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SUPPORT TO THE GOVERNMENT OF UKRAINE ON UPDATING ITS NATIONALLY DETERMINED CONTRIBUTION (NDC)

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REPORT 2/ BACKGROUND REPORT

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Executive Summary

This report was developed under EBRD project providing support to the Government of Ukraine (GoU) on developing second NDC under Paris Agreement.

The report aims to provide general overview of existing and planned national legislation relevant for second NDC development, to analyse existing Ukrainian NDC, including various sectoral GHG emissions modelling and forecasting tools applied for developing economy-wide target of first Ukrainian NDC, and to propose methodological approach for developing second Ukrainian NDC based on best international experiences, first NDC lessons learned and existing legislation framework and national circumstances in Ukraine.

In Section 1, the report provides general information on population, geography, climate, economy, political and legislation system of Ukraine, it's trading partners, participation in international treaties, UN agreements, international relations, including EU-Ukraine Association Agreement, and Russian Aggression. This section also gives an overview of existing and planned national legislations on mitigation and adaptation, that are relevant for second NDC development.

National energy, environment and climate legislation, such as Energy Strategy till 2035, State Climate Policy Concept and its Action Plan till 2030, Environmental Strategy till 2030, Transport Strategy, draft MRV Law and planned National Integrated Energy and Climate Action Plan till 2030, and first NDC are creating the national legislation framework for second NDC development.

EU-Ukraine Association Agreement, UNFCCC, Paris Agreement, CORSIA, UN 2030 Agenda for Sustainable Development and other international and bilateral treaties, agreements and initiatives are establishing international context for second Ukrainian NDC. Ukraine's 2050 Low Emission Development Strategy under Paris Agreement is an important policy document that will be considered under the second NDC development process. Absence of adaptation legislation and limited adaptation knowledge in Ukraine, creates constrains in formulating national adaptation goal under second NDC development process.

Ukraine's economic growth and social development indicators, it's low-middle income country status that participates in major South-South cooperation initiatives, are setting the scene for national circumstances approach and it's differentiated responsibility under UNFCCC to be considered while formulating national mitigation and adaptation target of second Ukraine's NDC.

Section 1 also gives a brief overview of existing climate finance structure and presents the approach to future climate finance planning and sources for second NDC implementation. In Ukraine, climate finance nowadays comes from IFIs, MDBs, international donors' organizations and under bilateral agreements mostly for the purposes of energy efficiency, renewable energy development and industrial modernization. This is expected to be changes overtime with more national public and private funds moving towards climate finance and leveraging international climate investments.

Section 2 of the report provides the analysis of first Ukrainian NDC, including, to the extent possible, modelling tools applied for each sector under IPCC definition - Energy, Industrial Processes, Waste, LULUCF and Agriculture, projections and scenarios used for formulation of NDC target – not to exceed 60% of GHG emissions level till 2030, compared to 1990 level. Limited additional information is available for first Ukrainian NDC other than UNDP report that was developed under technical assistance project supporting first NDC development in 2015. Thus, we have analysed the information in UNDP report as most reliable and the only available on first Ukrainian NDC.

Lessons learned from first Ukrainian NDC and potential improvements for the second NDC are - development of adaptation goal, application of reliable, formally and internationally recognized GHG emissions modelling tools, projections and forecasting approaches for all sectors, including Waste, LULUCF and Agriculture, synchronization of NDC target and approaches with national legislation and enhanced transparency of background and input information used for NDC development.

Further on, this sector gives an overview and comparative analysis of modelling tools used in the world for GHG emissions projections, forecasting and scenarios development under UNFCCC, national and multi-national processes, including IPCC guidelines. This comparative analysis process draws recommendations for second Ukrainian NDC modelling approaches and set of modelling tools for each sector (see Figure 2.4). The report runs through existing models in Ukraine, their pros and cons and proposes, and provides detailed overview of proposed models, such as TIMES-Ukraine, Ukrainian General Equilibrium model, Waste and LULUCF available modelling tools and visualization tool to be applied for second NDC development for illustration of results while synchronizing those results with National GHG Inventory data and reporting tools, including GRF tables.

The proposed modelling approach foresees the bottom-up approach to NDC development by modelling GHG emissions pathways under different development scenarios (see Figure 2.5 and 2.6) that will incorporate macroeconomic and other input data, including, but not limited to GDP, GDP per capita, population, just transition of job, technology options, energy and energy mix, carbon intensity, finance and investments.

Section 2 also describes the approach to the second NDC input data collection process and sources, including specific requirements and timelines, to ensure the reliability and comparability of input data and modelling results and to ensure access and availability of all input data.

Section 3 of the report is a description and materials of Methodological Workshop conducted under the framework of modelling approach in March 2019 in order to present and collect feedbacks from ministries, state agencies, private business, civil society, professional community and sectoral associations on proposed methodological approach (see Figure 2.4-2.7).

