measuring a fair and ambitious climate agreement using cumulative emissions. Environ. Res. Lett. 10, 105004 (2015).

[25] Tørstad, V. and Sælen, H. 2018. Fairness in the climate negotiations: what explains variation in parties' expressed conceptions?, Climate Policy, 18:5, 642-654, DOI: 10.1080/14693062.2017.1341372

[26] Höhne, N., den Elzen, M. & Escalante, D. 2013. Regional GHG reduction targets based on effort sharing: a comparison of studies. Clim. Policy 14, 122–147 (2013).

[27] Clarke, L. et al. in Climate Change 2014: Mitigation of Climate Change (eds Edenhofer, O. et al.) 456–462 (IPCC, Cambridge Univ. Press, 2014).

Ukraine's fair share contribution, as estimated by the Climate Action Tracker[28] for the existing Ukraine's first NDC.

Comparisons with the five approaches of Robiou du Pont et al. (2017), as well as Climate Action Tracker estimates, suggest that **both Scenario 2 and 3 (hence Combined Sensitivity scenario as well) are consistent with well-below 2°C mitigation efforts**, although **not quite ambitious to reach 1.5°C consistency**. Scenario 3 is one percent different to the 1.5°C-consistent mitigation effort for Ukraine as suggested by Robiou du Pont et al. (2017). Table 5 also shows that the first Ukrainian NDC is highly insufficient, according to both CAT and Robiou du Pont et al. (2017) estimates. Only under one equity principle option (Equal cumulative per capita) the first Ukrainian NDC commitment could be considered consistent with the 2°C mitigation efforts.

Table 2.7. Comparison of the Ukrainian climate mitigation efforts under different equity principles and Ukrainian targets for the First and updated NDCs, emissions change w.r.t. 2010, %

Allocation code	Allocation name	2°C-consistent	1.5°C-consistent	Scenario 2	Scenario 3	First Ukrainian NDC
CAP	Capability	-57	-70	-34.6	-36	+39
EPC	Equal per capita	-36	-54	-34.6	-36	+39
GDR	Greenhouse development rights	-50	-67	-34.6	-36	+39
CPC	Equal cumulative per capita	64	40	-34.6	-36	+39
CER	Constant emissions ratio	-5	-33	-34.6	-36	+39
Average over five allocation approaches		**-17**	**-37**	**-34.6**	**-36**	**+39**
Climate Action Tracker (All)		**-28.7**	**-46.8**	**-34.6**	**-36**	**+39**

Notes: all emission estimates exclude LULUCF. Climate Action Tracker uses six different effort sharing approaches. For the 2°C scenario we use the level of emissions that corresponds to the limit between 2°C compatible and insufficient. For the 1.5°C scenario we use the level of emissions that corresponds to the limit between 1.5°C Paris Agreement compatible and 2°C compatible.

In the "Scenario 2" and "Scenario 3" columns cells highlighted light green correspond to the cases consistent with 2°C and cells highlighted dark green correspond to the cases consistent with 1.5°C mitigation efforts.

Source: developed by authors based on Robiou du Pont et al. (2017), GOU (2015)[29] and TIMES-Ukraine model estimates.

[28] Climate Action Tracker (CAT). 2020. Ukraine. https://climateactiontracker.org/countries/ukraine/

[29] Government of Ukraine (GOU). 2015. Intended Nationally-Determined Contribution (INDC) of Ukraine to a New Global Climate Agreement. http://www4.unfccc.int/ndcregistry/PublishedDocuments/Ukraine%20First/Ukraine%20First%20NDC.pdf

SECTION 3. MITIGATION POLICIES AND MEASURES

While this part A of the Report 4 has been finalizing, there is a comprehensive and inclusive process of stakeholders' consultations is taking place that is chaired by MinEcology and partially supported by the Project. During this stakeholders' consultation process ministries, legislators, state agencies and local authorities, industry associations and civil society, academia and experts have been providing comments to proposed list of sectoral policies and measures outlined in this report, and some of proposed policies and measures below were amended, as appropriate, based on the results of those consultations . Informal consultations with Ministry of Energy took place and private energy corporation. It's also recommended to conduct consultations with recently established Ministry of Strategic Economic Sectors development to present and discuss proposed industrial policies. It is also recommended to conduct formal process of stakeholders' consultations with relevant responsible ministries for power sector and heavy industry during formal governmental concurrence process of Ukrainian NDC2 target, especially taking into consideration that these sectors emissions represents around 75-80% of total GHG emissions of Ukraine. MinEcology had also been conducting informal bilateral discussions with various private business groups representatives in order to inform the process of NDC development and expected target setting.

3.1 ELECTRICITY SECTOR

Decarbonizing electric power sector of Ukraine is one of the key element and challenge of decarbonizing Ukraine's economy. Policies and measures in this sector aim to increase the share of renewable energy sources, ensure proper functioning of national electricity market, introduction of RAB-tariffs, introducing and promoting smart grid and distributed energy principles, including smart metering and integration to EU power market. Construction of Energy Storage facilities is also proposed as one of key measure here.

Informal dialogue took place with Ministry of Energy in March 2021, where all four scenarios have been presented and discussed with state officials in order to provide more information and clarification to sector-responsible ministry. Questions around level and access to finance were raised, various financial instruments such as Energy Efficiency Fund revitalization, establishment of Decarbonisation Fund were discussed along with two new nuclear blocks construction during post-2030 time period feasibility. Ministry of Energy is currently developing new policy options for Energy Efficiency Fund revitalization, Energy Efficiency policy options, including ESCO mechanism operationalization and others. Enhanced role of bio-energy and renewable energy sources were discussed. Sectoral breakdown of Ukraine's NDC target within internal governmental process and under UNFCCC submission process were discussed.

Overall emission reduction potential in the electricity sector for 2021-2030, based on Combined Scenario: 391.2 mln t CO_2

3.1.1. Ensuring proper functioning of all segments of electricity market

1. **Status:** on-going
2. **Implementation period starts:** 2019
3. **Type of measure:** Regulatory, existing legislation enforcement
4. **Objectives**: to provide a better business climate and attract sustainable investments to modernization and building of new generation capacity, in particular flexible capacity necessary

for energy system balancing, to improve security of electricity supply.

5. **Description:** The policy implies the implementation of regulatory measures aimed at ensuring proper functioning of all segments of the electricity market, its transparency, openness, and competitiveness. That will provide the right price signals to investors and appropriate conditions for attracting new players to the market, ensuring greater liquidity and competitiveness. All electricity prices should be market-based, while price caps should be gradually eliminated, as well as other market distortions, particularly PSO and foreign trade regulatory restrictions. Ensuring an integration to ENTSO-E and the EU's electricity market could be the key driver for higher domestic market competition and provide the right price signals for all market participants. The ancillary service market should be fully launched to provide necessary conditions for investments in flexible generation capacity and other technologies, in particular energy storage.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions share in Scenario XX (t CO_2e):** Indirect
8. **Sectors affected**: power generation and coal sectors
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Cabinet of Ministers of Ukraine, Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish**: 2024
12. **Linkage with SDG:** SDG1, SDG7, SDG8, SDG9, SDG11, SDG12

3.1.2. Cost-reflective market prices for electricity for consumers

1. **Status:** planned
2. **Implementation period starts:** 2021
3. **Type of measure:** Economic, Regulatory
4. **Objectives**: to eliminate cross-subsidization and distortions in electricity pricing, to provide better price signals for energy efficiency and demand response of households, to ensure proper electricity market functioning and better business climate.
5. **Description:** The policy implies gradual elimination of public service obligations (PSO) mechanism and bringing electricity prices for households to the market-based level that is entirely in line with European legislation on electricity markets. Protection and support of vulnerable consumers should be provided transparently via direct monetization of subsidies for those households for payment of their energy bills. The policy should be accompanied by a proper information campaign to facilitate the process, increase awareness, and ensure better public readiness and acceptance.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power generation, buildings sector and commercial consumers
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Cabinet of Ministers of Ukraine, Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish**: 2024
12. **Linkage with SDG:** SDG1, SDG3, SDG7, SDG8, SDG9, SDG11, SDG12

3.1.3. RAB-tariffs for electricity transmission and distribution system operators

1. **Status:** adopted
2. **Implementation period starts:** 2021
3. **Type of measure:** Economic, Regulatory

4. **Objectives**: to provide incentives for the investments of TSO and DSOs in development of electricity infrastructure (networks) and introduction of smart-grid technologies.
5. **Description:** Current "cost+" tariff methodology for transmission system operator (TSO) and distribution system operators (DSOs) is inefficient and does not provide incentives for network development. RAB-tariff methodology is a European-wide practice of tariffs regulation for natural monopolies. It ensures sufficient return on investments in development of new network infrastructure necessary for greater security of electricity supply and deployment of distributed generation, in particular proper integration of renewables. The policy implies setting fixed profitability on the regulatory assets base of TSO and DSOs while committing them to develop networks and provide appropriate quality and reliability of electricity supply that are to be regularly reported by the TSO and DSOs and monitored by the Regulator. The policy also indirectly encourages the introduction of smart-grid technologies by the TSO and DSOs.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: electricity transmission and distribution
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** National Energy and Utilities Regulatory Commission of Ukraine, Ministry of Energy of Ukraine, Transmission and Distributor System Operators
11. **Implementation period finish**: n/a
12. **Linkage with SDG:** SDG1, SDG7, SDG8, SDG9, SDG11, SDG12

3.1.4. Smart solutions and demand-side management in electricity

1. **Status:** planned/Recommended
2. **Implementation period starts:** 2021
3. **Type of measure:** Economic, Regulatory
4. **Objectives**: to improve dispatching and energy system flexibility, to ensure proper possibilities for demand response of all consumers, to ensure better integration of intermittent renewable energy sources to the grid, to ensure better integration of prosumers to the network and to improve their demand responsiveness.
5. **Description:** The policy implies the development of specific smart grid programs managed by the Regulator to support innovative smart grid projects. The projects should be eligible to attract EU funding or funding of IFIs. Development of smart grids could also be tied to RAB-tariffs for transmission (TSO) and distribution system operators (DSOs), implying some regulatory premiums to return on investments while ensuring proper reporting by TSO and DSOs and monitoring by the Regulator. The policy should include the integration of universities, research centers, and businesses to ensure the domestic production of smart technologies and equipment, as well as promoting partnerships with EU institutions. The introduction of flexible retail electricity pricing will incentivize consumers to use smart meters and manage their consumption more flexibly and efficiently, contributing to grid sustainability.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power generation, electricity transmission and distribution, household and non-household consumers
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine, Transmission and Distributor System Operators
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG1, SDG3, SDG7, SDG8, SDG9, SDG11, SDG12

3.1.5. Integration to EU's electricity markets

1. **Status:** on-going
2. **Implementation period starts:** 2011
3. **Type of measure:** Economic, Regulatory
4. **Objectives**: to permanently improve competitiveness and liquidity of the internal electricity market and ensure that electricity prices are market-based, to provide better possibility for energy system balancing and security of electricity supply.
5. **Description:** The policy implies the implementation of regulatory and technical measures aimed at ensuring proper and competitive operation of all segments of the electricity market and integration of Ukraine's energy system to ENTSO-E. For the technical side of integration, the TSO should frequently develop and the Regulator should approve Report on the adequacy of generation capacity and Ten-year plan for transmission system development. Those documents are crucial for attracting investments and launching the projects aimed at the development of internal electricity network infrastructure and cross-border interconnections with European countries, in particular projects of common interest. Also, certification of Ukrenergo as TSO should be accomplished via amendments to legislation on network ownership issues.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power generation, electricity transmission and distribution, coal sector, household and non-household consumers
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine, Transmission System Operator, electricity producers
11. **Implementation period finish**: 2024
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG10, SDG11, SDG12, SDG17

3.1.6. Implementation of National emission reduction plan (NERP) for large combustion plants

1. **Status:** on-going
2. **Implementation period starts:** 2017
3. **Type of measure:** Regulatory, existing legislation enforcement
4. **Objectives**: to ensure the fulfillment of Directive 2010/75/EU on industrial emissions and modernization of thermal power plants and combined heat and power plants or their decommissioning, to cut the emission of pollutants, to ensure building of new conventional and/or alternative flexible generation capacity.
5. **Description:** The policy implies the fulfillment of the NERP that should lead to modernization or gradually phasing out of environmentally inefficient thermal power plants and combined heat and power plants. The policy is entirely in line with European policy and legislation, particularly Directive 2010/75/EU on industrial emissions.
6. **Quantified objectives**: SO2, NOx, emission limitation and dust set out in Annex 5 of Directive 2010/75/EU
7. **Total GHG emissions reductions (t CO_2e):** indirect
8. **Sectors affected**: power generation, coal sector
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG3, SDG7, SDG8, SDG9,SDG10, SDG11, SDG12, SDG13, SDG15

3.1.7. Energy Storage

1. **Status:** recommended
2. **Implementation period starts:**
3. **Type of measure:** Technological
4. **Objectives:** to introduce new energy storage technology into energy system of Ukraine
5. **Description:** to introduce new energy storage technology into energy system of Ukraine
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** power generation, transmission and distribution
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.1.8. Competition in RES deployment (renewable energy auctioning process)

1. **Status:** adopted
2. **Implementation period starts:** 2021
3. **Type of measure:** Economic, Regulatory, existing legislation enforcement
4. **Objectives**: to ensure a competitive and economically feasible way of further RES deployment and integration to the electricity market of Ukraine; to ensure the affordability of electricity from RES.
5. **Description:** The auctions on RES quotas distribution is good European practice that is also supported by the Energy Community for its member countries. The policy allows the deployment of renewables in a competitive and more economically feasible way comparing to the feed-in tariffs scheme that is not cost-reflective. Competition of developers bidding their prices via auction procedure leads to lower prices of electricity produced from renewables. The policy implies that the government sets out and publishes the technologically specific quotas for each sliding 5-year period and respective auction schedule and ensures further holding auctions in a transparent, competitive, and non-discriminatory way. Winners of the auction sign PPA that guarantees fixed selling price for electricity produced for a stipulated long-term period. However, further flexibility of RES' electricity prices should be envisaged to e nsure them to be more market-reflective, particularly applying a feed-in premium instead of a feed-in (green) tariff scheme.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power and heat generation
9. **GHG(s) affected**:
10. **Entities responsible for implementing:** Cabinet of Ministers of Ukraine, Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine, Transmission System Operator
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12, SDG13

3.1.9. Ensuring green electricity producers being active and responsible market participants

1. **Status:** planned
2. **Implementation period starts:** 2021

3. **Type of measure:** Economic, Regulatory
4. **Objectives**: to increase sustainability and predictability of electricity production from RES and ensure their operation in the electricity market in a more reliable way; to provide greater reliability of the energy system and security of electricity supply.
5. **Description:** The policy implies enabling RES electricity producers to sell electricity directly to consumers (both legal and physical persons) outside the formal green tariff scheme to foster stable and growing demand for green electricity among the consumers. It will also allow to decouple from unstable green tariff administration and going beyond 2030, when the green tariff is over. The policy also envisages enhancing the responsibility of RES for their electricity production imbalances. The RES producers are to be financially responsible for the deviation between their planned and actual daily production of electricity. Since RES operators are not so far responsible for the imbalances, that does not incentivize them to ensure more accurate forecasting and planning of electricity production. That also much complicates balancing in the system and causes frequent ramping-up the coal-fired power plants to provide quick balancing. Otherwise, that can also lead to more frequent RES curtailments and higher wholesale electricity prices, especially considering the significant growth of RES electricity production. The introduction of RES' financial responsibility for the imbalances contributes to the mitigation of balancing issues, system sustainability, and security of electricity supply.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power generation
9. **GHG(s) affected**:
10. **Entities responsible for implementing:** Cabinet of Ministers of Ukraine, Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish**: 2021
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.2 HEATING SECTOR

Heating sector is important for Ukraine as geographic and climatic zone requires use of district heating system for over six months during a year and heating infrastructure is mostly old and very inefficient. Decarbonization policies and measures propose to incentivize the use of renewable energy in district heating sector and promotion of de-centralized and individual heating systems as measure to reduce or avoid heating distribution losses and make district heating system more efficient and less carbon intensive.