Background Report (Task B)

Supporting the development of Ukraine's second NDC

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LIST OF ABBREVIATIONS

AFOLU – Agriculture, Forestry, Land Use
CORSIA – Carbon Offset and Reduction Scheme for International Aviation
CRF – Common Tablur Format
EBRD – European Bank of Reconstruction and Development
EE - Energy Efficiency
EIB – European Investment Bank
ETS – Emission Trading Scheme
EU – European Union
GCF – Green Climate Fund
GDP – Gross Domestic Product
GEF- Global Environmental |Facility
GHG – Greenhouse Gas
GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit
GoU – Government of Ukraine
ICAO – International Civil Aviation Organization
IEA – International Energy Agency
IEF – Institute for Economics and Forecasting National Academy of Sciences of Ukraine
IFC – International Finance Corporation
IFI – International Finance Institution
IMF – International Monetary Fund
INDC - Intended National Determined Contributions
IPCC – Intergovernmental Panel on Climate Change
JBIC – Japan Bank for International Cooperation
LEAP – Long-range Energy Alternative Planning
LEDS – Low Emission Development Strategy
LULUCF – Land Use, Land Use Change and Forestry
MDBs – Multilateral Development Banks
MRV – Monitoring, Reporting, Verification
NC – National Communication on Climate Change
NDC – Nationally Determined Contribution
OECD – Organisation for Economic Cooperation
PMR – Partnership for Market Readiness
RE – Renewable Energy
SDGs – Sustainable Development Goals
UN – United Nations
UNDP – United Nations Development Program
UNFCCC – United Nations Framework Convention on Climate Change
US$ - US dolllars
USAID – Unites States Agency for International Development
TIMES – The Intergrated MARKAL/EFOM Energy System (model generator)
WTO – World Trade Organization

SECTION 1. OVERVIEW OF LEGISLATIVE FRAMEWORK AND POLICY CONTEXT OF UKRAINE

1.1. INTERNATIONAL POLICY CONTEXT

Ukraine is a sovereign, independent, democratic, social, state with rule of law. Ukraine is one of the largest countries in Europe located in Central-Eastern Europe with the territory of 603,550 sq. km covering 5.7% of Europe with population of 44.6 million people (2018).

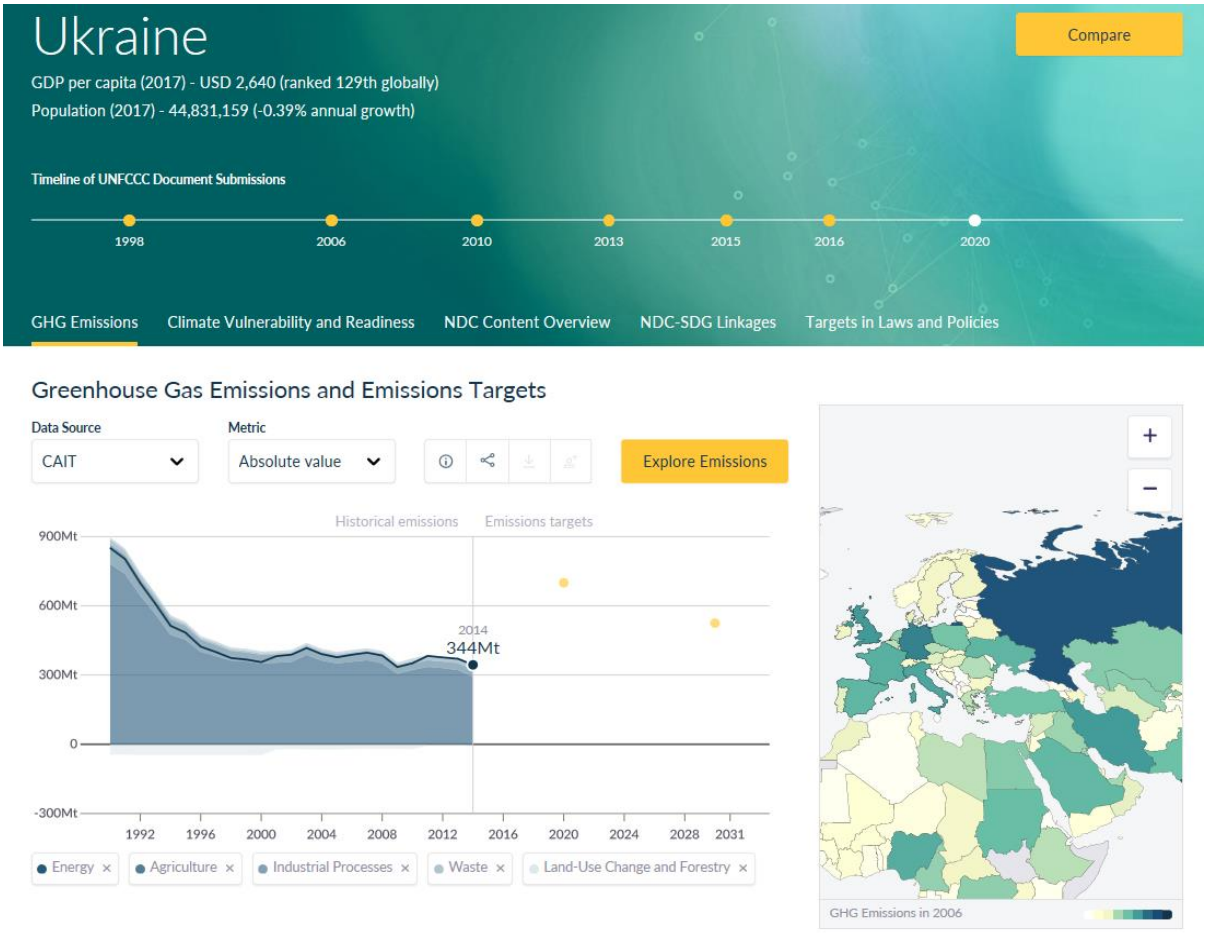
Key facts about Ukraine – Overall national context shaping policies	
Population	44.6 million people (*Note: There is no single number of Ukraine's population, due to the fact that population census took place in 2001. So, there are various numbers on total population, but the figure provided here is from [1]*)
Economy	Ukraine is Low Middle Income country with current GDP of US$ 130.8 billion and GDP per capita, current (2018) – US$ 3,095. In 2016 in Ukraine Life Expectancy at birth was 71.5 years. Ukraine is one of the most populous countries in Europe, endowed with some of the world's most fertile soils which help make it an important agricultural producer and a major exporter of agricultural commodities, particularly grains and oilseeds. Ukraine also manufactures a broad range of industrial goods, mostly a legacy of its industrialization during the time of the Soviet Union. Industrial output has been shifting gradually from heavy to light industries and food processing, while Ukraine has maintained its significant aviation and aerospace sectors. Services sectors have expanded rapidly since the abandonment of central planning following independence in 1991.
Climate and geography	Ukraine is one of the largest country in Europe located in Central-Eastern Europe with the territory of 603,550 sq. km covering 5.7% of Europe. Climate of Ukraine is a temperate continental one, with subtropical Mediterranean climate at the South Coast of the Crimea. Generally, Ukraine gets sufficient amounts of heat and moisture, which create favorable natural and climatic conditions in its territory. However, those conditions have been changing substantially throughout recent decades, bringing about serious threats and challenges for country's sustainable development due to increased risks for human health, life and activities, natural ecosystems, and economy sectors. The main manifestations of regional climate changes in Ukraine within the global warming processes include significant rise of air temperatures, changes of thermal regime and structure of precipitation, increased number of hazard meteorological phenomena and extreme weather events, which all result in losses for country's population and various economy sectors.
Type of government	The Constitution of Ukraine of 28 June 1996, as amended and supplemented until 2014, proclaims Ukraine a democratic State with power divided between the legislative, executive and judicial branches of government. Legislative power is vested in Ukraine's Parliament (the Verkhovna Rada of Ukraine), which consists of 450 People's Deputies elected by popular vote for five-year terms. Next Parliamentary elections will be held on 31 October 2019.

[1] The World bank – https://data.worldbank.org/indicator/SP.POP.TOTL?locations=UA

Key facts about Ukraine – Overall national context shaping policies	
	The Verkhovna Rada promulgates legislation in the form of laws, resolutions and other legislative acts. The laws lay down the basic rules for, *inter alia*, the exploitation of natural resources; the organization and use of domestic energy, transportation, and communication networks; and the protection of property and entrepreneurship. The Verkhovna Rada determines the main directions of foreign and domestic policies, approves economic policy programmes, develops antimonopoly and competition policy. As Head of State, the President of Ukraine is the guarantor of state sovereignty, territorial indivisibility, and citizens' rights and freedoms. The President is elected directly by the people for a maximum of two consecutive five-year terms. The mandate of the President includes the negotiation and conclusion of international treaties, many of which are subsequently presented to the Verkhovna Rada for ratification. The President has the authority to appoint (or dismiss) certain officials.
Legislative process	Ukraine's Verkhovna Rada adopts laws, resolutions and other legislative acts and determines the main directions of foreign and domestic policies, approves economic policy programmes, develops antimonopoly and competition policy. In addition, the Verkhovna Rada approves the state budget including the budgeting procedure, the system of taxation, rules for Ukraine's financial and money markets, the level and composition of national debt, and the issue and circulation of state securities. The President approves laws adopted by the Verkhovna Rada, and he may also issue decrees and directives in the areas of international relations, defence, and other issues (in accordance with Chapter V of the Constitution). He has the right to veto laws, return them to parliament for revision, or dissolve parliament under circumstances stipulated in Article 90 of the Constitution. The Cabinet of Ministers of Ukraine, headed by the Prime Minister, is formally proposed by the President and approved by the Verkhovna Rada. In addition to the Prime Minister, the Cabinet comprises a First Vice Prime Minister, Vice Prime Ministers, and Ministers that direct and coordinate the activities of 17 ministries and more than 40 state agencies, state services, and other central governmental bodies. Some of these entities report directly to the Cabinet of Ministers, while others are governed and coordinated by the Minister concerned. The Cabinet of Ministers implements economic and social development programmes, as well as policies with respect to foreign economic activity, customs, taxation, investment, prices, or financial regulation through the issuance of resolutions and orders.
Trade system **Key trading partners**	• WTO (since 2008), EU Ukraine Association Agreement (since 2017) • Key trade partners: EU (45.1% of net trade) Ukraine acceded to the WTO in 2008 with wide-ranging commitments on market access for goods and services and few transitional arrangements vis-à-vis the WTO rulebook. Ukraine joined the Information Technology Agreement upon accession and the plurilateral Agreement on Trade in Civil Aircraft in 2010. The terms of Ukraine's accession to the plurilateral Agreement on Government Procurement were approved in November 2015. After decades of centrally-planned industrial development within the Soviet Union, Ukraine as an independent nation favours market liberalization and economic reform as tools to raise living standards for