The stakeholders' consultations on the following policies and measures in heating sector took place during the period of December 2020 – January 2021, including consultations on residential housing (multi-stored and individual households), public buildings and district heating policies and measures with relevant responsible ministry and its authorities – MinRegion. During these consultations, proposed policies and measures were discussed and some initial reflections and feedback were provided by MinRegion and its supporting institutions. The main comments that MinRegion provided were on the i) thermo-modernization and enhanced energy efficiency of buildings with expected rate 0.5% of buildings modernized per year (under both Energy Efficiency Fund and Warm Credits State Program activities support) and ii) district heating modernization, which should be considered in close coordination with buildings modernizations and reconstructions to improve its' energy efficiency and

reduce fossil fuel consumption or replace types of fuels for less carbon intensive. Relevant updates related to these comments were included in Combined Sensitivity Scenario (see page 50-52 of this Report)

Overall emission reduction potential in the heating sector for 2021-2030, based on Combined Scenario: 58.9 mln t CO_2

3.2.1. Incentive mechanisms for renewable energy and high-efficiency cogeneration deployment in district heating

1. **Status:** recommended
2. **Implementation period starts:** 2022
3. **Type of measure:** fiscal
4. **Objectives**: introduce incentive mechanisms and stimulate renewable energy and high-efficiency cogeneration deployment in district heating systems.
5. **Description:** The policy aims at encouraging investments to the development of district heating with the use of renewable energy, in particular building of combined bioenergy heat and power plants (bioCHP) and high-efficiency CHP gradually replacing conventional obsolete district heating systems. The policy could envisage partial compensation of investments for building the bioCHP and high-efficiency CHP from the special fund created, low-cost bank loans or tax preferences. For funding the projects, green bonds can also be applied as an affordable way of attracting investments that is a European-wide practice. The support could also include the facilitation of granting permits, partial reimbursement of expenses for connection to the networks, or other support schemes.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: power and heat generation and distribution
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, Ministry of development of communities and territories of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine, local authorities
11. **Implementation period finish**:
12. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG11, SDG12, SDG15

3.2.2. Promotion of individual alternative heating systems

1. **Status:** recommended
2. **Implementation period starts:** 2022
3. **Type of measure:** Economic, fiscal
4. **Objectives**: to promote the development of individual heating with use of renewable energy sources and electric heating in residential and commercial sectors.
5. **Description:** The policy aims at encouraging investments of SMEs and households to the development of alternative individual/local heating systems in current building stock and new buildings with the use of renewable energy, in particular solar thermal, geothermal (heat pumps), and electric heating, etc. The policy could envisage low-cost bank loans, co-financing from the special fund created, or other relevant forms of financial support.
6. **Quantified objectives**: N/A
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected**: heat production and distribution

9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, Ministry of development of communities and territories of Ukraine, local authorities
11. **Implementation period finish**: n/a
12. **Linkage with SDG:** SDG7, SDG8, SDG12, SDG15

3.3 FUEL PRODUCTION, TRANSPORTATION AND DISTRIBUTION

Fuel (crude oil, natural gas and coal) production, transportation and distribution sector policies and measures aim to reduce technological losses and improve extraction, transportation and distribution technologies, including natural gas storage facilities improvements and incentives to apply best available technologies during extraction process.

No stakeholders' consultations took place to present or discuss the proposed policies and measures with relevant responsible Ministry of Energy and its support structure.

Overall emission reduction potential in the fuel production, transportation and distribution sector for 2021-2030, based on Combined Scenario: 218.7 mln t CO_2

3.3.1. Preventing of methane emissions during production of natural gas, crude oil and coal in existing coal mines

1. **Status:** recommended
2. **Implementation period starts:** N/A
3. **Type of measure:** Regulatory
4. **Objectives:** to stimulate and incentivize GHG emission reductions, leakages prevention and reduction of losses during extraction and processing of fuels
5. **Description:** In Ukraine, crude oil and natural gas production processes entail significant technological losses that do not meet international standards and best practices. Out-of-date coal mining process also requires modernization and introduction of new technologies for coal bed methane utilization. Introduction of comprehensive spectrum of approaches and solutions for reducing methane emissions, starting from robust program for monitoring, reporting and reduction of methane emissions. It's important to identify vulnerabilities in production circle of natural gas, oil, coal and introduce appropriate policies and create incentives for methane emissions reduction (e.g. flushing losses, leaks when pressure drops in storage tanks, wells and natural gas compressor stations at production); construction of compressor stations for collection of low pressure petroleum tail gas at production fields; reconstruction of flares at oil and natural gas production facilities and oil storage tanks; replacement of old parts and devices to reduce leakage and increase efficiency in the extraction of oil and natural gas.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected:** energy production sector
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12, SDG13

3.3.2. Reduction of methane emissions during oil and natural gas transportation

1. **Status:** Recommended
2. **Implementation period starts**: N/A
3. **Type of measure:** Economic, Technologic, Regulatory
4. **Objectives:** to stimulate and incentivize GHG emission reductions, leakages prevention and reduction of losses during oil and natural gas transportation
5. **Description:** Depreciation of Ukrainian gas transportation system is 61% with almost 60% of transportation networks have been in operation for more than 33 years, 2/3 of gas compressor stations have been in operation for more than 23 years. Natural gas transportation and distribution network losses are higher compared to European standards in 1-2%. The accumulated problems due to the long-term under-financing and the lack of investments in modernization infrastructure cause the unsatisfactory condition of many natural gas infrastructure facilities. The solution requires introduction of robust monitoring, reporting and reduction of methane emissions; reconstruction and updating of compressor stations, construction and renovation of gas-distribution stations, renovation of natural gas transportation and distribution infrastructure, installation of new smart gas-metering systems and infrastructure to ensure accuracy of measurement of volumes, physical and chemical indicators. Policy could also envisage reconstruction and replacement of telemechanic systems, modernization of oil and gas transportation facilities, such as repair of regenerators, air heating systems, oil cooling systems, air intakes, air purifier systems and air purification systems. There is a need for modernization/replacement of gas distribution pipelines and modernization of infrastructure, such as replacement of old gas distribution station, installation of smart metering system at all stages of natural gas transportation and distribution on supply and demand side. The policy could also envisage detection and eliminating natural gas leakage through sealing equipment installation and installation of CHP at natural gas turbine engines at compressors station during transportation process for heat recovery and electricity production and introduction of gas turbine flue gas heat recovery system with the production of additional electricity.
6. **Quantified objectives:**
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected:** oil and natural gas transportation and distribution
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine, Transmission and Distributor System Operators (TSO, DSO), local authorities
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12, SDG13

3.3.3. Upgrade of underground natural gas storage facilities to comply with existing mandatory standards and technical requirements

1. **Status:** Recommended
2. **Implementation period starts:** n/a
3. **Type of measure:** Technologic, existing legislation enforcement
4. **Objectives:** to reduce GHG emissions losses in natural gas storage system.
5. **Description:** About 80% of natural gas pumping units of Ukrainian gas storage facilities have a lifetime of more than 20 years. The overall percentage of technical wear and tear is low due to the small period (within a year) of using the main production equipment. However, in order to improve the energy efficiency of gas storage facilities and reduce the technological losses of the system, it is necessary to reconstruct the reservoirs with technological measurement to

improve metering system; reconstruction of natural gas drying installations with process automation, which will increase efficiency and reduce costs; reconstruction and modernization of gas collection points by replacing obsolete and physically obsolete equipment to ensure modern management and operation of underground gas storage facilities, operational management of gas extraction and injection, reliable operation of natural gas transportation system.

6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected:** natural gas storage
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine
11. **Implementation period finish:** n/a
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12, SDG13, SDG17

3.3.4. Incentives to use of geothermal energy of depleted oil-and-gas wells

1. **Status:** recommended
2. **Implementation period starts:** 2022
3. **Type of measure:** Economic, Regulatory
4. **Objectives:** economic incentives to promote co-generation at oil and gas depleted wells.
5. **Description**: Use of geothermal energy of depleted oil-and-gas wells tha will allow to replace the use of fossil fuels with environmentally friendly energy and allow to reduce greenhouse gas emissions (and other pollutants). The potential of oil and gas fields owned by state companies is 38 fields in PJSC "Ukrgazvydobuvannia" and 28 fields in PJSC "Ukrnafta". In 2015, NJSC Naftogaz of Ukraine collected and preliminarily analyzed 1,000 wells awaiting liquidation. They also developed a registry of the company's fields with formation temperatures above 85°C in accordance with the minimum technological requirements that could be used for geothermal energy production.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** n/a
8. **Sectors affected:** electric and heat power production
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine
11. **Implementation period finish:** n/a
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12

3.3.5. Introduction of conservation technologies in order to reduce GHG emissions from old oil wells, natural gas fields and closed coal mine

1. **Status:** recommended
2. **Implementation period starts:** N/A
3. **Type of measure:** Economic, Regulatory
4. **Objectives:** introduction of conservation technologies in order to reduce GHG emissions from old/non-operational wells and fields and closed coal mines.
5. **Description:** After energy source exploration is complete, old wells, mines and fields continue to accumulate and release significant amounts of greenhouse gases into the atmosphere. In Ukraine, a large amount of oil, gas wells and coal mines are currently undergoing significant exhaustion and should be closed in the near future. Mines in temporarily occupied territories that have been exploited in breach of security or abandoned in recent years is also a major problem. All these wells and fields infrastructure will need proper conservation and capture of

the abandoned coal mine methane.

6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected:** energy production
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine
11. **Implementation period finish:**
12. **Linkage with SDG:** SDG6, SDG7, SDG8, SDG9, SDG12, SDG13

3.3.6. Hydrogen Deployment

1. **Status:** recommended
2. **Implementation period starts:** -
3. **Type of measure:** Technological
4. **Objectives**: production and energy use of hydrogen
5. **Description:** Green hydrogen is expected to play an important role in the decarbonization of Ukrainian economy, given the country's considerable hydrogen supply and demand potential. On the supply side, the country may use the part of existing and future renewable energy generation facilities; demand for green hydrogen, in turn, could well stem from heavy industry, transport, power generation and district heating sectors, coupled with some hydrogen export opportunities.

   At the same time, unlocking hydrogen potential of Ukraine will require considerable technical research, related policy and legislative arrangements and support schemes as well as the necessary technical testing and piloting along the whole green hydrogen value chain, including the green gas generation, transportation and consumption. Given the considerable demand for green hydrogen from the EU and intensive dialog between Ukraine and the EU countries of hydrogen cooperation, the market is expected to develop already in short and medium run, while the first hydrogen pilots may start already in 2021.
6. **Quantified objectives**: not yet established, but the Draft Strategy on Hydrogen is already being developed (?)
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected**: transport, energy
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, State Agency for Energy Saving and Energy Efficiency of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG6, SDG7, SDG8, SDG9, SDG12, SDG13

3.4 INDUSTRY

Industry decarbonisation policies and measures aimed to introduce energy audit, energy management system, ESCO contracting and establishment of energy efficiency incentives for industrial companies, while enabling access for EU research and development activities. All proposed policies and measures should be putting Ukrainian industry on economic transformation pathways leading to decarbonisation.

Stakeholders' consultation process for policies and measure in industry sector has been initiated, but only partially thus far due to the distribution of functions on different industry sub-sectors between two different ministries – MinEconomy and newly established Ministry of Strategic Industries

Development. MinEconomy provided their initial comments on i) energy management impacts in food processing industry and ii) on the importance of access to technology transfer mechanisms and best available technologies.

Stakeholders' consultation process on heavy industry (iron and steel, petro-chemical, cement and others) with Ministry of Strategic Industries Development did not take place as of mid-February 2021, but various bilateral discussions took place with relevant business representatives.

Overall emission reduction potential in the Industry sector for 2021-2030, based on Combined Scenario: 111.4 mln t CO_2

3.4.1. Energy audits and energy management systems for industrial companies

1. **Status:** on-going
2. **Implementation period starts:** 2014
3. **Type of measure:** Regulatory, Institutional
4. **Objectives:** Identification of least cost EE opportunities, which can offer Ukrainian industrial enterprises more than 20% energy savings; guarantee that the robust energy and production data are gathered and reported by large (and medium sized) organizations; better definition of the costs and benefits of larger capital investment projects, reducing uncertainty and risk in the capital expenditure appraisal.
5. **Description:** As part of the Energy Efficiency Directive 2012/27/EU, Article 8 obliged all "non-SME" organizations (i.e. large businesses) to introduce: mandatory energy auditing of at least 90% of the Organization's estate every 4 years, or Independent certification of a recognized Energy Management system standards (e.g. ISO 50001). In Ukraine, this requirement is planned to be adopted as part of the adoption of the Energy Efficiency primary legislation. It is estimated that 446 non-SME organizations would be subject to the legislation with the obligation for the first series of audits being complete before 2022. It is expected that this requirement of energy audits and / or energy management systems will also apply to any company seeking state assistance for energy efficiency measures - in order to make a proper Measurement, Reporting and Verification system possible. Energy auditing and energy management systems will also be encouraged amongst other SMEs but not required.
   This measure also involves the setting up of officially approved qualification certification and/or accreditation schemes, including suitable training facility and programmes for industry.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Industry
9. **GHG(s) affected:** CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry of Strategic Industrial Sectors
11. **Implementation period finish: 2030**
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12, SDG16

3.4.2. Service contracting and additional consultancy for industrial companies

1. **Status:** planned/recommended
2. **Implementation period starts:** 2020
3. **Type of measure:** Regulatory
4. **Objectives:** improvement of efficiency/competitiveness of industry, decrease of pollution from coal burning and improvement of air quality.

5. **Description:** This measure involves implementation of the energy service contracts between enterprises owners and ESCO companies. GoU will develop a clear definition of energy performance contracting in the industry sector with clearly defined financing system from the side of ESCO companies. Additionally, the measure will include awareness raising activities and ongoing support from the Government for industrial actors / ESCOs as those are prerequisite for the effective implementation of this measure.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Industry
9. **GHG(s) affected:** CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry of Strategic Industrial Sectors
11. **Implementation period finish:** 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12

3.4.3 Energy efficient measures stimulation/incentives for industrial enterprises

1. **Status:** planned/recommended
2. **Implementation period starts:** 2020
3. **Type of measure:** Regulatory
4. **Objectives:** introduction of energy efficiency measures stimulation mechanisms for industrial companies.
5. **Description:** establishing governmental financial incentive mechanism to encourage EE measures in industrial companies. Another mechanism is voluntary energy performance targets for key industrial sectors that are based on energy-audit results and would create additional fiscal incentives for the companies that meet those voluntary targets. Over time, if deemed necessary, these targets may become mandatory for certain industries.
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Industry
9. **GHG(s) affected:** CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry of Strategic Industrial Sectors
11. **Implementation period finish:** 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12

3.4.4. Access to EU R&D activities for Ukrainian industrial companies

1. **Status:** Recommended
2. **Implementation period starts**: 2020/ 2021
3. **Type of measure:** institutional
4. **Objectives:** to ensure access of Ukrainian industrial companies to EU-based R&D activities and it's outcomes, industrially proven best available technologies
5. **Description:** European Union supports various research & development initiatives aimed to increase competitiveness and efficiency of different European industries. However, currently Ukrainian enterprises are not involved in such activities, although accordingly to the Association Agreement Ukraine eventually will be aligning its major industrial policies with those of the EU. It's important to ensure proper access of Ukrainian industrial companies and industrial associations into R&D and modernization activities conducted by the European Union.
6. **Quantified objectives:** no indicators

7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Industry
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** The Ministry of Economic Development, Trade and Agriculture of Ukraine; Ministry of Strategic Industrial Sectors
11. **Implementation period finish:** 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12, SDG17

3.4.5. Hydrogen Technologies for Industry

1. **Status:** recommended
2. **Implementation period starts:** 2022-2025
3. **Type of measure:** economic, technological
4. **Objectives**: stimulation of hydrogen and other time green hydrogen use for industrial processes
5. **Description:** Promotion of hydrogen and green hydrogen use to produce methanol for polymers output. Hydrogen can also be source for ammonia production that is used for fertilizers to replace currently used natural gas. In 2019 in Ukraine, consumption of conventional ammonium nitrate reached 2 million tons, and of carbamide-ammonia mixture – 0.9 million tons. Domestic output of conventional ammonia fertilizers shrinks due to increasing competition from cheap natural gas producing countries. Therefore, the use of green hydrogen for ammonia fertilizers in Ukraine should take into account relevant costs implications for fertilizers production, while aiming to enhance agricultural and economic safety of Ukraine.
6. **Quantified objectives**: n/a
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected**: chemical industry
9. **GHG(s) affected**:
10. **Entities responsible for implementing:** The Ministry of Economic Development, Trade and Agriculture of Ukraine; Ministry of Strategic Industrial Sectors
11. **Implementation period finish**: n/a
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12

3.5 TRANSPORT

Policies and measures for transport sector are aimed to improve transport infrastructure, including inter-modality, on national, regional and municipal levels, improving quality of public transportation and thus increasing the number of people choosing it to travel, incentivizing efficient and electric vehicle purchase and use, improving quality of roads, railroad electrification and introduction of hydrogen as new fuel for vehicles. All proposed policies and measures will be also leading to improved quality of air in the cities, improved traffic situation and security of transport. It is also recommended to introduce separate renewable energy target for transport sector.

Stakeholders' consultation process on the following sectoral transport and transport infrastructure policies and measures and with Ministry of Infrastructure took place, and Ministry of Infrastructure provided their comments as per Ukraine's 2030 Transport Strategy relevant goals and indicators. Key comments from Ministry of Infrastructure and its support structures were on: i) rail transport electrification rate, ii) transport inter-modality, iii) reliability of data used for modelling, iv) urban mobility and v) public transport electrification policies and measures. Some of the comments for transport sector policies and measures were also related to planned rate of electrification of railroad transport.