Key facts about Ukraine – Overall national context shaping policies	
	its population and the further development of Ukraine's industrial, agricultural, scientific, technological, intellectual and cultural potential. Ukraine believes trade should be unhampered, based on transparent rules that are respected by all its trading partners. The period of accession to the WTO was used to push domestic reforms. Ukraine would like to be seen as a reliable, predictable partner for the entire international community. Its WTO Membership, followed by negotiations to forge a closer relationship with the European Union, has been pursued with a view to modernizing and harmonizing Ukraine's business legislation with best international practice, enhancing product standards and the compatibility of such norms across borders, and the creation of new, mutually profitable opportunities for trade.
International relations	Ukraine was one of founding members of the United Nations and sign the United Nations Charter in 1945. Ukraine is a Party to Paris Agreement, Annex I Party to UNFCCC and Annex B Party of Kyoto Protocol (the Doha Amendment has not been ratified yet). Under UNFCCC framework Ukraine is eligible for GEF support. Ukraine is a member of IMF since September 3, 1992. Ukraine is not a member of IEA and not OECD country-member. At the same time Ukraine has worked with OECD for a quarter-century and getting support of Ukraine's efforts to transform its economy and integrate more deeply into international markets and institutions. Ukraine co-operation with OECD is implemented under a Memorandum of Understanding between the OECD and the Government of Ukraine till 2020. Under the Action Plan agreed for the implementation of the Memorandum, the OECD supports reforms in Ukraine in three key areas identified as priorities by the government: anti-corruption; governance and rule of law, and investment and business climate. Ukraine also has operational presence of various donors' organizations, IFIs and multilateral development funds that provide technical assistance and financial support in deference areas, including, *inter alia*, economic development, health care, human rights protection, building democratic society, institutional development and humanitarian response to military aggression of Russia. Donors' organizations and development programs that are active in Ukraine - UNDP, UNEP, IFC, IMF, UNHCR, IOM, UNAIDS, ILO, UNICEF, UNOPS, UN OCHA, FAO, WFP, WHO, UNPF, UNWOMEN, UN Volunteer, UN Office of High Commissioner for Human Rights, United Nation Office on Drugs and Crime, World Bank, EBRD, KfW, USAID, GIZ, SIDA, NEFCO, IKI and others.
EU Ukraine Association Agreement	*Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Ukraine, of the other part* has been ratified by the Parliament of Ukraine and the European Parliament simultaneously on September 16, 2014. On 1st September 2017, EU - Ukraine Association Agreement entered fully into force after a long period of ratification. The Association Agreement in its scope and thematic coverage is the biggest international legal document in the history of Ukraine and the biggest international agreement with a third country ever concluded by the European Union.

Key facts about Ukraine – Overall national context shaping policies	
	It defines a new format of relations between Ukraine and the EU on the basis of "political association and economic integration" and serves as a strategic guideline for systematic socio-economic reforms in Ukraine. The chapter on Deep and Comprehensive Free Trade Area between Ukraine and the EU defines the legal framework for the free movement of goods, services, capital and partly labour force between Ukraine and the EU. It also defines regulatory convergence aimed at the gradual integration of Ukraine into the EU common market. Ukraine is a Contracting Party of European Energy Community since 2011. Ukraine is a founding member of the Energy Charter Process and signed the International Energy Charter in May 2015.
Russian Military Intervention	As a result of the temporary occupation of the Autonomous Republic of Crimea and the city of Sevastopol by the Russian Federation and its further military aggression in certain areas of the Donetsk and Luhansk regions, since 2014 slightly over 7 % of the territory of Ukraine temporarily remains out of control of the Government of Ukraine. The ongoing military aggression of the Russian Federation against Ukraine has a strong negative impact on the overall economic situation in Ukraine and has led to the reduction in industrial production. First NDC says “After restoration of territorial integrity and state sovereignty over the whole territory of Ukraine, the need will arise to reconstruct ruined industrial facilities and infrastructural networks, including railway infrastructure, gas and oil pipelines, water supply systems, sewerage networks, and to repair and build new residential houses and social facilities. All this will cause increase in the production of metals, non-metal construction items, food products, etc. Ukraine will acutely need multi-billion capital investments”. The temporary occupation of the Autonomous Republic of Crimea and the city of Sevastopol as well as the Russian Federation military aggression in certain areas of the Donetsk and Luhansk regions is steadfastly condemned by international community, territorial changes by force are not recognized, sanctions remain in place till full compliance of the Russian Federation with international law. In particular, the UN General Assembly resolution 68/262 of March 27, 2014 «Territorial Integrity of Ukraine» confirmed the internationally recognized borders of Ukraine and the absence of any legal basis to change the status of the Autonomous Republic of Crimea and the city of Sevastopol. The same stance was confirmed by the UN General Assembly resolution 71/205 “Situation of human rights in the Autonomous Republic of Crimea and the city of Sevastopol (Ukraine)” of December 19, 2016, which unambiguously defines Russia as an occupying power. Besides that, numerous documents in support of Ukraine’s territorial integrity within its internationally recognized borders were approved by the Committee of Ministers of the Council of Europe, Parliamentary Assembly of the Council of Europe, OSCE Parliamentary Assembly and other international organizations.



1.2. RELEVANT EXISTING AND PLANNED NATIONAL LEGISLATIONS AND POLICIES/STRATEGIES

The hierarchy of Ukraine's national legislation system includes laws, resolutions adopted by the Parliament and signed by the President, legislation acts (decree, resolution, protocol decisions) adopted by the Cabinet of Ministers of Ukraine and orders adopted by sector-specific ministries and, in some cases, endorsed by Ministry of Justice. National laws and decrees could have sectoral, regional or national coverage. As of early 2019, Ukraine does not have any economic and/or social legislation framework, therefore all climate related policies are incorporated in sectoral or climate specific legislation.

Climate change related national legislation covers both mitigation and adaptation. Major sectoral legislation covers mitigation and GHG emission reduction policies and actions. Core climate related sectoral legislation includes National Energy Strategy till 2035, National Energy Efficiency and National Renewable Energy Actions Plans, Environmental Strategy till 2030, State Climate Policy Concept till 2030 and others.

1.2.1. Mitigation actions and instruments

Ukraine has been developing and implementing national energy policies since its independence 1992 in order to ensure energy security, reliability and affordability of energy supplies and since early 2000, Ukraine has been implementing national climate change policy framework to reduce GHG emissions across the sectors. As of early 2019, Ukraine has quite comprehensive energy and climate related legislation framework that includes:

- First Ukrainian NDC (till 2030);
- Low Emission Development Strategy till 2050;
- National Energy Strategy till 2035;
- State Climate Policy Concept and its Action Plan till 2030;
- Environmental Strategy till 2030;
- Waste Management Strategy till 2030;
- Transport Strategy till 2030;
- Planed Integrated Energy and Climate Action Plan till 2030.

The rest of sectoral legislation covers period up till 2020 only.

Ukraine adopted its first (I)NDC in September 2015. First Ukrainian NDC is economy wide GHG emissions reduction target - not to exceed 60% of GHG emissions by 2030 compared to 1990 level. First NDC has been adopted in the format of GoU decree and all sectoral legislation adopted afterwards, such as New Energy Strategy till 2035, National EE and RE Actions Plans, recently adopted Environmental Strategy till 2030 and other incorporate first NDC target. Second Ukrainian NDC planned to be adopted in the format of GoU decree.

As mentioned above, Ukraine does not have any strategic long-term economic and/or social legislation, therefore legislation development, planning and implementation takes place within sectoral legislation framework. The overall strategic planning has fragmental approach in Ukraine and does require significant improvements in order to incorporate mitigation targets in all sectors of the economy.

Recently, energy sector had become top priority for Ukrainian Government and international organizations in Ukraine that is reflected in recently adopted comprehensive energy sector legislation framework, including Energy Strategy, EE and RE Actions Plans and other numerous legal acts in order to implement Energy Community, EU-Ukriane Association Agreement and Energy Treate provisions. Therefore, energy sector currently has the most comprehensive and elaborated legislation framework among economic sectors. This also stimulated by energy security needs and needs for diversification of energy supply sources.

GHG emission wise, Energy sector is in charge of over 80% of all Ukrainian emissions and therefore, its important that this sector continues to be carefully considered for second NDC development process.

Most of energy sector legislation covers supply side, while demand side planning needs more attention on both national and regional levels, especially under current process of de-centralization. Waste Management Strategy till 2030 adopted in 2018 provides the grounds for establishment of EU waste management hierarchy and establishment of inter-regional landfields. Transport sector policies and measures have been elaborated in recently adopted Transport Strategy till 2030. Agriculture and forestry sectors do not have sectoral policies other than developed draft legislation. Environmental policies outlined in Environmental Strategy till 2030, adopted by Verkhovna Rada law in February 2019. Industry strategy draft has been developed in 2018, but has not been adopted yet.

National climate policy legislation framework is quite comprehensive and includes, among Paris Agreement Ratification Law, EU-Ukraine Association Agreement, Montreal Protocol and other international treaties and protocols, national specific legislation developed recently

– State Climate Policy Concept till 2030 and its Action Plan, Environmental Strategy till 2030, Sustainable Development Strategy till 2020, draft MRV, draft Ozone Depleting Substances Law and others. The list of NDC relevant energy, climate, transport and waste legislation is in Annex VII, including brief descriptions of goals and indicators.

The major legislative constraints for second NDC development are related to poor implementation, limited legislation enforcement process and, as a result, limited performance of existing national legislation; NDC adopted by the GoU does not have legal enforcement power for national laws and that creates legislation gap in coordination between ministries and state agencies and creates constrains in incorporating national NDC target into high level legal acts, such as laws.

The role and impact of existing mitigation policies for second Ukrainian NDC development

Second NDC scenarios (see section 2.3), scenarios design, forecasting and projections will be modelled based on relevant indicatiors, goals, targets and policies of existing and planned legislation (see Annex VII).

GHG emission targets of Energy Strategy, Environmental Strategy and LEDS will be assessment and re-calculated based on level of ambition, access to adequate finance and climate-friedndly technologies.