Overall emission reduction potential in the Transport sector for 2021-2030, based on Combined Scenario: 80.2 mln t CO_2

3.5.1. CO2 Emissions Performance Standards

1. **Status:** recommended
2. **Implementation period starts:** 2016
3. **Type of measure:** regulatory, economic
4. **Objectives:** Improved CO2 emission performance standards of new passenger and light commercial vehicles.
5. **Description:** Emission standards is one of the most effective means of state policy in transport sector, aimed at reduced CO2 emissions. CO2 emissions performance standard is an impetus for innovation and increased competitiveness of economy, coupled with citizens indirect health benefits. Regulation provisions similar to Regulation (EU) 2019/631 should be adopted in Ukraine, whereas in the EU these provisions are enacted from 2020. The Regulation sets the threshold of emission not exceeding 95 g CO_2/km for the new passenger car and 147 g CO_2/km for new light commercial vehicles. Starting 2021 and onwards, the respective threshold of emissions should decrease by 10 g/CO2/km. Starting 2025 and onwards, average emissions level from both passenger and light vehicles should decrease by 15% compared to 2021 level.
6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected**: transport
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Infrastructure
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12, SDG13, SDG17

3.5.2. Improving the quality of highways

1. **Status:** On-going
2. **Implementation period begins:** 2018
3. **Type of measures:** Technological, enforcement of existing legislation
4. **Description:** The Regional Development Strategy for the period up to 2027 sets a goal to improve the quality of highways as annually the economy of Ukraine loses a lot of money through poor quality roads. Climate change in Ukraine is a key factor in the impact on the roads, namely rising air temperatures, and as a consequence of increasing the pavement temperature, that directly affects the performance and life cycle of the road.
5. **Objectives:** High quality highways and roads not only promotes economic development in many ways (for instance increases crop yields[30]), but also decreases fuel consumption, carrying an important mitigating potential. the usage of cement concrete (rigid road clothing) technologies in road construction that will allow reducing substantially the state budget expenditures, provided that the projects are calculated on the basis of the full life cycle of the road, that is several times higher in cement concrete projects than in asphalt concrete. Compulsory compliance with the requirement of DBN B.2.3-4: 2015 "Highways. Part I. Designing. Part II. Building, "namely clause 4.3.4:" when the expected intensity of heavy goods vehicles is greater than 15% of the total flow, only rigid road clothing is designed".
6. **Quantified objectives**:

[30] Nelson G. C. (2009) Climate Change: Impact on Agriculture and Costs of Adaptation. International Food Policy Research Institute: Washington. http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/130648/filename/130821.pdf

7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected:** transport
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish:**
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12, SDG13, SDG15

3.5.3. Improved Transportation Infrastructure

1. **Status:** Recommended
2. **The implementation period begins:** N/A
3. **Type of measures:** regulatory
4. **Objectives:** GHG emission reductions as a result of transportation modes optimization and therefore improved air quality.
5. **Description:** Development of road infrastructure (cement concrete (rigid road clothing) technologies in road construction) for transportation of heavy goods by road and corresponding reduction of the number of trucks on the roads. Renewal of railway network with consideration of higher air temperature, heavy snowfalls would prevent transportation disruptions and economic losses. Use of rail instead of trucks has high mitigating effect, allowing emission reduction derived from road construction and vehicles manufacturing[31]. Transfer of part of the passenger traffic from private cars to water transport (where applicable) could also have mitigating effect, however it requires creation and improvement of respective infrastructure.
6. **Quantified objectives**:
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected:** transport
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish:** n/a
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12, SDG13, SDG15

3.5.4. Optimizing the structure of passenger and freight traffic in cities

1. **Status:** on-going
2. **Implementation period starts:** 2010
3. **Type of measure:** Regulatory
4. **Objectives:** energy and fuel savings in transport sector, reduced traffic issues, improved air quality.
5. **Description:** This measure would envisage national support for transport infrastructure planning for local authorities. The fuel savings would result from decreasing fuel consumption via creating more zones (in cities) forbidding the use of private transport and launching paid parking lots, so to stimulate people to use public transport. Introduction of schemes and modes of passenger and freight transport services that would help consume less fuel. Introduction of new transport service technologies related to logistics, navigation, communication, and information.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Municipal Transport

[31] Åkerman, J. The role of high-speed rail in mitigating climate change – The Swedish case Europabanan from a life cycle perspective. Transportation Research Part D: Transport and Environment. Volume 16, Issue 3, May 2011, Pages 208-217

9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Local/municipal authorities
11. **Implementation period finish: 2030**
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12

3.5.5. Support for public transport fleet renovation

1. **Status:** on-going
2. **Implementation period starts:** 2014
3. **Type of measure:** Regulatory, existing legislation enforcement
4. **Objectives:** renovation of the public transport fleet by more efficient vehicles, including hybrid and electric vehicles.
5. **Description:** At the national level and at the municipal level, various institutions have plans to replace the obsolete public transport vehicles with more comfortable and passenger-friendly ones by modernization and purchasing new vehicles. This measure requires introduction of incentives and/or requirements for private and public entities to purchase electric vehicles in order to increase the efficiency of the fleet over time.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Transport
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish: 2030**
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12

3.5.6. Incentives and Stimulation Measures for Electric Vehicles

1. **Status:** recommended
2. **Implementation period starts:** N/A
3. **Type of measure:** fiscal, regulatory
4. **Objectives**: stimulation and promotion of e-mobility and increased share of EVs in the domestic road transport
5. **Description**: This policy measure aims at introducing procurement regulation for public companies to purchase electric vehicles. The volume of public procurement in Ukraine annually reaches 13% of GDP. Draft Laws 3476 and 3477, adopted in the first reading, contain provision of purchase not less than 50% of Electric Vehicles from the total until 2030. In December 2017, VAT tax and import tax exemptions were introduced for electric vehicles. Currently, VAT exemption for imported EVs valid until 2023, excise tax for EVs was lower than that for hybrid passenger vehicles (excise tax for EVs is EUR 1/kWh of battery capacity), and additional 5% import duty abolished. But in June 2020, vehicle classification for taxation purposes was amended, so from July 2020 e-vehicles are subject to VAT. Tax exemption of sales profit obtained from selling of electric chargers, vehicles and their parts manufactured in Ukraine is valid until 2034; provision of a tax rebate on personal income tax for those buy Electric Vehicle valid until 2031; exemption from the mandatory state retirement pension insurance for those buying Electric Vehicles until 2031. Introduction of fines for parking of vehicles using internal combustion engines on parking spaces marked as those for EVs. New green numeric plates for EVs and new road signs were introduced. Promotion and stimulation of local authorities to install municipal EV chargers and creating EV Charging infrastructure by adoption of municipal and regional programs of EV Charging infrastructure programs shall be introduced, simplifying land entitlement procedures

and creating financial incentives for e-vehicles infrastructure is needed.

6. **Quantified objectives**: National Transport Strategy until 2030 set e-transport target - reaching 75% of domestic electric vehicles by 2030
7. **Total GHG emission reductions (tCO2e)**: indirect
8. **Sectors affected**: transport
9. **GHG(s) affected**: CO_2, CH_4,
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine, Ministry of Economic Development, Trade and Agriculture of Ukraine, local authorities
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.5.7. Fiscal incentives for private transport fleet renovation

1. **Status:** on-going
2. **Implementation period starts:** 2014
3. **Type of measure:** Regulatory, existing legislation enforcement
4. **Objectives:** increase the share of high fuel efficiency vehicles (e.g. hybrids) and electric vehides in the private transport fleet.
5. **Description:** This measure involves an existing national policy to stimulate the purchase of hybrid and electric vehicles by reducing the excise tax on them. This policy has reduced the excise tax for electric vehicles to EUR 1 per kW. Since most cars are imported to Ukraine, this will have an impact on fuel efficiency and the vehicle fleet. Another potential way to revise this policy would be to base the excise tax upon expected fuel consumption (or GHG emissions) per unit of distance – to prevent large engines which are hybrid (or electric) engines but do not actually save energy or reduce emissions.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Transport
9. **GHG(s) affected:** CO_2,
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.5.8. Electrification of Road Transport

1. **Status:** on-going
2. **Implementation period starts:** 2018
3. **Type of measure:** regulatory, existing legislation enforcement
4. **Objectives**: increased share of EVs in the domestic road transport stock.
5. **Description:** The use of EVs is one of the tools that can reduce GHG emissions by the transport sector and significantly improve the quality of air in cities, especially in case the EVs use electricity from renewables. EVs have a lower noise level than those with internal combustion engine (ICE); they can contribute to the reduction of pollutants, and enable Ukraine to implement new technologies.
6. **Quantified objectives**: According to National Transport Strategy until 2030, the share of e-transport has to reach 75% of domestic transport stock by 2030.
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: transport, power
9. **GHG(s) affected**: CO_2,
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine

11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.5.9. Hydrogen Technologies for Transport

1. **Status:** recommended
2. **Implementation period starts:** 2022-2025
3. **Type of measure:** economic
4. **Objectives**: stimulation of hydrogen use for transport to replace traditional fossil fuels to improved GHG emission performance and improve fuel security.
5. **Description:** Stimulation and promotion of use of hydrogen, including green hydrogen to replace traditional transport fossil fuels, including LPG. Ukraine has estimated potential of annual output of 5.5 million cubic meters of green hydrogen.
6. **Quantified objectives**:
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected**: transport
9. **GHG(s) affected**: CO2, CH4
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish**: non applicable
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12

3.5.10. Approximation of Directive on roadworthiness tests for motor vehicles and their trailers

1. **Status:** on-going
2. **Implementation period starts:** 2019
3. **Type of measure:** Regulatory
4. **Objectives:** improved energy performance due to improved maintenance of the vehicle fleet.
5. **Description**: Ukraine has committed to implementing the EU Directive No 2009/40/EC on roadworthiness tests for motor vehicles and their trailers. This measure involves introduction of an inspection regime for all types of road vehicles which would be linked with vehide registration. The measure improves safety, efficiency and environment impact of the vehicles. Implementation involves the setting up of approximately 100 technical inspection centres around the country, with 3 inspection lanes each. The inspections is mandatory on annual basis for all registered cars - with the exception of new cars which may have a grace period of 2-3 years.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** Transport
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish:**
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12

3.5.11. Renewable Energy Target in Transport Sector

1. **Status:** on-going
2. **Implementation period starts:** 2014
3. **Type of measure:** Regulatory, enforcement of existing legislation
4. **Objectives**: increase the share of renewable and alternative energy sources in transport sector

5. **Description:** National policy on renewable energy set the renewable energy target in order to increase the share of energy sources, produced from renewable energy in structure of total energy consumption in Ukraine in 2020 until the level not lower than 11%. This policy also has a goal of increasing the use of renewable energy sources in transport sector.
6. **Quantified objectives**: 10% of renewable energy share in transport sector by 2020. and share level of biofuels and electricity use has to reach 50% by 2030.
7. **Total GHG emissions reductions (t CO_2e):** Direct
8. **Sectors affected**: transport
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, Ministry of Infrastructure of Ukraine
11. **Implementation period finish**: n/a
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12, SDG13

3.6 BUILDINGS

Buildings/housing sector is an important sector for Ukraine, therefore policies and measures proposed in this sector are aimed in improving institutional capacities of recently established Energy Efficiency Fund, introducing recent EU buildings standards and requirements, while establishing relevant financial mechanisms for improving energy efficiency of public buildings, private buildings and housing, and commercial buildings. Smart metering system for all utilities is another set of complex policies that ought to be gradually introduced throughout the utilities supply system.

The same stakeholders' consultations on the following policies and measures in heating and buildings sectors took place during the period of December 2020 – January 2021, including consultations on residential housing (multi-stored and individual households), public buildings and district heating policies and measures with relevant responsible ministry and its authorities – MinRegion. During these consultations proposed policies and measures been discussed and some initial reflections and feedback had been provided by MinRegion and its' supporting structures officials. MinRegion provided comments on proposed policies and measures under the following structure – thermo-modernization and enhanced energy efficiency of buildings with expected rate 0.5% of buildings modernized per year (under both Energy Efficiency Fund and Warm Credits State Program activities support) and district heating modernization, which should be considered in close coordination with buildings modernizations and reconstructions to improve its energy efficiency and reduce fossil fuel consumption or replace types of fuels for less carbon intensive. Relevant updates were included in Combined Sensitivity Scenario (see page 50-52 of this Report).

Overall emission reduction potential in Buildings sector for 2021-2030, based on Combined Scenario: 95.5 mln t CO_2

3.6.1. Empowering Energy Efficiency Fund

1. **Status:** on-going
2. **Implementation period starts:** 2019
3. **Type of measure:** Economic, Regulatory
4. **Objectives:** improvement of the building stock and decreasing the ongoing costs for energy in

buildings.

5. **Description:** The Energy Efficiency Fund was set up by the Ukrainian government in 2018, in close cooperation with the EU and Germany. EUR 80 million (for grants to Ukrainian home-owners) have already been allocated by the EU and Germany has also allocated EUR 20 million to the programme. The Financing Agreement between Ukraine and the EU provides a basis for the implementation of the EUR 104 million Energy Efficiency support programme for Ukraine (EE4U), adopted by the European Commission and co-signed by the Government of Ukraine in 2018.
   For the first 3 to 4 years, the main target group will be multi-apartment buildings with possible extension to single family buildings. With a larger contribution from the Ukrainian State budget, the target could perhaps (e.g. after 2025) start providing grants for public building improvements. However, the latter will would require upgrading of the monitoring and verification system for public buildings.
   Besides the EE Fund, there are other ongoing and planned programmes such as the "Warm Loans" programme – "State Target Economic Program for Energy Efficiency and Development of the Energy Sources for Renewable Energy Sources and Alternative Fuels for 2010-2020". The programme was supported by the European project "Support to the implementation of Ukraine's Energy strategy in the area of energy efficiency and renewable sources of energy". Another example is The IQ Energy program implemented by the EBRD and funded by the EU.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** municipal/housing sector
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry for Communities and Territories Development of Ukraine
11. **Implementation period finish:**
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.6.2. Energy Performance and Energy Certification of Buildings

1. **Status:** on-going
2. **Implementation period starts:** 2017
3. **Type of measure:** Regulatory
4. **Objectives:** implementation of the EPBD requirements will likely lead to significant cost-effective energy savings.
5. **Description:** The EPBD has been transposed in the primary legislation of Ukraine through the Law on Energy Efficiency in Buildings. This measure includes the following:
   - Adoption of a methodology for calculating the energy performance of buildings;
   - Calculation of cost-optimal levels of minimum energy performance requirements and setting these levels for new and existing buildings;
   - For new buildings, ensuring that before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems if available is considered and taken into account;
   - For existing buildings, ensuring that when buildings undergo major renovation, the energy performance of the building or the renovated part is upgraded to meet minimum energy performance requirements;
   - For the purpose of optimizing the energy use of technical building systems, setting system requirements in respect of the overall energy performance, the proper installation, and the appropriate dimensioning, adjustment and control of the technical building systems;

- Ensuring that a target date is set and implemented for all new buildings to be nearly zero energy buildings;
- Where considered appropriate, development of financial incentives to address market barriers;
- Development and implementation of a system for energy performance certification for new and existing buildings;
- Implementation of necessary actions to establish regular inspection of the accessible parts of systems used for heating buildings and air conditioning systems;
- Development of a building stock Inventory;
- Development of reference buildings.

Additionally, development of minimum energy performance requirements for new or newly refurbished buildings is included in the law – though the levels have not yet been established. Implementation of energy certification in buildings sector involves:

- Setting up of officially approved certification of building schemes which is important for enhancing information available for consumers when purchasing or renting property, and ensuring a standardized approach and process for certification of buildings (also to ensure compliance with the Law on Energy Efficiency and secondary legal acts); and
- Setting up their accompanying accreditation schemes for experts, including suitable training facility and programmes as relates to buildings. This will increase the number and capacity of providers of energy services, energy audits, energy managers and installers of energy-related building elements. :

6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** building sector
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry for Communities and Territories Development of Ukraine
11. **Implementation period finish:**
12. **Linkage with SDG:** SDG1, SDG7, SDG8, SDG9, SDG11, SDG12

3.6.3. Energy management and information system for public buildings

1. **Status:** on-going
2. **Implementation period starts:** 2017
3. **Type of measure:** Economic
4. **Objectives:** reduction of energy consumption in the public buildings sector.
5. **Description:** The aim of this policy is to provide information about energy efficiency planning on the municipal and national level for publicly owned buildings. This will make it possible to calculate savings required to comply with Article 5 EED. The measure involves creating a database on energy consumption at the national level to allow for analysis and evaluation. Based on increased availability of information and the implementation of an Energy Management Information System, it will then be possible to implement no-cost / low-cost measures such as lighting controls (turning lights off when buildings are not occupied), heating controls (ensuring appropriate temperatures and turning off heating / cooling systems when buildings are not occupied), identification of large energy losses and actions to prevent those losses, etc.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect

8. **Sectors affected:** building sector
9. **GHG(s) affected:** CO_2, CH_4,
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry for Communities and Territories Development of Ukraine, local authorities
11. **Implementation period finish:** n/a
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.6.4. Energy efficiency investment programs for public buildings

1. **Status:** on-going
2. **Implementation period starts:** 2017
3. **Type of measure:** Economic, fiscal
4. **Objectives**: creation of investment programs and special preferential loans for energy efficiency measures in public buildings sector.
5. **Description:** This policy foresees the establishment of fiscal incentives and preferential loans and crediting lines for improvement of EE in public buildings. Investments will include refurbishment of the building envelopes and heating / cooling systems to reduce overall energy losses/decrease demand. In terms of national-level support to local authorities, the policy involves activities related the implementation of the State Fund of Regional Development operated by Ministry Communities and Territories Development of Ukraine that is used to finance refurbishments of substantial amount of public buildings throughout Ukraine. This measure is in line with fiscal measure 2.10.3
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** building sector
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine, Ministry for Communities and Territories Development of Ukraine
11. **Implementation period finish: n/a**
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12

3.6.5. Promotion heat and hot water metering and consumption-based billing

1. **Status:** on-going
2. **Implementation period starts:** 2015
3. **Type of measure:** Regulatory, existing legislation enforcement
4. **Objectives:** reliable and on-going heat and hot water consumption levels in order to take best investment decisions.
5. **Description:** This measure involves policies leading to increase the level of heat and hot water metering in the building sector – in particular related to the district heating sector. There is a requirement for heat meters to be installed at the building level for all new buildings and – over time - for existing buildings as well. Additionally, there will be encouragement of dwelling-level metering in the residential sector. It's expected that 100% of multi-apartment buildings will have metering of heat and hot water by 2030.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** building sector
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** The National Commission for State Regulation of Energy and Public Utilities, Ministry for Communities and Territories Development of Ukraine, local

authorities

11. **Implementation period finish:** n/a
12. **Linkage with SDG:** SDG6, SDG7, SDG8, SDG9, SDG11, SDG12

3.7 AGRICULTURE AND FORESTRY

Agriculture and forestry policies and measures are aimed to introduce smart agriculture and forestry principles and promote best available technologies application in crop and livestock production, as well as enhancing sustainable forests management practices. Development and adoption of framework national Agricultural Strategy that will enable and incentivize smart agriculture technologies, such as wider application of telecommunication, no-tillage, smart and controlled fertilizers use, development of organic and local production. Empowering forestry sector through afforestation and forest protection are crucial policies for GHG emissions removals.