As we could see from Annex VII, most of sectoral and climate mitigation legislation have 2020 planning horizon and only limited number of legislations' timeframe goes up to 2030 or 2035. Keeping in mind the absence of overall social-economic strategy in Ukraine and short planning horizon of national strategic documents, existing and planned climate mitigation legislation framework will most likely have insignificant influence for the second NDC development process and will provide limited input data for GHG emissions scenarios modelling.

Low Emission Development Strategy has 2050 indicative target of 31-34% of GHG emissions compared to 1990 level and there are no mid-term targets in LEDS. During the second NDC development process, the team will evaluate all the scenarios, projections and forecasting used in LEDS for second NDC.

Energy Strategy 2035 RE target of 25 % and other infrastructural indicators of Sustainable Development Stage will be incorporated into second NDC development scenarios. Energy Strategy and second NDC scenarios and forecasting will be synchronized. Transport Strategy indicators and goals till 2030 will be also incorporated into second NDC scenarios and reflected in the forecasting results.

Waste Management Strategy indicators will be incorporated into second NDC modelling process to the extent possible, in order to provide the space for regional and municipal Waste Management Plans to be developed and adopted in upcoming 2020. Environmental Policy Strategy till 2030 (adopted in February 2019) has GHG emissions reduction indication – in 2030 GHG emissions should be less than 60% of 1990 level, that is the level of first Ukrainian NDC.

See Table 1.1 for non-exhaustive list of major existing climate mitigation national legislation.

Table 1.1. Existing core sectoral legislation on climate mitigation

Legislation Title	Power generation	Transport	Industry	Agri-culture	Forestry	Waste
Sustainable Development Strategy "Ukraine 2020"	X	X				
National Renewable Energy Action Plan till 2020						
National Energy Efficiency Action Plan till 2020	X					
New Energy Strategy of Ukraine till 2035	X					X
State environmental policy Strategy of Ukraine till 2030	X	X	X	X	X	X
State Heat Supply Policy Concept	X					
Waste Management Strategy in Ukraine till 2030						X
State Climate Policy Concept and its Action Plan						
Transport Strategy till 2030		X				

Current Climate Finance

In order to implement existing climate mitigation legislation provisions, to fulfil international obligations and meet national targets on climate change, Ukraine needs reliable climate finance both from national and international sources. See Fig. 1.1 for proposed approach to climate finance.

Climate finance is funding drawn from national – public and private, international – public and private and other resources for GHG emissions reductions and adaptation to climate change.

Currently, climate activities are carried out through international technical assistance programs and various financial instruments of international financial institutions. Even legislation development related to climate is not funded under state budget and sources through various technical assistance projects and donors' organizations. However, it is expected that Ukraine will move towards the use of mixed funding sources - public, private, international in the long-term future.

Most of Ukraine's experience in attracting climate finance is under climate mitigation portfolio, such as energy efficiency, energy saving and renewable energy finance. Current external climate finance comes from IFIs - the World Bank Group, IFC, EID, EBRD, E5P, CTF, NEFCO, USELF, KfW, IKI, GEF, OPIC, JBIC and other national and internation donor's organizations.

Here are the examples of successful climate mitigation finance programs under energy sector - EBRD Green Cities 2 Project (GrCF2) and FINTECC program.

Private funds that are active in Ukraine in energy sector aiming in increasing efficiency and therefore reducing GHG emissions are – Horizon Capital, Blazer Foundation, Bill and Melinda Gates Foundation and others.

Bilateral technical assistance agreements (with Austria, Denmark, Canada, Germany, Norway, USA, Sweden, Switzerland, Japan, Israel, EU structures) were and will remain the primary sources of grants and concessional lending.