Stakeholders' consultations in forestry and agriculture sectors took place during December 2020 – February 2021 with MinEconomy and Agriculture and State Forestry Agency. In total, four meetings were conducted. The MinEconomy (currently still responsible for agriculture) provided clarification comments on proposed policies and measures, such as IT technologies in agriculture, no-tillage and switch to organic farming and bioenergy potential for GHG removals and sinks. MinEconomy also informed that no separate Agricultural Strategy is planned to be developed and all sectoral development plans and indicators are reflected in recently adopted National Economy Strategy until 2030.

Relevant comments provided on projected level of afforestation were considered and reflected in the policies and measures presented below. While stakeholders' consultations took place, a separate Ministry of Agriculture was established, taking relevant functions that so far had been under the MinEconomy, and this could have potential consequences for formal concurrence process for the NDC adoption.

Overall emission reduction potential in Agriculture and Forestry sector for 2021-2030, based on Combined Scenario: 66.4 mln t CO_2

3.7.1. Agricultural strategy

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Economic
4. **Objectives**: to develop long-term vision of development of agriculture
5. **Description:** agriculture is one of key sectors in Ukrainian economy, especially crop production. Having many big, medium and small enterprises in this field, as well as farmers, the Government needs to develop and communicate long-term vision of development of agriculture. The strategy may contain high-level vision of high priority areas in the agriculture, desirable management practices from sustainable and low Carbon development point of view, elements of land-use management in different regions and other. The strategy should include instruments to overcome barriers for implementation, especially economical. Strategic vision for agricultural sector is reflected in general National Economy Strategy up to 2030, adopted by GoU in March 2021.
6. **Quantified objectives**: -
7. **Total GHG emissions reductions (t CO_2e):** -

8. **Sectors affected**: agriculture
9. **GHG(s) affected**: CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine, Ministry of Environmental Protection and Natural Resources of Ukraine, Ministry of Finance of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG1, SDG2, SDG5, SDG6, SDG7, SDG8, SDG9, SDG12, SDG13, SDG15

3.7.2. Promotion of conservation tillage technologies

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Recommendation on management practices
4. **Objectives**: to reduce GHG emissions from agricultural soils
5. **Description:** low and no-till technologies are proven to reduce GHG emissions from agricultural soils, as well as save some operational costs for enterprises and farmers. This measure has some limitations in terms of which crops and where it might be applied, but the estimated potential of technology application is around 17 mln ha. This policy could be operationalized by fiscal and other economic incentive instruments such as tax exemptions, reduced rate loans and others.
6. **Quantified objectives**: 5 million ha
7. **Total GHG emissions reductions (t CO_2e):** 3 000 000
8. **Sectors affected**: agriculture
9. **GHG(s) affected**: CO_2, N_2O
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG2, SDG6, SDG8, SDG12, SDG13, SDG15

3.7.3. Promotion of use of information and telecommunication technologies in crop production

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Recommendation on management practices
4. **Objectives**: to reduce GHG emissions from excessive irrigation and use of fertilizers
5. **Description:** information and telecommunication technologies, like drones and satellite images, together with specialized software, help to develop and use detailed maps of soil and crops conditions. This would enable to define particular plots of fields, where application of fertilizers is needed instead of applying it to entire field, consequently reducing emissions from fertilizers application. It also has co-benefits of reducing GHG emissions from reduced equipment and tractor use for irrigation and fertilization and some others.
6. **Quantified objectives**: -
7. **Total GHG emissions reductions (t CO_2e):** 350 000 (N_2O)
8. **Sectors affected**: agriculture
9. **GHG(s) affected**: CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG4, SDG8, SDG9, SDG12

3.7.4. Promotion of use of slow- or controlled-release fertilizer forms

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Recommendation on management practices
4. **Objectives**: to reduce GHG emissions from increased efficiency of fertilizers use
5. **Description:** during application of traditional forms of inorganic fertilizers there are losses of Nitrogen due to inability of plants to uptake immediately all of it, together with some losses due to leakages. New forms of fertilizers, which slowly releases Nitrogen, allows to increase share of Nitrogen consumed by plants, decreasing need to apply big amounts of fertilizers. There are also additional effects of this on GHG emission reduction by decreased N-fertilizers production.
6. **Quantified objectives**:
7. **Total GHG emissions reductions share (t CO_2e):** 300 000
8. **Sectors affected**: agriculture
9. **GHG(s) affected**: N_2O
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG6, SDG9, SDG12, SDG15

3.7.5. Promotion of organic crop production

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Recommendation on management practices/Economic
4. **Objectives**: to promote low emission organic agriculture systems in Ukraine
5. **Description:** Organic agriculture is known management practice, which largely exclude use of chemicals (including ones that emits GHGs) but rely on organic products. By this means it is seen as low emission agricultural system. Ukraine has big potential for organic agriculture, however usually it is supported by governments (for example, in EU).
6. **Quantified objectives**: 2 million ha of production
7. **Total GHG emissions reductions (t CO_2e):** 2 000 000
8. **Sectors affected**: agriculture
9. **GHG(s) affected**: CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG2, SDG4, SDG12, SDG13, SDG15

3.7.6. Reduction GHG emissions from livestock

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Recommendation on diet
4. **Objectives**: to promote low emission diet for livestock
5. **Description:** Emissions from enteric fermentation of livestock has limited capacity for reductions. However, feeding practices directly affects methane emissions from livestock, for example specific diets and dietary additions (inhibitors, lipids etc.). Share of information about possible options in diet is needed (possibly through the state consultancy).

6. **Quantified objectives**: -
7. **Total GHG emissions reductions (t CO_2e):** 1 500 000
8. **Sectors affected**: agriculture
9. **GHG(s) affected**: CH_4
10. **Entities responsible for implementing:** Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG2, SDG6, SDG12, SDG13

3.7.7. Afforestation

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Economic
4. **Objectives**: to accelerate afforestation
5. **Description:** afforestation is one of the simplest and efficient way of GHG removals increase. Previous experience with the state program of afforestation promotion showcasing good practice of establishment of new forests by providing funding by the state budget.
6. **Quantified objectives**: 17 % forest cover in 2030
7. **Total GHG emissions reductions (t CO_2e):** 22 590 000
8. **Sectors affected**: forestry
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources of Ukraine, State Forest Resources Agency of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG6, SDG12, SDG13, SDG15

3.7.8. Land allocation mechanism

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Economic, regulatory, existing legislation enforcement
4. **Objectives**: to facilitate conversion of lands into forests and grasslands
5. **Description:** the policy is related with plans of conversions of lands to forests and grasslands. Previous experience resulted in some issues with land allocation for afforestation. In light of establishment of market of arable lands, the Government should consider how lands for implementation of state programs should be assigned. Special priority should be given to lands not allocated for forestry, but covered by woody vegetation naturally, to retain and promote the growth of forest.
   The mechanism should also include instruments (regulatory, enforcement) to ensure, that lands are used in accordance to their legal allocation.
6. **Quantified objectives**: -
7. **Total GHG emissions reductions (t CO_2e): -**
8. **Sectors affected**: forestry
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources of Ukraine, State Forest Resources Agency of Ukraine, State Service of Ukraine for Geodesy, Cartography and Cadastre
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG1, SDG2, SDG3, SDG6, SDG12, SDG13, SDG15

3.7.9. Strengthening the forest protection

1. **Status:** Recommended
2. **Implementation period starts:** -
3. **Type of measure:** Economic
4. **Objectives**: to strengthen forest protection activities in forests
5. **Description:** portion of GHG emissions from forests occur due to disaster events, like fires, pests and disease. Investing more efforts for protection of forests (early fire warning systems, chemical and biological treatment and others) will result in lower losses due to disturbances. Economic incentives for forest enterprises is one of the options for enhancement of forest protection.
6. **Quantified objectives**: -
7. **Total GHG emissions reductions (t CO_2e):** 2 030 000
8. **Sectors affected**: forestry
9. **GHG(s) affected**: CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources of Ukraine, State Forest Resources Agency of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG2, SDG3, SDG6, SDG12, SDG13, SDG15

3.8. WASTE SECTOR

Waste sector policies and measures are aimed to introduce best practices waste management hierarchy in Ukraine, while ensuring the development of centralized waste collection system throughout Ukraine and putting Ukraine on track of circular economy principles. Municipal solid waste and sludge/waste water treatment technologies in Ukraine are out-of-date and therefore best available technologies application is essential for sustainable development of waste sector in Ukraine. Another set of policies in municipal waste management is stimulation of waste use and utilization as alternative fuel in other industries, such as cement and others. One more set of proposed policies is recovery of valuable energy sources, such as electricity and biogas production, fertilizers production and others. Municipal waste prevention policies that limit the amount of waste reaching the landfills are also important in this sector, as this sector is expected to grow in the mid-term.

Stakeholders' consultation process on waste sector took place with relevant department of MinEcology, who provided their clarification comments, especially on the investment level for landfill or waste processing unit. During the follow-up meeting with MinEcology and sectoral experts, potential level of investment per landfill, specific technology and less ambitious targets of waste treatment than in the existing Waste Management Strategy were mainly discussed.

Overall emission reduction potential in the waste sector for 2021-2030, based on Combined Scenario: 15.4 mln t CO_2

3.8.1. Prevention of MSW disposal

1. **Status:** on-going
2. **Implementation period starts:** 2017
3. **Type of measure**: Fiscal, Economic, Regulatory
4. **Objectives:** to decrease the share of MSW landfilling.
5. **Description**: National Waste Management Strategy of Ukraine up to 2030 approved in 2017 sets up the target to decrease MSW landfilling share from approximately 95 % in 2016 to 30 % in 2030. For its implementation, National Waste Management Plan up to 2030 was approved

in early 2019, which includes concrete policies and measures to be implemented in accordance with fixed time schedule, responsibilities and quantitative indicators. Unfortunately, the goals that have been set up un the Strategy are overambitious in light of Ukraine's circumstances, and could be hardly achieved by 2030. In this regard, decreasing of MSW landfilling share from 95 % in 2017 to 70 % by 2030, from one hand is realistic, from the other hand is moderately optimistic.

To prevent the disposal of 30 % from the amount of generated MSW, a complex of policies and measures should be implemented, which would be consistent, have a synergy effect, stimulate modern waste treatment technologies diffusion and liberalization of waste treatment services market.

Such a reduction of MSW disposal share could be achieved primarily due to diffusion of the following waste treatment technologies, which are also recommended by TNA project in Ukraine:

- Waste sorting;
- The closure of old waste dumps;
- The construction of new regional sanitary MSW landfills (as an intermediate measure to avoid a collapse from rapid closure of old dumps)[32];
- The mechanical biological treatment of waste with biogas and energy production;
- The mechanical-biological treatment of waste with alternative solid fuel for district heating and/or electricity production;
- The mechanical biological treatment of waste with SRF production for cement industry;
- The aerobic biological treatment (composting) of food and green residuals.

Annex A provides information in detail on the concrete measures to achieve 30 % reduction of MSW disposal by 2030, the existing barriers to achieve this indicator, as well as the ways to overcome them.

Cross-sectoral issues:
Rational use of waste as an energy and material resource have a strong synergistic effect leading to significant GHG emission reductions in other sectors. Secondary use and recycling will decrease the fuel and mineral production needs to produce glass, plastics, metals, cardboard etc., effecting to correspondent GHG emission reductions in Energy sector (Energy industries and Manufacturing industries and construction) and Industrial Processes and Product Use sector (Mineral, Chemical, Metal industries etc.). Composting will prevent the loss of biomass leading to decreasing of fertilizers needs in agriculture sector, as well as for municipal and small-scale households (private sector) needs. Energy use of waste directly as a fuel or as a raw material for fuel production will lead to increasing the share of renewables in total primary energy supply and correspondent reduction of GHG emissions in Energy sector (Energy industries and Manufacturing industries and construction) and Industrial Processes and Product Use sector (Mineral industries, e.g. cement production).

6. **Quantified objectives**: Share of MSW landfilling – 70 %.
7. **Total GHG emissions reductions (t CO_2e):** 93 000 t CO_2-eq.
8. **Sectors affected**: waste
9. **GHG(s) affected**: CH_4, N_20, CO_2
10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources of Ukraine, Ministry of Community and Territory Development of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish**: 2030

[32] May lead to increase of methane emissions in short-term perspective. Nevertheless, will contribute to methane emission reduction in long-term time horizon. The other important benefits are environmental, social, market development, increasing of gender equality et.

12. **Linkage with SDG:** SDG3, SDG8, SDG9, SDG11, SDG12, SDG13

3.8.2. Stimulation of electricity production from landfill biogas

1. **Status:** Ongoing
2. **Implementation period starts:** 2013
3. **Type of measure**: Economic, Fiscal
4. **Objectives:** to stimulate landfill operators to put into operation efficient degassing systems with subsequent landfill gas energy recovery facilities
5. **Description**: This measure is an example of effective acting mechanisms aimed to increase the share of RES in power sector of Ukraine, as well as to reduce GHG emissions in Waste sector. Such a result was achieved due to the implementation of "green tariff' for electricity production from landfill biogas. Further decreasing of GHG emission reduction caused by energy recovery of landfill biogas can be successfully achieved mostly due to the construction of new regional sanitary landfills equipped with landfill gas energy recovery infrastructure for electricity production needs. The amount of such new regional sanitary landfills needed for reduction of MSW disposal to the level of 70 % equals to 20 units.

Cross-sectoral issues:
Electricity production from landfill biogas will lead to increasing the share of renewables in total primary energy supply and correspondent reduction of GHG emissions in Energy sector, namely in Electricity and heat production category.

6. **Quantified objectives**: 16.5 % energy recovery from the total amount of generated MSW landfill gas
7. **Total GHG emissions reductions (tCO2e):** GHG emission reduction effect is included in section A.3.2
8. **Sectors affected**: Waste
9. **GHG(s) affected**: CH_4
10. **Entities responsible for implementing:** The Ministry of Finance of Ukraine, The Ministry of Energy and Environmental Protection of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12, SDG13

3.8.3. Stimulation of landfill gas flaring at MSW landfills

1. **Status:** Recommended
2. **Implementation period starts:** 2021
3. **Type of measure**: Economic, Fiscal
4. **Objectives:** to stimulate landfill operators to put into operation efficient degassing systems with subsequent landfill gas flaring facilities
5. **Description**: Currently (as for 2020) the fee for methane emissions is 138.57 UAH per 1 ton. Such a low rate does not stimulate landfill operators to reduce methane emissions from MSW landfills by using flaring technologies. Thus, only 31 tons of landfill methane was flared in Ukraine in 2017. Increasing of a fee for methane emissions, strengthening the monitoring system and stimulation of voluntary methane flaring activity at landfills will lead to diffusion of such type of technologies and corresponding decreasing of generated GHG from solid waste disposal sites
6. **Quantified objectives**: 4.2 % flaring from the total amount of generated MSW landfill gas
7. **Total GHG emissions reductions (t CO_2e):** 394 000 t CO_2-eq.
8. **Sectors affected**: waste
9. **GHG(s) affected**: CH_4

10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG8, SDG9, SDG11, SDG12, SDG13

3.8.4. Stimulation of methane energy recovery from wastewater treatment

1. **Status:** Recommended
2. **Implementation period starts:** 2021
3. **Type of measure**: Regulatory, Economic
4. **Objectives:** to stimulate operators of centralized wastewater treatment system to put into operation methane tanks with subsequent energy recovery or flaring.
5. **Description**: Centralized wastewater treatment systems are not equipped with methane energy recovery or flaring technologies in Ukraine. It results in millions of tons (in CO_2-eq.) of methane emissions. Implementation of practice to put into operation methane tanks with subsequent energy recovery or flaring as a required condition at the wastewater treatment facilities will lead to a significant methane emissions reduction from wastewater treatment. Sufficient "green" tariff for electricity production and increase of fee for emissions will contribute to reduction of methane emissions caused by wastewater treatment as well.

Cross-sectoral issues:
Electricity and heat production from methane generated as a result of wastewater treatment processes will lead to increasing the share of renewables in total primary energy supply and correspondent reduction of GHG emissions in Energy sector, namely in Electricity and heat production category.

6. **Quantified objectives**: 66 % utilization of methane generated from wastewater treatment
7. **Total GHG emissions reductions (t CO_2e):** 1 932 175 t CO_2-eq.
8. **Sectors affected**: waste
9. **GHG(s) affected**: CH_4
10. **Entities responsible for implementing:** State Agency for Water Resources of Ukraine, Ministry of Environmental Protection and Natural Resources of Ukraine, National Energy and Utilities Regulatory Commission of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG6, SDG7, SDG8, SDG9, SDG11, SDG12, SDG13

3.8.5. Denitrification of wastewater and sludge

1. **Status:** Recommended
2. **Implementation period starts:** 2021
3. **Type of measure**: Regulatory, Economic
4. **Objectives:** to stimulate operators of centralized wastewater treatment facilities to carry out deep denitrification of wastewater and sludge.
5. **Description**: High concentrations of nitrates and nitrites in wastewater and sludge lead to significant N_2O emissions in Ukraine. As for example, N_2O emissions per capita from wastewater treatment is many times less in Germany. Increasing the fee for N_2O emissions, which is 2452 UAH as for 2020 and raising the standards for wastewater purifying from nitrates and nitrites will ensure the further downwards trend of N_2O emissions from wastewater treatment in Ukraine.