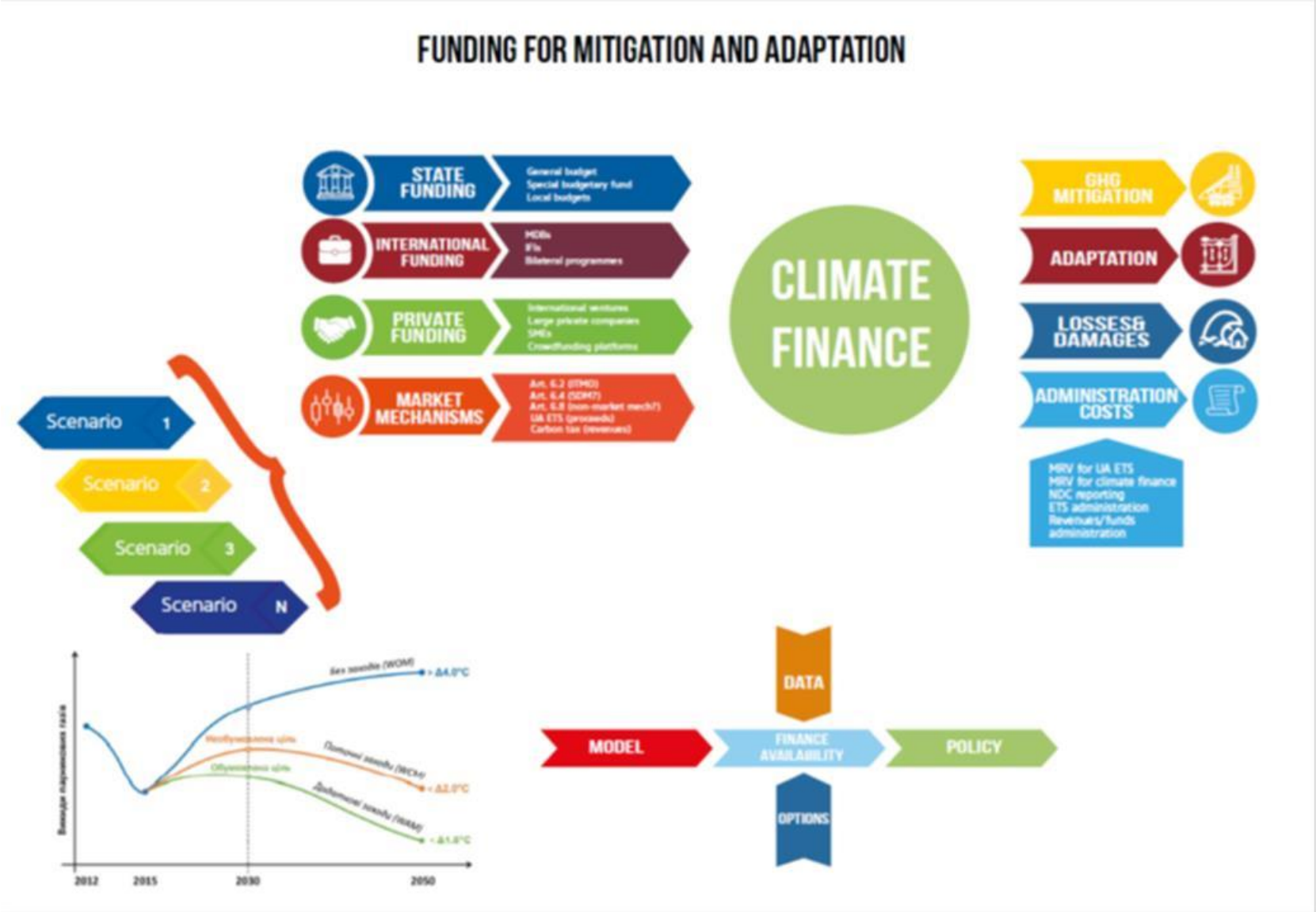


Fig.1.1. Funding for mitigation and adaptation

Future Climate Finance Approach

As the likelihood of adverse effects of climate change grows over time, so do estimates for the required funding for GHG emissions abatement, adaptation to climate change and coverage of costs related to adverse effects.

The extended outline represents the proposed methodological approach to assessment of required, available and potentially available climate finance from the different sources of origin, and requirements for development of the new/improvement of existing system for the monitoring and reporting of the international climate finance obtained/provided by the Ukraine. This approach is presented here for illustrative purposes and will be elleborated in the Report 4:

I. Climate finance - Methodological approaches to classification of climate finance (sources – national/international; funding size; target areas);

II. Overview of climate finance in Ukraine - national funding originates from the budget, and is distributed at several levels - central, regional and local budgets; MDBs/IFIs/International donor organisations; bilateral funding programmes);

III. Assessment of resources required under the scenarios in the 2nd NDC of Ukraine – matching potentially available resources to the required funding, outlining eligibility requirements and target areas;

IV. Monitoring, reporting and verifation of climate finance.

Carbon markets

During 1990-2000, carbon markets became core instrument to reduce GHG emissions and to finance climate actions on installations level. Carbon market is a market instrument and along with fiscal and legislative instruments is considered to be transparent and reliable instrument of GHG emissions reduction; and therefore is important for NDC implementation. The Paris Agreement established a new international approach to addressing climate change, but many of the details remain to be negotiated, among which is to work out concerns the guidance and rules for the implementation of Article 6. Article 6 allows Parties to lower the costs of emissions mitigation through the use of internationally transferred mitigation outcomes (ITMOs) created within their jurisdictions and resulting from cooperative actions to achieve the GHG emissions targets included in their Nationally Determined Contributions (NDCs). Many parties to the Paris Agreement plan to utilize Article 6 to achieve their goals. For example, the signatories to the Carbon Pricing in the America's Declaration (Paris, December 2017) and the New Zealand-led Carbon Markets Declaration (Paris, December 2015) signaled interest in cooperative approaches.

EU-Ukraine Association Agreement foresees the establishment of domestic ETS. Ukraine Ukrainian Emission Trading Scheme is under development by GIZ Project of «Support for the Establishment of an Emission Trading Scheme (ETS) in Ukraine» (2017-2020) [1; 2]. The Project will develop draft national industries' benchmarks, national cap setting methodology, will develop national ETS legislation and draft national allocation plan. Ukrainian ETS development and launch timelines have not been formally disclosed, but MinEcology does not foresees ETS before 2022.

Starting from January 1, 2019, Ukraine participates in CORSIA (Carbon Offsetting Scheme for International Aviation) – MRV pilot phase of ICAO initiative to reduce GHG emissions from civil aviation transport across the planet. As of April 1, 2019, Ukraine has developed but not yet adopted is national legislation to monitor GHG emissions of national civil aviation companies. MRV [3].