Cross-sectoral issues:
Sludge may be used on agricultural soils as an organic fertilizer. It creates additional possibility to decrease GHG emissions in Agriculture and Industry and Product Use sectors, namely in the categories, related with fertilizer production and use, due to the substitution of fertilizer by sludge.

6. **Quantified objectives**: Reducing water supply intensity for GDP – 60 % in comparison with 2015, N_2O generation per capita – 17 g/cap/yr.
7. **Total GHG emissions reductions (t CO_2e):** 178 300 t CO_2-eq.
8. **Sectors affected**: waste
9. **GHG(s) affected**: N_2O
10. **Entities responsible for implementing:** State Agency for Water Resources of Ukraine, Ministry of Environmental Protection and Natural Resources of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG6, SDG8, SDG9, SDG11, SDG12, SDG13

3.8.6. Production of alternative fuel from MSW with the purpose to decrease fossil fuel needs in cement industry

1. **Status:** On-going
2. **Implementation period begins:** 2017
3. **Type of measures:** regulatory
4. **Objectives:** creating a market for waste treatment services that will include the production of alternative fuels from different types of waste, with subsequent use of it to produce cement, that is an environmentally resource-efficient way of reducing waste that falls into landfills and landfills. Reducing greenhouse gas emissions by reducing the amount of waste that falls into landfills
5. **Description**: About one third of MSW is suitable to produce alternative fuels, which could be used in a cement production. At present, this waste is buried in MSW landfills, while cement industry use fossil fuels.
6. **Quantified objectives**:
7. **Total GHG emissions reductions (t CO_2e):** it's a part of Energy sector GHG emission reduction potential
8. **Sectors affected**: waste, power and heat generation
9. **GHG(s) affected**: CO_2, CH_4, N_2O
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, Ministry of Environmental Protection and Natural Resources of Ukraine
11. **Implementation period finish**: 2030
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG11, SDG12, SDG13

3.9 BIOENERGY

These policies and measures aim to foster the development of bioenergy sector in Ukraine as one of the major drivers of Ukraine's green growth and circular economy transition. On one hand, the bioenergy sector shall further unfold, in a sustainable way, the huge energy potential of agrarian and wood biomass, biofuels, biogas/biomethane and energy crops. On the other hand – it shall contribute to effective biowaste management practices and the improvement of soil quality and its carbon sequestration capacities. Finally, the sector shall be able to create significant social and economic merits generating green jobs mainly at rural areas as well as fostering organic agriculture practices.

Stakeholders consultation process on bioenergy policies and measures took place under agriculture sector.

3.9.1. Bioenergy Road Map and Action Plan Development

1. **Status:** recommended

2. **Implementation period starts: - 2020**
3. **Type of measure:** institutional
4. **Objectives:** intensive and sustainable bioenergy sector development.
5. **Description:** The measure aims to depict and detail the major milestones, instruments and investment needs of the bioenergy sector development as well as its contribution to the climate change mitigation and adaptation activities until 2050. The document will be based the respective targets of the Energy Strategy of Ukraine until 2035, National Transport Strategy as well as other relevant Ukraine's strategic documents. At the same time, the Road Map and the Action Plan shall bear the reference to specific regulatory and legislative improvements enabling the further bioenergy sector development in medium and long run.
6. **Quantified objectives:** non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** agriculture, energy
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine; Ministry for Development of Economy, Trade and Agriculture of Ukraine; State Agency for Energy Efficiency and Energy Saving
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG12, SDG13

3.9.2. Sustainability Criteria for Biomass

1. **Status:** recommended
2. **Implementation period starts:** supposedly 2021
3. **Type of measure:** Regulatory
4. **Objectives**: decreased pressure on land and food security derived from increased use of biomass.
5. **Description:** Sustainability criteria serve to define the type and the amount of biomass feedstock that can be used for biofuels output or other energy use of biomass. These criteria should be introduced in order to minimize food-versus-fuel and ILUC problems.
6. **Quantified objectives**: Similar to the European Sustainability Criteria
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: agriculture, transport, industry
9. **GHG(s) affected**: CH_4, CO_2
10. **Entities responsible for implementing:** State Agency of Energy Efficiency and Energy Saving of Ukraine; Ministry of Energy of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG12, SDG17

3.9.3. Biomass Based Heat and CHP generation

1. **Status:** recommended
2. **Implementation period starts: - 2020**
3. **Objectives:** intensive and sustainable biomass to energy sector development.
4. **Description:** The installed capacity of biomass to heat facilities and biomass to electricity facilities constitutes around 8 gigawatt of heat and 100 megawatt of electricity respectfully, utilizing only the small portion of the agriculture and wood biomass potential of the country. New support measures shall be created for the further sub-sector development, in addition to the current feed-in tariff for the biomass based electricity and existing legislation enabling simplified procedure for heat tariff settlement. Such measures may include green procurement

procedures, removal of existing CO2 taxation of biomass based heat and electricity production, improving the biomass supply side and other measures. Overall, the further development of this bioenergy subsector would require better integration with Ukraine's electricity market, district heating sector, and supply of biomass based heat and electricity to the industrial processes.

5. **Quantified objectives:**
6. **Total GHG emissions reductions (t CO_2e):** 9 million tonnes CO_{2e}
7. **Sectors affected:** agriculture, energy
8. **GHG(s) affected:** CO_2
9. **Entities responsible for implementing:** Ministry of Energy of Ukraine; Ministry for Development of Economy, Trade and Agriculture of Ukraine; State Agency for Energy Efficiency and Energy Saving
10. **Implementation period finish:** ongoing
11. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG12, SDG13

3.9.4. Creation of Biomass Burse

1. **Status:** recommended
2. **Implementation period starts:** 2021
3. **Type of measure:** Regulatory
4. **Objectives:** timely and predictable supply of biomass.
5. **Description:** Biomass burse is an e-platform that aims to promote relatively stable price for biomass and biomass products, such as pellets, wood chips or sunflower husk briquettes. In different regions, prices for these sub-products vary significantly, quit often hindering biomass project development and negatively affecting project feasibility. Should the supplier be willing to terminate the contract, biomass burse would help the buyer to find another supplier. The burse may also set the minimal requirements to the quality of biomass, as low quality of biomass is a serious obstacle towards its use, especially by municipal boiler houses. Overall, efficient operation of biomass burse is a key element of a transparent and predictable biomass market.
6. **Quantified objectives:** non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** agriculture, energy
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine
11. **Implementation period finish:** non-applicable
12. **Linkage with SDG:** SDG7, SDG8, SDG9, SDG12

3.9.5. Biogas/ Biomethane Supply and Demand

1. **Status:** ongoing/recommended
2. **Implementation period starts:** 2012
3. **Type of measure:** regulatory, fiscal
4. **Objectives:** increased biogas and biomethane generation and energy utilization, utilization of biowaste, improved soil conditions due to proper digestate utilization
5. **Description:** In 2012 Ukraine introduced the special feed-in tariff for biogas based electricity (0.124 EUR/kWh). In 2020 the biogas to electricity facilities reached 96 megawatt (electric) utilizing only a small part of the country biogas generation and utilization potential. Additional efforts shall be applied to further promote the biogas supply and demand through the creation of additional incentives and the elimination of existing barriers. Such steps shall include the

simplification of the biogas based electricity access to electrical grid, the promotion of biomethane production and utilization for the generation of green heat and electricity, its introduction and transportation, the proper utilization of biogas digestate for the improvement of the soil conditions. In addition, some additional financial incentives to foster biogas/biomethane demand may be applied, addressing such topics as the better integration of biogas/biomethane electrical facilities with national electricity market, especially its balancing part, monetization of bigas/biomethane carbon emission reductions as well as through the international demand for biomethane.

6. **Quantified objectives:** non-applicable
7. **Total GHG emissions reductions (t CO_2e):** 1 million tonnes CO_{2e}
8. **Sectors affected:** agriculture, energy
9. **GHG(s) affected:** CH_4, CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine; Ministry of Finance of Ukraine, Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG12, SDG13

3.9.6. Energy Crops

1. **Status:** ongoing
2. **Implementation period starts:** 2020
3. **Type of measure:** regulatory, fiscal
4. **Objectives:** biomass supply, marginal lands restoration.
5. **Description:** dedicated energy crops (Salix, Willow, Poplar and others) can be used for bioenergy purposes, in particular for heat and electricity generation; some of them (lignocellulosic biomass) can be used as feedstock for advanced biofuels. Ukraine has nearly 4 million ha of unused marginal lands, that can be potentially used for the growing of dedicated energy crops, while the current energy crops area constitutes around 6000 hectares only. Further improvement of the sector will greatly depend from the creation of better conditions for the energy crops growth, including the access to long term financing, favorable conditions for long term land rent, better knowledge of energy crops plantations management as well as better integration of energy crops with national climate change adaptation practices.
6. **Quantified objectives:** non-applicable
7. **Total GHG emissions reductions (t CO_2e):** covered in 2.9.3
8. **Sectors affected:** agriculture, energy
9. **GHG(s) affected:**
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine; Ministry of Finance of Ukraine, Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish:** N/A
12. **Linkage with SDG:** SDG2, SDG7, SDG8, SDG9, SDG12, SDG15

3.9.7. Biofuels Blending Mandate

1. **Status:** recommended
2. **Implementation period starts:** supposedly 2021
3. **Type of measure:** Regulatory
4. **Objectives**: increase the share of biofuels transport sector supplementing the utilization of synthetic carbon intensive fuels
5. **Description:** Blending Mandate Requirement aims to introduce and gradually expand the utilization of biofuels, i.e. bioethanol and biodiesel, at the transportation sector. This policy

measure was adopted in 2012 and later abolished in 2015. Use of advanced biofuels is one of the ways to use renewable energy sources, using the feedstock that does not endanger food safety and reducing the pollutants (compared to fossil fuels). The policy measure aims to create the market of biofuels and to increase the use of renewables in transport sector.

6. **Quantified objectives**: According to Energy Strategy of Ukraine until 2035, the share of biomass and biofuels in TPES has to reach 4.9% in 2020 and 11.5% in 2035. According to National Transport Strategy until 2030, the level of biofuels and electricity use has to reach 50% by 2030.
7. **Total GHG emissions reductions (t CO_2e):** 1 million tonnes CO_{2e}
8. **Sectors affected**: transport, agriculture, industry (machine building, biofuels production and blending),
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Energy of Ukraine, State Agency for Energy Saving and Energy Efficiency of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG4, SDG7, SDG8, SDG9, SDG12, SDG13

3.10 FISCAL AND MARKET MECHANISMS

Based on best international practices and recent approaches to sustainable, green and climate finance - as presented by MDBs, IFIs and other financial organizations outlined and analysed in various reports (Joint MDBs Climate Finance Report 2019, Global Landscape of Climate Finance 2019) - the overall objectives of fiscal and financial policies and measures are to build institutional capacity of Ukraine's financial and banking system for scaling up green and climate finance, including from public and private sources, enabling various, innovative green and climate fiscal and financial instruments (e.g. green bonds, blended finance instruments such grants, bonds, sustainable finance, green taxonomy, e quity, guarantees, investment loans, line of credits, sustainable investment, etc.). No stakeholders' consultations took place specifically on fiscal and market-based policies and measures in the context of the NDC consultation, but informal discussions are taking place at the same time on various elements of proposed policies and measures, e.g. green bonds legislation operationalization discussions, domestic ETS development under EU-Ukraine Association Agreement and relevant Annexes revision process, and have been taken into consideration. Some further updates could be introduced as a result of general stakeholders' consultation of formal governmental concurrence process.

3.10.1. Green Bonds

1. **Status:** adopted
2. **Implementation period starts:** 2021
3. **Type of measure:** Regulatory
4. **Objectives:** increased investments in green projects
5. **Description:** The legislation on Green bonds was adopted in August 2020 through introducing relevant amendments to Tax Code provisions. National green bonds legislation creates enabling legislative environment for private and public companies to issue green bonds/securities while the income of these securities must be used for implementation of environmental projects (renewable energy, energy efficiency, waste management, clean transport, organic agriculture, protection of flora and fauna, water resource protection, adaptation to climate change and other environmental protection projects leading to reducing emissions into the atmosphere and protecting environment).
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect

8. **Sectors affected**: transport, agriculture, energy, industry and others
9. **GHG(s) affected**: all
10. **Entities responsible for implementing:** State Fiscal Service of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG8, SDG9,SDG10, SDG12, SDG17

3.10.2. Climate finance institutional framework

1. **Status:** proposed
2. **Implementation period starts:** 2021
3. **Type of measure:** Institutional
4. **Objectives:** creating enabling environment and institutional framework, building capacity for enhanced green and sustainable finance
5. **Description:** Introduce institutional, organizational and structural changes into Ministry of Finance and it's support structures that will be leading to enhanced understanding and enabled environment and enhanced institutional capacity of public and private financial institutions to attract and allocate finance for green climate and sustainable activities by private and public stakeholders.
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: all
9. **GHG(s) affected**: all
10. **Entities responsible for implementing:** Ministry of Finance, EkrExim Bank
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG1, SDG4, SDG8, SDG9, SDG10, SDG12, SDG17

3.10.3. Climate finance instruments (Grants, bonds, equity, guarantees, investment loans, lines of credits, sustainable investment)

1. **Status:** proposed
2. **Implementation period starts:** 2021-2023
3. **Type of measure:** Regulatory, fiscal
4. **Objectives:** increased investments in green, climate and sustainable projects and technologies
5. **Description:** This policy recommendation aimed to establish the set of various efficient climate and green finance instruments (e.g. grants, bonds, equity, guarantees, investment loans, lines of credits, blended finance, sustainable investment, climate finance tracking) for both public and private sectors, leading to establish enhanced, predictable, secured and transparent financial flows into sustainable, climate friendly and green projects/economic activities (e.g. renewable energy, energy efficiency, waste management, clean transport, smart agriculture, afforestation, protection of biodiversity, water resource protection, adaptation to climate change, reducing pollutions). Such instruments should be developed based on the latest international practices and lessons learned while taking into account national existing and emerging legislation and introducing relevant amendments, whenever necessary. Implementation of existing and emerging carbon markets and prices instruments, such as Article 6 of Paris Agreement, access to voluntary carbon markets and regional carbon markets and instruments, both bilateral and multilateral.
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: all
9. **GHG(s) affected**: all

10. **Entities responsible for implementing:** Ministry of Finance, State Treasury, National Bank, State Fiscal Service of Ukraine
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG1, SDG2, SDG7, SDG8, SDG9, SDG10, SDG12, SDG17

3.10.4. Green Procurement

1. **Status:** proposed
2. **Implementation period starts:** 2022
3. **Type of measure:** Regulatory
4. **Objectives:** gradually introducing green/sustainable provisions into public and private procurement rules
5. **Description:** To develop and adopt the legislation/regulation that will define and gradually introduce green and sustainable procurement provisions into both public and private procurement procedures on national, regional, municipal and community levels, including green procurement prioritization. Green procurement will enable the development of national sustainable and green products and services, while ensuring substantial and measurable positive environmental impacts and co-benefits, including but not limited in green public transport, promotion of recycled products and limiting polluting and harmful impacts on environment and ecosystems.
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: transport, agriculture, energy, industry and others
9. **GHG(s) affected**: all
10. **Entities responsible for implementing:** Ministry of Finance, State Treasure
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG8, SDG9, SDG10, SDG12

3.10.5. Green Taxonomy (Taxation system greening)

1. **Status:** proposed
2. **Implementation period starts:** 2022
3. **Type of measure:** Regulatory
4. **Objectives:** enhancing and increasing finance in sustainable investments
5. **Description:** Development and introduction of special financial conditions, fiscal incentives, restrictions, tax exemptions and introduction, access to finance and others, for sustainable and green projects that will be contributing to national environmental objectives and goals and enabling implementation of national legislation on sustainable development, environmental protection and restoration, and combating climate change, including but not limited to stimulation and incentivizing of renewable energy, VAT exemption system, improvements of existing and introduction new green-stimulus taxes (e.g. CO2 tax, road and fuel tax and others), gradual removal of fossil fuel subsidies, extended producers' responsibilities schemes introduction, and others.
6. **Quantified objectives:** N/A
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: transport, agriculture, energy, industry and others
9. **GHG(s) affected**: all
10. **Entities responsible for implementing:** Ministry of Finance
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG1, SDG8, SDG9, SDG10, SDG12, SDG13, SDG17

3.10.6. Establishment of national GHG emissions cap-and-trade scheme (GHG emissions trading scheme)

1. **Status:** Planned
2. **Implementation period starts:** 2025
3. **Type of measure**: Regulatory Market Mechanism
4. **Objectives:** GHG emissions reduction in pre-defined sectors and EU-Ukraine Association Agreement implementation through alignment of Ukraine legislation with EU acquis.
5. **Description:** As per EU-Ukraine Association agreement provision, Ukraine will introduce EU-ETS-type GHG emissions cap & trade Emissions Trading Scheme (ETS). Once the monitoring, reporting and verification system (MRV) that shall become operational as of 2021, will operates for a certain period of time and collect sufficient, reliable and comparable information about GHG emissions level on installation level, cap-and-trade ETS ought to be establish in order to create economic stimulus for companies to reduce GHG emissions and implement state of art technological innovations.
6. **Quantified objectives**:
7. **Total GHG emissions reductions (t CO_2e):**
8. **Sectors affected**: electricity and heat power sector, cement, iron & steel, petro-chemical, glass and brick production.
9. **GHG(s) affected**: CO_2
10. **Entities responsible for implementing:** Ministry of Environmental Protection and Natural Resources
11. **Implementation period finish**: N/A
12. **Linkage with SDG:** SDG8, SDG9, SDG10, SDG12, SDG13, SDG17

3.11 SOCIETY COVENANT

Policies and measures under Society Covenant are aimed to introduce, promote and advocate new, more responsible, smarter, sustainable and climate friendly behaviour patterns by citizens, companies and organizations. Enhanced role of private business, communities and civil society organization under this group of policies and measures are expected to be empowered by proper established and operationalized financial and other incentives on municipal and national levels. Promotion of responsible consumption of resources and food, legally recognized remote mode of work, development of smart mobility networks and others are among recommended policies and measures.

As not specific ministry within GoU structure is responsible for these group of policies and measures, it is recommended that stakeholders' consultation will be conducted under formal governmental concurrence process that is scheduled to take place during March-April 2021.

3.11.1. Introduction of energy labelling and eco-design regulations

1. **Status:** on-going
2. **Implementation period starts:** 2013
3. **Type of measure:** Regulatory, Institutional
4. **Objectives:** elimination of energy non-efficient products from the internal market; make it possible for domestic producers to export energy efficient products to the EU market – and also likely increase potential market share in non-EU markets which are increasingly adopting similar standards and where the energy label and eco-design compliance increase the popularity of products being sold.

5. **Description:** This measure deals with the adoption and enforcement of technical regulations that would impose energy labelling and/or eco-design (minimum energy performance) requirements on certain types of products placed on the Ukrainian market. The primary legislation which lays out the framework for adopting this regulation is the Law of Ukraine "On Technical Regulations and Conformity Assessment", Decrees of the Cabinet of Ministers of Ukraine dated 16 December 2015, No. 1057. Various technical regulations have been already developed in close cooperation with the European Bank for Reconstruction and Development (EBRD) IFC experts within the Finance and Technology Transfer Centre for Climate Change (FINTECC) programme. Although there are quite a few other labelling regulations that shall be approved.
   In order to ensure that these regulations are effectively implemented and have a market impact, an effective market surveillance authority will need to be trained and empowered to inspect products on the market to ensure they comply with the regulations on labelling and eco-design. This should be done in partnership with the retail and importer economic operators – including training these economic operators on how to comply with the regulations and at the same time market more energy efficient products.
6. **Quantified objectives:** no indicators
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected:** consumption sector
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** State Agency on Energy Efficiency and Energy Saving of Ukraine
11. **Implementation period finish: 2030**
12. **Linkage with SDG:** SDG2, SDG3, SDG4, SDG8, SDG9, SDG11, SDG12

3.11.2. Smart Mobility

1. **Status:** on-going/recommended
2. **Implementation period starts:** on-going
3. **Type of measure:** regulatory
4. **Objectives**: Modal shift to public transport or non-motorized transport;
5. **Description:** Development of Bicycle infrastructure to be used by bicycles and electric micro-mobility modes of transportation (e-scooters); promotion of car sharing initiatives; choice preferences towards use of EVs, smart urban planning, use of a smaller engine cars.
6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: transport, healthcare
9. **GHG(s) affected:** CO_2,
10. **Entities responsible for implementing:** Ministry of Infrastructure of Ukraine
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG4, SDG9, SDG11

3.11.3. Remote Work

1. **Status:** on-going/recommended
2. **Implementation period starts:** on-going
3. **Type of measure:** legislative, behaviour pattern change
4. **Objectives**: legislation on remote work where possible; justified use of equipment available.
5. **Description:** COVID-19 pandemic has shown that transition toward remote work could be a feasible way out for both employees and employers. It does not lead to significant electricity

demand growth by households[33] but it does require relevant legislation changes to Labour Code. In post-COVID-19 times, international and domestic work-related travelling needs to be minimized or avoided where possible, preferably being substituted by online events, as transportation e.g. by airplane requires significantly much more energy than does virtual meeting. The available computer equipment needs to be used reasonably and without remaining idle overnight, as it leads to unwanted electricity consumption.

6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: transport, energy
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Social Protection, Ministry of Infrastructure of Ukraine, Ministry for Development of Economy, Trade and Agriculture of Ukraine
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG1, SDG4, SDG9, SDG11

3.11.4. Diet and Nutrition

1. **Status:** recommended
2. **Implementation period starts:** not applicable
3. **Type of measure:** behaviour pattern change
4. **Objectives**: Reduced animal protein intake; Choice preferences.
5. **Description:** Animal-derived protein-rich diet is based on development of cattle farming that is a source of methane emissions. Despite cattle stock in Ukraine is decreasing over the last 30 years and it is projected to increase in future, additional conscious choice preference towards healthy nutritious-based limitation intake or replacement of animal protein could be considered. To ensure the proper nutrition, fiber- and nutrients-rich diet is recommended, as it has high climate change mitigation potential. Similarly, consumption of locally grown (in the vicinity of 100 km) animal food products leads to lower expenditure of fuel for transportation.
6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: healthcare, agriculture
9. **GHG(s) affected:** CO_2, CH_4
10. **Entities responsible for implementing:** Ministry of Health
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG2, SDG4, SDG9, SDG11, SDG12

3.11.5. Responsible Consumption

1. **Status:** recommended
2. **Implementation period starts:** non-applicable
3. **Type of measure:** behavior pattern change
4. **Objectives**: responsible and resource efficiency use of water, heat and other resources
5. **Description:** Water, readily available for households in towns, requires processing, treatment and transportation. These processes, in turn, require electricity and chemical substances. Reasonable use of water, i.e. use of water only when it is needed, leads to decreased water consumption (Installation of tap aerators that enrich water flow with oxygen decrease water consumption by 30%; use of grey water in toilets also leads to water saving). During cold season,

[33] IEA (2020). Global Energy Review 2020. The impacts of the Covid-19 crisis on global energy demand and CO2 emissions. International Energy Agency https://www.iea.org/reports/global-energy-review-2020

decrease of room temperature of 1-2 ˚C leads to decrease energy carriers' demand. As for clothing, preferences should be given to recycled materials.

6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: healthcare, energy, housing
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Social Protection
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG1, SDG2, SDG3, SDG4, SDG9, SDG11, SDG16

3.11.6. Awareness raising, outreach and education

1. **Status:** ongoing
2. **Implementation period starts:** non-applicable
3. **Type of measure:** behaviour pattern change
4. **Objectives**: increased awareness; fair contribution of all citizens
5. **Description:** Policy aimed at increased awareness of consequences of regular actions and their alternatives, so that citizens could make responsible choices that could potentially reduce climate change vulnerability. Major program documents, such as Energy Strategy of Ukraine until 2035, Ukraine 2050 Low Emission Development Strategy and others contain the provisions on necessity of information spread to general public about activities in energy sphere, GHG emissions etc.
6. **Quantified objectives**: non-applicable
7. **Total GHG emissions reductions (t CO_2e):** Indirect
8. **Sectors affected**: healthcare, energy
9. **GHG(s) affected:** CO_2
10. **Entities responsible for implementing:** Ministry of Education, Ministry of Social Protection
11. **Implementation period finish**: non-applicable
12. **Linkage with SDG:** SDG4

SECTION 4. ADAPTATION POLICIES AND MESAURES

Adaptation is one of the key components of the long-term global and country-specific response to climate change. By 2030, Ukraine plans to establish robust national framework for adaptation to climate change in order to enhance its adaptive capacity, strengthen resilience and reduce vulnerability to climate change, as provided for in Article 7 of the Paris Agreement.

Adaptation policies and measures have been discussed and presented to MinEcology and to a large extent lots of elements have been incorporated into National Framework Adaptation Strategy on-going consultation, conducted by the MinEcology.

4.1. REGULATORY AND INSTITUTIONAL ADAPTATION POLICIES AND MESAURES

4.1.1. Development and adoption of the Adaptation Strategy of Ukraine until 2030

1. **Status:** on-going
2. **Implementation period starts:** 2019
3. **Objectives**: to provide a vision of national tasks and determine priorities in the sequencing of activities in order to achieve the main adaptation goal.
4. **Description:** Adaptation Strategy of Ukraine until 2030 will form the ground for adaptation activities to provide:
   - justification for additional regulation related to adaptation for the long term perspectives;
   - scope of research programs aimed at addressing knowledge gaps, including regional climate change model runs enabling for impact assessments/projections, vulnerability assessments and scientific estimations of risks for natural, social and economic systems, making it possible to take informed decisions;
   - support of the system for monitoring climate parameters, extreme events and impacts;
   - support of the systems for adaptation technologies needs assessments and adaptation cost assessment;
   - guidance, mechanisms and instruments for incorporating national priority adaptation policies into existing and planned development programs at the regional and community levels;
   - guidance for development and implementation of sectoral adaptation strategies/program/plans;
   - guidance for updating current national programs/plans for disaster risk management;
   - guidance for development of adaptation action plan for coastal zone of Azov and Black Seas to take into account the expected sea level rise and flooding;
   - prerequisites for implementing new governance approaches that balance benefits and trade-offs considering for various adaptation policies;
   - prerequisites for setting up the linkage between climate change adaptation and mitigation and consideration of synergies that can provide co-benefits;
   - introduction of up-to-date governance approaches and tools to communicate climate information and support awareness raising, professional training and education more broadly;
   - support of transboundary cooperation.
5. **Sectors affected:** all sectors, country-wide.
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine**,** other ministries and central authorities.
7. **Implementation period finish**: 2030.

4.1.2. Development, adoption and implementation of Adaptation Action Plan by 2030

1. **Status:** planned
2. **Implementation period starts:** 2021
3. **Objectives**: to develop, adopt and implement Adaptation Action Plan (AAP) pursuant to the Adaptation Strategy of Ukraine by 2030.
4. **Description:** Development of the Adaptation Action Plan will be an essential next step in the adaptation process. Its fast operationalization will depend on how the existing barriers related to relatively low priority of climate change adaptation in national agenda will change i.e. due to permanent presence of other issues related to national security and high economic instability, there has consistently been lack of budget and resources available even to plan for adaptation activities. The national understanding on adaptation needs to be improved, so that it is not always deprioritised against climate change mitigation actions.

   The AAP is expected to set out activities at the national level. The Plan will create a broad landscape of adaptation in Ukraine that is coordinated with the regions and communities and offers guidance to them.

   Each policy and measure included in the AAP will be based on quantitative estimation of vulnerability/risks, assessments to what extent adaptive capacity is enhanced, resilience is strengthened, and vulnerability is reduced. Given the great importance of quantification of assessment of climate-related risks and vulnerabilities, workable methodologies for such assessment will be developed and approved at the first planning stage. The same requirement is to be applied to regional and community adaptation plans, prepared either in separate document or included as a section in the appropriate development plan/program.

   The AAP will be revised and updated during the regular evaluation as it will be stipulated by the Adaptation Strategy of Ukraine by 2030.
5. **Sectors affected:** all sectors, country-wide.
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine**,** other ministries, central and local authorities, private sector, NGOs.
7. **Implementation period finish:** 2030.

4.1.3. Strengthening cooperation on enhancing adaptation actions

1. **Status:** on-going
2. **Implementation period starts:** 2021
3. **Objectives**: to formalize and institutionalize cooperation of state and non-state actors to address adaptation to climate change, including enhancing adaptive capacity, strengthening resilience and reducing vulnerability.
4. **Description:** The success of adaptation actions depends on the establishment of coordination: central authorities for adaptation policy-making, horizontal (i.e. sectoral), vertical (i.e. across levels of administration), process of involving other stakeholders in preparing and implementing policies, including private sector and NGOs. The enhanced institutional structure that clarified and enshrined responsibilities of actors such as ministries, state agencies, and regional authorities is planned to be in place in order to improve coordination across sectors to foster an integrated approach to adaptation and climate resilience, including explicit linkages and synergies with Sustainable Development Goals (SDGs).

   An innovative cooperation mechanism will be set up for the government and non-state actors, including private sector, to capitalize on existing capacity and currently fragmented ongoing activities having been implementing for adaptation.

5. **Sectors affected: all sectors, country-wide.**
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine, other ministries, central and local authorities, private sector, NGOs.
7. **Implementation period finish:** 2021.

4.1.4. Assessing continuous progress in adaptation actions and reporting under Paris agreement

1. **Status:** planned
2. **Implementation period starts:** 2023
3. **Objectives**: to develop and operationalize a results-based monitoring and evaluation system to track progress made in implementing the National Climate Change Action Plan; to ensure reporting system, including national communication on adaptation.
4. **Description:** In order to maintain the monitoring and evaluation system, as well as to prepare adaptation national communications, the responsible bodies will be identified, skilled personnel will be attracted and sources of financing will be found.
   The monitoring and evaluation system will define country-specific priority areas. For tracking purposes, each priority area is to be accompanied by a results chain that includes ultimate, intermediate, and immediate outcomes, output areas, and indicators.
   The monitoring and evaluation system should be based on metrics and indicators that require solid scientific and analytical support. Given that adaptation does not easily lend itself to a universal, objective, quantifiable measure of success or effectiveness, selection of metrics and indicators is a key issue to be addressed.
   The IPCC (2014) has identified at least three uses of metrics for assessing adaptation: 1) determining the need for adaptation, 2) measuring the process of implementing adaptation, and 3) measuring the effectiveness of adaptation. Metrics related to the need for adaptation measure vulnerability. Metrics that measure the process of implementing adaptation action include assessments of progress in areas such as spending on adaptation action. Metrics that strive to measure the effectiveness of adaptation are important for measuring progress but are especially challenging to find due to the long-time horizons of adaptation outcomes and the changing conditions in which they materialize.
5. **Sectors affected:** all sectors, country-wide.
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine, other ministries, central and local authorities, private sector, NGOs.
7. **Implementation period finish:** N/A

4.2. SECTOR-SPECIFIC ADAPTATION POLICIES AND MESAURES

4.2.1. Agriculture

1. **Status:** planned
2. **Implementation period starts:** 2021
3. **Objectives**: to finalize and adopt Adaptation Strategy for Agriculture (ASA) aimed at achieving sustainable development contributing adaptation and climate resilience.
4. **Description:** Agriculture, being itself an emitter of GHGs and hugely depending on changing climate conditions, plays an important role both in mitigation and adaptation activities. In Ukraine, agricultural sector has to provide cost-efficient supply of food, ensuring food

availability and food accessibility to guarantee food security.

Despite of lack of adopted Adaptation Strategy for Agriculture, its draft has been developed within the Project "German-Ukrainian Agricultural Policy Dialogue" (APD) and took into consideration national experience gained by large agricultural companies and farmers, international best practices, needs in technologies.

Draft ASA includes the following main groups of actions:

- Establishment of Climate Change Advisory and Coordination Body in Agriculture, including regional offices;
- Enhancement of scientific support on climate change in crop production, livestock, forestry, fishery and hunting sectors;
- Raising awareness, education and professional education enhancement on adaptation to climate change in agriculture;
- Building capacity on adaptation to climate change for local communities and households in rural areas;
- Agricultural producers' stimulation on climate change adaptation measures implementation in the following sub-sectors:

  Crop production:

  - Production diversification based on broad implementation of multi-field soil-protective crop rotation and rational agricultural crops location based on modern agro-climate territories;
  - Applying most recent selection capacities for breeding more drought-resistant crop varieties with higher productivity and hybrids of agricultural crops with higher resistance to diseases and pests and to higher/lower temperatures;
  - Enlargement of agricultural crop varieties with shorter vegetation period;
  - Growing more crop types and varieties for increasing biodiversity level and enhancing agroecosystem capacity to resist external stresses, especially eliminating risks of losing yields due to drought;
  - Implementation and recovery of effective irrigation systems, increase in drip irrigation system area;
  - Stimulating recovery and establishment of new field-protective poly-functional forestry strips and their management improvements (agricultural forestry)
  - Improving agricultural crops diseases and pests monitoring system, especially for atypical varieties, stimulating of implementation of complex biological and compound feed methods of agricultural crops pests control;
  - Establishing efficient insurance systems for minimizing financial losses of agricultural producers and incentivise them to apply insurance systems;
  - Incentivizing implementation of climate oriented (Climate Smart Agriculture) and soil conservation agro technologies for agricultural crop production;
  - Establishing additional seeds storage capacities and seeds generic banks for efficient management of unexpected climatic phenomena consequences;
  - Protection of underground water by protecting soil cover through mulching by natural or artificial bio-materials;

  Livestock:

  - Improvements and development of new breeds of animals, resistant to long-term heat waves and less prone to diseases in agricultural companies and farmers;
  - Using new varieties of feeding crops for livestock feeding management system and change of feed crops content due to increased aridity;
  - Creating insurance feeding stocks;

- Increasing areas of natural and artificial pastures, including special pastures for livestock grazing during late-autumn period for households and local communities;
- Improving monitoring system of spread of diseases, parasites and pests of animals that there not specific for this area/region;
- Increasing capacity of veterinary services;
- Review of existing regulations and developing recommendations on livestock animals' farms requirements in order to mitigate dangerous diseases break out risks under negative climate change conditions, especially prolonged periods of extreme high temperature, droughts and others;
- Stimulating farms construction practices and technologies changes, in order to include new technologies and materials for heat protection during long periods, increasing resilience to other extreme weather events;
- Establishment of efficient insurance system in animal livestock;
- Stimulating of water resources conservation, water collection practices, water purification and secondary usage of water resources;

Fishery and aquaculture:

- Ichthyologic fauna monitoring (varieties biodiversity, ichthyologic fauna recovery stage, adaptation of ichthyologic fauna to climate change, feeding system development for ichthyologic fauna);
- Establishing of efficient insurance system in fishery;
- Development and implementation of monitoring system of fish diseases in special fish farms and natural water reservoirs;
- Development and implementation of plans of therapeutic and preventive measures for limiting risks of fish diseases under climate change conditions;
- Implementation of reclamation measures for internal water reservoirs and those that are connecting systems river-sea, recovery and improvements of spawning grounds;
- Annual stocking in national water reservoirs (Dnipro river reservoirs and estuary) by local types of fish;
- Ensuring good conditions of aboriginal population of hydro biota.

Hunting:

- hunting fauna monitoring system improvements in the framework of climate change;
- stimulation of enlargement of agriculturally useful wild animals that are demonstrating their inhabitant area enlargement under changing climate conditions under conditions of excluding negative anthropogenic influence on ecosystems;
- implementation of best practices in managing invasive hunting animals.

5. **Sectors affected:** agriculture.
6. **Entities responsible for implementing:** Ministry of Economic Development, Trade and Agriculture of Ukraine, other ministries, central and local authorities, private sector: large/mid/small agricultural producers, farmers.
7. **Implementation period finish:** 2030.

4.2.2. Forestry

1. **Status:** planned
2. **Implementation period starts: 2021**
3. **Objectives: to set up an effective system for adaptation of forestry to climate change.**
4. **Description:** Forestry in Ukraine is under threat of extinguishing due to climate change. This trend is especially worrisome considering the fact that Ukrainian rate of forest cover is 15.9%,

while the respective optimal rate should be not less than 20%. Climate change is a driving force of influence on forests in the transition zone between forest and steppe regions. In the southern regions, the productivity of forests decreases mainly due to impact of high temperatures and water scarcity. About 20-30% of forest-covered lands are lost in practically all steppe regions. Other negative effects include deterioration of growth, increased stresses caused by high temperature and low moistening and susceptibility to forest pests and pathogens.

Draft Adaptation Strategy for Forestry (ASF) has been developed as a component of the Project "German-Ukrainian Agricultural Policy Dialogue" (APD).

Draft ASA includes the following main groups of actions:

- Forestry legislation improvement in order to reflect adaptation to climate change;
- Increasing scientific support to forestry on climate change;
- Raising awareness, improvement of education and professional education in adaptation to climate change;
- Increasing capacity to adapt to climate change in forestry sector:
  - support and stimulation of sustainable forestry in order to improve multi-functional role of forests;
  - development of regional system of adaptation measures for forestry that are leading to conservation of forests biodiversity, increasing its resilience and productivity under climate change conditions;
  - improvements of forests management instructions and regulations in order to reflect various aspects of climate change during planning, project development and managing forests;
  - improving technological level of institutions that are collecting information on forests conditions in Ukraine (forest management, inventory and forests monitoring, disease control), especially, incorporating GPS-system and IT, communication technologies;
  - support of on-site and off-site methods of forestry inventory and monitoring ensuring needs to monitor impacts of climate change;
  - conservation and enlargement of biodiversity of forestry ecosystems, continuous monitoring of flora and fauna populations under changing climate;
  - adaptive review of terms and technologies of soil preparation, locations and timing of planting and forests management of forests crops;
  - introduction of forests crops in order to enlarge the forests crops varieties that are grown in the areas, where climatic conditions are similar to those that are projected by climatic scenarios;
  - stimulating of establishing mixed and complex forests structures, minimization of mono-culture forests area coverage;
  - implementation of best practices of control on forests diseases and harmful insects spread out;
  - implementation of modern technologies and mechanisms to identify forests fires and ensuring availability of modern technologies of firefighting.
- Incentivizing production companies and institutions on improving climate change adaptation measures during:
  - stimulating innovation activities on climate-oriented forest management (Climate Smart Forestry);
  - providing various support to local communities on inventory of forestry strips that are located in those communities and developing forests strips management plans that include adaptation;
  - implementation of international experience in climate change adaptation in forestry

and broad information of scientific researches results in forestry.

5. **Sectors affected:** forestry**.**
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine**,** State Agency for Forestry, other central authorities, local authorities, united territorial communities, private companies, farmers.
7. **Implementation period finish:** 2030**.**

4.2.3. Water management system

1. **Status:** planned
2. **Implementation period starts: 2021**
3. **Objectives:** to improve a country-wide water management system, so that it guarantees reliable water supply for households, industries, commercial and social sectors in a changing climate and contributes to climate resilience.
4. **Description:**
   National scale policies with transboundary perspective include:

   - Development and adoption of the river basin management plans for 9 river basins districts in Ukraine in accordance with national legislation and in line with EU Water Framework Directive. The first river basin management plans are to be submitted for approval by the Cabinet of Ministers of Ukraine by 1 August 2024 (in accordance with the article 132 of the Water Code[34] and the Decree of the Cabinet of Ministries on Approval of the Order on Development of the River Basin Management Plan[35]. Such cross-cutting issues as climate change and disaster risk reduction (floods and droughts) are to be included into river basin management plans according to the Action plan for the Concept of the implementation of the national policy on climate change by 2030[36], as well as according to the EU Water Framework Directive. In addition, updating the vulnerability assessments for the basins is foreseen as part of the river basin management plans in accordance with EU Water Framework Directive. Therefore, while enabling integrated water management, river basin management plans will also support better adaptation to climate change. The examples of the draft descriptive parts of the river basins management plans which include climate change, floods and droughts/water scarcity as cross-cutting issues/risks are available for the Dniester and the Dnipro[37]. State Agency for water resources leads the process of development of the river basins management plans[38].
   - Implementation of the new national monitoring program in accordance with the Decree of the Cabinet of Ministries on the Approval of the Order on State Water Monitoring[39] will enable better data collection according to biological, hydro morphological, physical and chemical indices and their analysis, among other objectives also supporting adaptation of water resources management and other water-related sectors to climate change.
   - Development and update of the water use balance for main Ukrainian river basin districts

[34] https://zakon.rada.gov.ua/laws/show/213/95-%D0%B2%D1%80#n946
[35] https://zakon.rada.gov.ua/laws/show/336-2017-%D0%BF
[36] https://zakon.rada.gov.ua/laws/show/878-2017-%D1%80#n8
[37] https://dniester-commission.com/en/news/experts-are-invited-to-comment-on-the-dniester-basin-management-plan/ https://www.euwipluseast.eu/en/component/content/article/150-all-activities/activites-ukraine/reports-of-ukraine/504-development-of-draft-river-basin-management-plan-for-dnipro-river-basin-in-ukraine-ph-ase-1-step-1-description-of-the-characteristics-of-the-river-basin?Itemid=397&fbclid=IwAR13FitEJml1joaJIGkE43UafOFHp689ujvZE3ngDyLBf1NZ5-ZOFULJRLY
[38] https://www.davr.gov.ua/site/material?psevd=https%3A%2F%2Fwww.davr.gov.ua%2Fplani-upravlinnya-richkovimi-basejnamiuuyi8
[39] https://zakon.rada.gov.ua/laws/show/758-2018-%D0%BF/conv

in accordance with the articles 134 and 15 of the Water Code[40] and the Decree of the Ministry of Energy and Environment Protection[41]. Application of the results for water allocation, analysis and improved use of water resources, as well as establishing limits for water abstraction and wastewater disposal will inform decision-makers and help better plan and implement water policies under climate change. Such analysis taking into account climate change has already been performed for the Dniester river basin[42].

- Development of bilateral and multilateral transboundary cooperation with neighbouring states in order to support integrated management of transboundary water resources and to share experience and knowledge for improved resilience, reduced risks of water-related disasters, and better adaptation of transboundary basins to climate change. The need for transboundary adaptation to climate change is acknowledged in both the Concept of the implementation of the national policy on climate change by 2030 and its Action plan.
- Implementation of the EU Flood Directive in Ukraine will help to reduce the risk to floods, the intensity and frequency of which increase under climate change. Climate change is taken into consideration while developing preliminary flood risk assessments, flood risk models and maps, and during the elaboration and implementation of flood risk management plans[43]. The need to include climate change into disaster risk management plans is acknowledged in the Action plan for the Concept of the implementation of the national policy on climate change by 2030.
- Reconstruction of water supply and wastewater treatment systems contributing to adaptive capacity of the country[44] .
- Updating vulnerability assessment for water sector, to be followed by the improvement of corresponding adaptation plans and measures.
- Establishment and operation of the river basin councils to ensure the engagement of stakeholders and the integration of different sectoral needs into development and implementation of river basin management plans under climate change (in accordance with article 13^3 of the Water Code[45]
- Strengthening the adaptation potential of biosphere reserves through capacity building, awareness raising and the implementation of concrete ecosystem-based adaptation measures. In Roztochya, West Polesie and Desnianskyi biosphere reserves such activities are supported by the project Ecosystem-based adaptation to climate change and regional sustainable development by empowerment of Ukrainian biosphere reserves financed by Michael Succow Foundation for the Protection of Nature[46]. In the Danube Biosphere Reserve restoring connectivity of the rivers will improve ecosystem resilience and will help nature and communities of the Danube Delta to better adapt to climate change[47]. Those activities are also based on the Climate change adaptation strategy and action plan for

[40] https://zakon.rada.gov.ua/laws/show/213/95-%D0%B2%D1%80#n946
[41] https://zakon.rada.gov.ua/laws/show/z0232-17
[42] https://www.davr.gov.ua/vodogospodarski-balansi-osnovnih-rajoniv-richkovih-basejniv
http://vb.dniester-commission.com/
[43] https://www.dsns.gov.ua/ua/Vprovadghennya-Directiva-2007-60-EC-of-the-European-Parliament-and-of-the-Council-of-23-october-2007-on-the-assessment-and-management-of-flood-risks.html
[44] https://www.nefco.org/procurements/general-procurement-notice-nip-ukraine-water-modernisation-programme/
[45] https://zakon.rada.gov.ua/laws/show/213/95-%D0%B2%D1%80#n946
https://zakon.rada.gov.ua/laws/show/z0231-17
[46] https://succow-stiftung.de/ukraine-ecosystem-based-climate-adaptation.html
[47] https://rewildingeurope.com/news/rewilding-progress-as-multiple-dams-removed-in-ukrainian-danube-delta/, https://www.theguardian.com/environment/2019/dec/27/it-is-amazing-how-quickly-mother-nature-can-recover-restoring-ukraines-rich-wetlands-aoe

Danube Delta region: Romania, Ukraine and Moldova[48]

Dniester river basin

Concrete adaptation measures in the Dniester basin are implemented, taking into account transboundary cooperation with the Republic of Moldova (based on the Strategic adaptation framework and its implementation plan for the basin as well as activities of the Dniester Commission with support of the GEF / UNDP/ OSCE/ UNECE project "Enabling transboundary co-operation and integrated water resources management in the Dniester River Basin":

Ongoing activities:

- inclusion of climate change adaptation into the activities of the Commission on Sustainable Use and Protection of the Dniester River Basin (the Dniester Commission), in particular, into the activities of its Working Groups on River Basin Planning and Management and Emergencies;
- inclusion of climate change, floods and droughts into the river basin management plan for the Dniester as cross-cutting issues;
- updating the rules for the operation of Dniester reservoirs in consultation with Moldova, accompanied by further assessment of the ecological-reproductive water release in Spring and minimal environmental flow through the year under climate change;
- regular consideration of the operational regime of the Dniester reservoirs by the Inter-departmental Commission helps to support ecological-reproductive water release each Spring and a minimal environmental flow throughout the year while taking into account the changing climate;
- restoration of the pilot area on the Yagorlyk tributary in the Lower Dniester as an example of ecosystem-based adaptation which can be further applied to restoration of other medium and small rivers in arid zone in Ukraine;
- development of a package of adaptation measures for the Dniester delta including development of the project proposals for the planned activities listed below.

Planned activities:

- improvement of water exchange in the Dniester floodplain and adaptation to negative impacts of climate change, primarily through the minimization of fire and flooding risks along M15 road Odesa-Reni between Mayaki and Palanca (included into the Implementation plan for 2021-2023 for the Development Strategy of Odesa oblast for 2021-2027);
- prevention of pollution of the Dniester estuary by untreated waste waters in case of a possible breakdown of wastewater utility at Shabo village due to accelerated coastal erosion (included into the Implementation plan for 2021-2023 for the Development Strategy of Odesa oblast for 2021-2027).

5. **Sectors affected:** water management**.**
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine**,** State Agency for Water Resources, other central authorities, local authorities.
7. **Implementation period finish:** 2030**.**

4.2.4. Health protection from climate change

1. **Status:** planned

[48] https://www.preventionweb.net/english/professional/policies/v.php?id=58367

2. **Implementation period starts: 2021**
3. **Objectives:** to incorporate specific adaptation measures into climate change into a plan to transform the public health system.
4. **Description:** The on-going process of transformation of medical care takes are being implemented in accordance with the Law of Ukraine "On state financial guarantees of medical services to the population"[49].
   The transformation process provides a window of opportunity for a gradual transition to climate resilient health system covering robust surveillance, early warning and response measures.
   Depending on the availability of funds, it is planned to:
   - conduct a comprehensive research on health vulnerability to climate change and detail risk assessments;
   - improve the existing national health plans on climate-sensitive diseases, taking into account the outcome of the health vulnerability/risk assessment;
   - revise existing operating procedures within the public health system to respond to climate risks;
   - strengthen human resources capacity via educational curricula and professional training of health personnel to ensure sufficient number of health workers capable to deal with the health risks associated with climate change;
   - establish the early warning system on climate health risks.

   The first step should be the recommendations that are planned to prepare within the World Bank project "Climate Change Risks, Opportunities and Priorities for Ukraine".
5. **Sectors affected:** health protection**.**
6. **Entities responsible for implementing:** Ministry of Health of Ukraine**,** National Health Service**,** other central authorities, local authorities.
7. **Implementation period finish:** 2030**.**

4.2.5. Energy sector

1. **Status:** planned
2. **Implementation period starts: 2021**
3. **Objectives:** to ensure energy security in the context its reliability and sustainability of country's energy system through reducing its vulnerability and strengthening climate resilience.
4. **Description:** Although Ukraine conducted a study of the vulnerability of the fuel and energy system to climate change (2012), it is not sufficient to formulate relevant policies and measures. Nevertheless, some conclusions were received as to what effects of climate change for energy sector are observed, including:
   - Changes in levels and modes of consumption of fuel and energy resources (FER) - daily, weekly, seasonal, annual - under impact of climatic factors, namely: reductions in energy demand for heating; rise of energy demand for air conditioning and refrigeration; rise of electricity demand for irrigation systems and watering; increase of technological losses in FER; rise in uneven daily power consumption on summer days.
   - Rise of uneven daily schedules of electric loads due to the development of air conditioning and refrigeration.
   - Possible reduction of the working capacity of thermal and nuclear power plants (TPP, NPP) due to: temperature rise in water cooling systems and ambient temperature; increase in

[49] https://zakon.rada.gov.ua/laws/show/2168-19

water loss by evaporation; reduction in water availability.

- Reduction of power generation and lack of balancing capabilities of HPP due to drought or floods.
- Increase of accidents in electric networks, destruction of buildings and equipment failure due extreme weather events.
- Faster corrosion and destruction of metal and concrete structures with increasing frequency and severity of rainfalls, including acid rain.

Depending on the availability of funds, it is planned to:

- conduct a comprehensive research on vulnerability of the fuel and energy system to climate change and a detailed risk assessment**;**
- develop policies and measures based on the results of a vulnerability / risk assessment and best European practices;
- incorporate science-based policies and measures into existing plans and programs related to the fuel and energy system.

5. **Sectors affected:** energy
6. **Entities responsible for implementing:** Ministry of Energy, Ministry of Environment Protection and Natural Resources of Ukraine**,** other central authorities, local authorities public and private energy companies.
7. **Implementation period finish: 2030.**

4.2.6. Municipal sector

1. **Status:** planned
2. **Implementation period starts: 2019**
3. **Objectives:** to increase adaptive capacities and strengthen climate resilience of urban territories and infrastructure to changed climate conditions in order to make cities/settlements more liveable, safe and comfortable.
4. **Description:** The municipal authorities are gradually realizing the need to incorporate climate change related policies and measures into the development plans of cities / settlements.
   In Ukraine the Covenant of Mayors for Climate & Energy (EU-funded project aimed at introducing the EU climate and energy initiative to the Eastern Neighbourhood countries) is supporting adaptation planning under Sustainable Energy (and Climate) Action Plan.
   Each city / settlement is recommended to conduct a research on vulnerability to climate change and assess specific risks. On the basis of findings concrete adaptation and resilience-related measures will be developed and implemented.
   Taking into account already identified general risks, the objectives for adaptation and climate-resilient development pathway include:
   - District heating / Electricity: adapting buildings by using up-to-date technologies and materials, electricity and heat networking upgrades to meet changed heating/cooling demands.
   - Solid waste management: elimination of uncontrolled disposals, which promote pathogen and disease vectors under hotter temperature.
   - Resilient water supply: introduction of water efficient technologies and network upgrades to combat water stress; diversification of water sources, improving of water storages, network upgrades/leak reduction, introduction of risk management measures related to droughts and floods.
   - Green infrastructure: encourage urban forestry, urban and peri-urban agriculture, adapting land use toward greening through regulation and planning.
5. **Sectors affected:** municipal

6. **Entities responsible for implementing:** Municipal authorities, public and private companies.
7. **Implementation period finish:** 2030**.**

4.2.7. Transport

1. **Status:** planned
2. **Implementation period starts:** 2021
3. **Objectives:** to increase adaptive capacities of transport and infrastructure in order to ensure reliability and comfort of transportation services. The impact of climate change on Transport sector in Ukraine is ambiguous – it is expected that there will be less snow and less frequent very low temperatures, so it will be easier to maintain the infrastructure. However, due to higher temperatures and related heat stress during the warm season (especially in summer time), nearly all transportation modes will require more energy for cooling. Apart from rising temperature and decreasing snow cover, there are unfavorable weather phenomena, such as high wind, landslides, heavy rainfalls, wildfires etc. An important issue is more frequent freeze-thaw episodes, which negatively affects the quality of all surfaces, including that of roads and bridges.
4. **Description:** it is important to adapt not only vehicles, but the entire transport infrastructure. The infrastructure is mostly old, being constructed long time ago for other climatic conditions. So new bridges have to consider new climatic conditions and their change. General measures include, but not limited to:
   - construction of new transport infrastructure on high land plots (due to floods and expected sea level rise);
   - timely warning of passengers about extreme weather events;
   - development of insurance programs that would include unfavorable weather events;
   - fighting with wildfires (which is especially important for railway).

   Specific measures in road transportation include:
   - proper quality of road surfaces with timely removal of snow, as well as
   - reconstruction of water sewage systems to ensure efficient and fast water intake in case of heavy precipitations.

   In railway, continuous check of integrity of trains and carriages with different measures including ultrasound together with efficient maintenance of rail beds are essential.

   In water transport, ensuring the necessary depth of waterways in the long run is needed.

   In air transport, refurbishing of take-off strips with ice-proof elements is required.
5. **Sectors affected:** transport, municipal, construction
6. **Entities responsible for implementing:** Ministry of infrastructure of Ukraine, municipal authorities
7. **Implementation period finish:** 2030

ANNEXES

ANNEX A. MAPPING BETWEEN GTAP 10 DATA BASE AND UGEM MODEL

Table A.1. Mapping between GTAP 10 Data Base regions and aggregate regions used for the policy simulation

No.	Modelled regions		Disaggregate regions in the GTAP database
	Region code	Description	
1	Oceania	Australia, New Zealand	aus nzl xoc
2	China	China	chn
3	Japan	Japan	jpn
4	XEastAsia	Rest of East Asia	hkg kor mng twn xea brn
5	SEAsia	Southeast Asia	khm idn lao mys phl sgp tha vnm xse
6	India	India	ind
7	XSouthAsia	Rest of South Asia	bgd npl pak lka xsa
8	USA	United States	usa
9	Canada	Canada	can
10	XNAmerica	Rest of North America	mex xna
11	LatinAmer	Latin America	arg bol bra chl col ecu pry per ury ven xsm cri gtm hnd nic pan slv xca dom jam pri tto xcb
12	EU_27	European Union 27	aut bel bgr hrv cyp cze dnk est fin fra deu grc hun irl ita lva ltu lux mlt nld pol prt rou svk svn esp swe
13	UK	UK	gbr
14	EFTA	European Free Trade Area	che nor xef
15	MENA	Middle East and North Africa	bhr irn isr jor kwt omn qat sau tur are xws egy mar tun xnf
16	SSA	Sub-Saharan Africa	ben bfa cmr civ gha gin nga sen tgo xwf xcf xac eth ken mdg mwi mus moz rwa tza uga zmb zwe xec bwa nam zaf xsc
17	Ukraine	Ukraine	ukr
18	Russia	Russia	rus
19	XFSU	Rest of Former Soviet Union	alb blr xee kaz kgz tjk xsu arm aze geo
20	RestofWorld	Rest of World	xer xtw

Note: Complete list of the GTAP 10 Data Base regions can be found at https://www.gtap.agecon.purdue.edu/databases/regions.aspx?version=10.211

Table A.2. Mapping between GTAP 10 Data Base sectors and aggregate sectors used for the policy simulation

No.	Modelled sectors		Disaggregate sectors in the GTAP database
	Sector code	Description	
1	Crops	Crops	pdr wht gro v_f osd c_b pfb ocr
2	Livestock	Livestock	ctl oap rmk wol fsh
3	Forestry	Forestry	frs
4	Coal	Coal mining	coa
5	Oil	Crude oil	oil
6	Gas	Natural gas extraction	gas gdt
7	OthMinerals	Other extraction	oxt
8	Oil_pcts	Refined oil products	p_c
9	ProcMeat	Processed meat	cmt omt mil
10	XFood	Other food	vol pcr sgr ofd b_t
11	PapWood	Paper products, publishing	ppp
12	Chemical	Chemical products	chm bph rpp
13	NonMet	Non-metallic minerals	nmm
14	IronSteel	Ferrous metals	i_s
15	XMetals	Non-ferrous metals	nfm
16	XManuf	Other manufacturing	tex wap lea lum fmp omf
17	MotorVeh	Motor vehicles	mvh otn
18	XMachin	Other machinery	ele eeq ome
19	Electricity	Electricity	ely
20	Trade	Trade, warehousing, hotels	trd afs whs
21	Transp	Transportation services	otp wtp atp
22	XServices	Other services	wtr cns cmn ofi ins rsa obs ros osg edu hht dwe

Note: Complete list of the GTAP Data Base sectors can be found at https://www.gtap.agecon.purdue.edu/databases/v10/v10_sectors.aspx#Sector65

ANNEX B. DEFINITION OF SECTORS FOR GHG EMISSIONS REPORTING

Table B.1. Definition of sectors for GHG emissions and investments reporting

Sector	NACE rev. 2 (КВЕД 2010)	Description
Agriculture	**A (01-03)**	GHG emissions from fuel combustion (Investments in applications) by users classified as agriculture (including engines used for agricultural transportation), hunting and forestry. GHG emissions from fuel (investments in applications) used for transportation of agricultural products not by special vehicles is reported in the Transport sector; GHG emissions from fuel (investments in applications) used by rural population is reported in the Residential sector; GHG emissions from fuel (investments in applications) used for electricity and heat production is reported in Autoproduction
Commercial, ***incl.***	**33, E (36-39), G (45-47), 52, 53, I (55-56), J (58-63), K (64-66), L (68), M (69-75), N (77-82), O (84), P (85), Q (86-88), R (90-93), S (94-96), U (99)**	GHG emissions from fuel combustion (Investments in applications) by business and offices in the public and private sectors. GHG emissions from fuel (investments in applications) used for transportation (except special vehicles like ambulances, fire trucks) is reported in transport sector; GHG emissions from fuel (investments in applications) used for electricity and heat production is reported in Autoproduction
Space Heating	own estimations (based on State Statistics)	GHG emissions from fuel combustion by (Investments in) autonomous applications for space heating purposes in the Commercial sector
Retrofitting	own estimations (based on State Statistics)	Investments in building's retrofitting technologies in the Commercial sector
Cooling	own estimations (based on State Statistics)	Investments in space cooling (ventilation) technologies in the Commercial sector
Water Heating	own estimations (based on State Statistics)	GHG emissions from fuel combustion by (Investments in) autonomous applications for water heating purposes in the Commercial sector
Public Lighting	own estimation (incl 52.21 and 81.10)	Investments in public lightning applications
Production of electricity and heat, ***incl.***	**35.11, 35.30, Autorpoduction (from 4-mtp)**	GHG emissions from fuel combustion (Investments in applications) for the electricity and/or heat production by all the generating sets. Power plant producers are classified either as "Main activity producers" (plants operated by private or public owners which are producing the electricity or heat for sale to third parties as their main business) or as "Autoproducers" (plants operated by private or public owners which are not producing the electricity or heat as their main business, but wholly or partly for their own consumption). Power plants can be classified as electricity only or heat only plants (designed to produce only electricity or heat) or CHP plants (designed to produce both heat and electricity). GHG emissions from fule (investments in applications) used for transportation (except special vehicles) is reported in transport sector
Main activity producer electricity plants, incl.	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Main activity producers" power plants producing electricity only
Wind power plants	35.11, 35.30, Autorpoduction (from 4-mtp)	Investments in applications by "Main activity producers" power plants for electricity generation from wind (kinetic energy of wind exploited for electricity

		generation in wind turbines) and producing electricity only
Solar power plants	35.11, 35.30, Autorpoduction (from 4-mtp)	Investments in applications by "Main activity producers" power plants for electricity generation from photovoltaic systems and producing electricity only
Bio power plants	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Main activity producers" power plants for electricity generation from primary solid biofuels and biogases and producing electricity only
Main activity producer CHP plants, incl.	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Main activity producers" CHP plants producing electricity and heat
Bio CHP plants	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Main activity producers" CHP plants for energy generation from primary solid biofuels and biogases and producing electricity and heat
Autoproducer CHP plants, incl.	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Autorpoducers" CHP plants producing electricity and heat
Bio autoproducer CHP plants	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Autoproducers" CHP plants for energy generation from primary solid biofuels and biogases and producing electricity and heat
Producer heat only plants, incl.	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by both "Main activity producers" and "Autoproducers" heat only plants producing heat from all sources and types of fuel
Bio heat only plants	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Main activity producers" heat only plants producing heat from primary solid biofuels and biogases
Autoproducer heat only plants, incl.	35.11, 35.30, Autorpoduction (from 4-mtp)	GHG emissions from fuel combustion (Investments in applications) by "Autoproducers" heat only plants producing heat from all sources and types of fuel
Industry icnl.		GHG emissions from fuel combustion (Investments in applications) by all industrial sectors with the exception of the "Energy sector". GHG emissions from fuel (investments in applications) used for transportation of industrial products not by special vehicles is reported in the Transport sector; GHG emissions from fuel (investments in applications) used for electricity and heat production is reported in Autoproduction
Iron and steel	24.10, 24.20, 24.30, 24.51, 24.52	GHG emissions from fuel combustion (Investments in applications) in the Iron and steel industry
Non-ferrous metals	24.40, 24.53, 24.54	GHG emissions from fuel combustion (Investments in applications) in non-ferrous metals industries
Non-metallic minerals	23	GHG emissions from fuel combustion (Investments in applications) in the nonmetallic minerals industry (glass, ceramic, cement and other building materials industries)
Chemical	20, 21	GHG emissions from fuel combustion (Investments in applications) in the chemical and petrochemical industries
Paper, pulp and print	17, 18	GHG emissions from fuel combustion (Investments in applications) in the paper and printing industry, including production of recorded media
Other industries	07-16, 22, 25-32, F (41-43)	GHG emissions from fuel combustion (Investments in applications) in other industries and Construction

Residential, incl.	**Estimated by the State Statistics Service**	
Space Heating	own estimations (based on State Statistics)	GHG emissions from fuel combustion by (Investments in) autonomous applications for space heating purposes in the Residential sector
Retrofiting	own estimations (based on State Statistics)	Investments in building's retrofiting technologies in the Residential sector
Cooling	own estimations (based on State Statistics)	Investments in space cooling (ventilation) technologies in the Residential sector
Water Heating	own estimations (based on State Statistics)	GHG emissions from fuel combustion by (Investments in) autonomous applications for water heating purposes in the Residential sector
Supply Sector, incl.		GHG emissions from fuel combustion (Investments in applications) by the "Energy sector" for primary fuel production (extraction), processing and transportation. GHG emissions from fule (investments in applications) used for transportation of energy resources (except for pipelines) is reported in the Transport sector; GHG emissions from fule (investments in applications) used for electricity and heat production is reported in Autoproduction
Oil&Gas Pipelines	49.5	GHG emissions from fuel combustion (Investments in applications) in the support and operation of oil&gas pipelines. This includes GHG emissions from fuel combustions (investments) for pump stations and maintenance of the pipeline but excludes for the pipeline distribution of natural or manufactured gases
Liquid Biofuels Infrastructure	own estimation	GHG emissions from fuel combustion (Investments in applications) in the support of liquid biofuels infrastructure
Transport, incl.	49-51 ecxluding 49.5 and including private and sectoral transport	GHG emissions from fuel combustion (Investments in applications) by all transport activities irrespective of the economic sector in which the activity occurs, i.e., rail, road, aviation and domestic navigation (excluding pipeline transport). GHG emissions from fule (investments in applications) used for electricity and heat production is reported in Autoproduction
Private cars	own estimations (based on State Statistics)	GHG emissions from fuel combustion (Investments in applications) for the propulsion of all types of cars, whether for own use or the use of others
Trucs	49.4	GHG emissions from fuel combustion (Investments in applications) for the propulsion of all types of trucks, whether for own use or the use of others
Buses	49.3	GHG emissions from fuel combustion (Investments in applications) for the propulsion of all types of busses, whether for own use or the use of others
Rail	49.10, 49.20, 49.31	GHG emissions from fuel combustion (Investments in applications) in rail traffic, including industrial railways and electrified urban transport systems

ANNEX C. PREVENTION OF MSW DISPOSAL

Overall structure of MSW treatment system

Ukraine plans to create a circular economy in a long-term prospective, which was defined as a conceptual challenge to be resolved e.g. in National Waste Management Strategy of Ukraine up to 2030 and National Report "Sustainable Development Goals: Ukraine". Nevertheless, solid waste disposal and energy use of waste (directly as a fuel or as a raw material for fuel production) still will be important waste treatment practices in Ukraine in middle-term time horizon. The accent should be focused on the cost efficiency, as well as high environmental and climate requirements for these technologies.
Reduction of MSW disposal share in Ukraine to the level of 70 % by 2030 could be obtained due to expanding the following modern waste treatment practices to the level of: secondary use – 8 %; composting – 5 %; recycling – 10 %; incineration – 7 %, coverage of centralized MSW collecting system – 90 %.

Technology specific objectives

Closure of old dumps. To reduce the share of MSW disposal by 30 %, approximately 2 020 old acting dumps have to be closed.

Waste sorting. To increase the share of MSW recycling and MSW secondary use by 10 % and 8 % respectively, approximately 70 new reception/collecting centres have to be introduced, as well as 40 new centres for collecting of MSW materials with the purpose of reuse; 25 additional MSW sorting lines; 25 000 of additional containers and 170 additional collection vehicles; and construction of 55 reloading stations (as integral part of new regional sanitary landfills).

Stimulation of product use, which have been manufactured from recycled materials, will raise the cost-efficiency of waste sorting and recycling, contributing to the waste sorting diffusion, e.g. mandatory CO_2-newtral paper use in governing activity, large enterprises etc.

Construction of new regional sanitary MSW landfills. Construction of 20 new sanitary regional landfills (equipped with landfill gas utilization/recovery infrastructure, also see measure A.3.2) to avoid collapse in waste treatment sphere due to closure of more than 2 000 of old dumps.

Mechanical biological treatment of waste. The total need in MSW mechanical biological treatment facilities, including ones allowing biogas and energy production, alternative solid fuel for district heating and/or electricity production and SRF production for cement industry is 15-20 units. Concrete proportion between the different types of mechanical biological treatment facilities will depend from development of regional waste management plans. Regional waste management plans will play a key role in finding the optimal solution for the type of mechanical biological treatment technology to be applied depending on regional specific indicators such as number of population, waste composition, regional structure of industry and energy infrastructure etc.

Composting of food and green residuals. To ensure the share of MSW composting at the level of 5 %, 85 Waste Reception/Collection Centres are to be provided in cities with a population above 20,000. Basic windrow compost centres are to be co-located in these Centres for green waste.

Existing Common Barriers

Common economic and financial barriers for reducing of MSW disposal share in Ukraine are:

- low feasibility or even unprofitability (low IRR, NPV, long payback period) for most of technologies;
- low tariffs on MSW management for population and other waste generators;
- low tariffs on MSW disposal (tariffs do not include costs for closure, care and aftercare monitoring); • Inadequate access to financial resources;
- high cost of finance;
- disincentives to foreign investment;
- absence of economy incentives to process and recycle MSW;
- absence of producer re responsibility on the generated waste;
- low population income.

Common non-financial barriers for reducing of MSW disposal share in Ukraine are:

Regulation/legislation barriers:

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

Market conditions barriers:

- over-bureaucratic procedures and corruption;
- no possibility to sigh long-term contract;
- no possibility to sigh direct contracts between local governments and waste processing companies;
- involvement of informal sector;

Technological barriers:

- few local equipment and service suppliers and local references;
- bad quality of mixed waste;
- insufficient skilled manpower for O&M.
- information barriers:
- limited awareness of technology used in the developed countries;
- lack of available information, pure population knowledge and involvement in waste treatment issues;
- missing feedback among interested parties.

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

For more details, please see TNA project in Ukraine.

Common measures to overcome the existing barriers:

Common measures to overcome economic and financial barriers for reducing the share of MSW disposal in result are:

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

Common measures to overcome non-financial barriers or reducing the share of MSW disposal in result are:

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

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

To overcome active gender barriers, which are salary and carrier paths inequality, additional specific measures have to be implemented in waste management system, which are:

- implementation of quotas for woman representativeness in central and local authority bodies;
- requirements on vacancies should be gender neutral both for government and business;
- implementation of awards focused on promoting women to be involved in waste management issues;
- ensuring social guaranties for pregnant women and women with children;
- implementation of supporting mechanisms stimulating migration of hired workers in waste management from informal sector to legal business.