1.2.2. Adaptation actions and instruments

Adaptation to adverse effects of climate change is an important part of Paris Agreement along with mitigation, but adaptation planning and activities are new for Ukraine's national and regional legislation framework. The first legislative steps on adaptation took place under State Climate Policy Concept and its Action Plan development, with provisions to develop National Adaptation Strategy till 2030 and to perform other adaptation activities (see Section 1.2).

Under UNFCCC reporting process, Ukraine develops National Communication on Climate Change every 4 years and most recent Sixth National Communication (submitted in 2014) includes Assessment of Climate Change Impact Section, covering mid and long-term scenarios of climate change in Ukraine, analysis of current trends and frequency of extreme weather events. Ukraine has not developed last, Seventh, National Communication on Climate Change that was due to be submitted in 2017.

MinEcology has a mandate of developing adaptation legislation, but do not have state budget funds to perform this important legislative step, and therefore, international donors are expected to finance the adaptation legislation development. At the same time, effective implementation of adaptation and climate-resilient policies and actions will take place once predictable access to adequate adaptation finance is secured.

In April 2019, EU4CLIMATE technical assistance project has been launched in Ukraine and it's expected that this project will support GoU on developing National Adaptation Strategy till 2030.

Existing Adaptation Plans and Strategies

Currently, there is no adaptation legislation in Ukraine. The development of comprehensive Adaptation Strategy of Ukraine under State Climate Policy Concept is constrained by lack of state budget funds, gaps in information on damage and adaptation costs and benefits as well as regional level risk assessments, lack of models and tools to support informed decision-making, and means of monitoring and evaluating past adaptation efforts.

At the same time, three technical assistance projects provided assistance to the GoU on developing pilot projects and sectoral adaptation policies and plans, but nothing has been adopted on national level.

FAO project (2016-2017) "Support in technical and institution potential improvement as of prevention of climate change" developed draft Adaptation Strategy for Agriculture, Forestry and Fishery till 2030 and provided the draft to MinAgropolicy, who is in the process of revising and updating it now.

EU ClimaEast project (2014-2017) in Ukraine implemented local community based pilot project on wetlands - conservation and sustainable use of peat in the Chernihiv region.

"Environment and Security" Initiative (ENVSEC) – joint initiative of OSCE, UNECE, and UNEP - implemented projects "Dniester-I" (2004-2006), "Dniester-II" (2006-2007) and "Dniester-III" (2009-2011) [These projects covered Dniester River basin and not only adaptation itself but also some other security-related issues. The results can be found in: Strategic Framework for Adaptation to Climate Change in the Dniester River Basin, and Implementation Plan for the Strategic Framework for Adaptation to Climate Change in the Dniester River Basin. These projects, as well as the Dniester component of the EU Instrument for Stability-funded project Climate Change and Security in Eastern Europe, Central Asia and the Southern Caucasus (since 2013), have provided support for development of cross-border cooperation in the Dniester River basin, including cooperation on adaptation. Both Ukraine and Moldova endorsed "Strategic Framework for Adaptation to Climate Change in the Dniester River Basin" in April 2015, developed under the project activities and are implementing the comprehensive Implementation Plan for the Strategic Framework for Adaptation to Climate Change in the Dniester River Basin, developed as a result of the preoject.

Sectoral Adaptation Measures

State Climate Policy Concept Action Plan foresees the following adaptation goal steps:

- integration of mitigation and adaptation measures into regional development strategies and relevant action plans;
- priority adaptation measures for all economic sectors;
- forestry adaptation plan till 2030 development;
- incorporating climate change adaptation measures to river basin management plans as part of the implementation of integrated water management;
- consideration of forecasting maps of possible flooding due to climate change, when constructing and renovating residential/public/industrial buildings, engineering and transport infrastructure in the coastal areas of the Black and Azov Seas.

As mentioned above, there is draft Adaptation Strategy for Agriculture, Forestry and Fishery till 2030 developed with FAO assistance and MinAgropolicy, currently, is in the process of revising and updating this sectoral adaptation document. It's not clear, when this document will be sent for concurrence of state bodies and further adoption by the GoU.

Limited spot-on adaptation activities took place in Ukraine within the Nationwide Target Program of Population and Territories Protection from Techno gene and Natural Emergencies and under the emergency and natural disaster impacts mitigation.

The existing National Action Plan for Combating Land Degradation and Desertification till 2020 foresees the implementation of adaptation related activities, such as:

- agricultural land - promotion of integrated basin water management by developing and implementing river basin management plans, including drought management measures;
- creation, restoration and protection of forests, including forest protection strips and other protective stands, ensuring forest management, inventory, inspection, monitoring and accounting;
- creation and restoration of hayfields and pastures taking into account regional peculiarities and natural and climatic conditions;

- implementation of anti-flood, coastal and anti-slip measures, protection of territories against flooding; announcement of new and expansion of existing territories and objects of the nature reserve fund;
- development of regional ecological network programs and land planning taking into account the consequences of climate change etc.

Unfortunately, the results of above listed adaptation activities have not been neither monitored nor reported.

Local Adaptation Measures

Over 180 Ukrainian municipalities joined European voluntary initiative Covenant of Mayors for Climate and Energy. Under CoM local authorities commit to reduce GHG emissions, implement energy efficiency measures and increase renewable energy share, while implementing adaptation planning. The adaptation planning is on municipal training stage now and neither implementation, nor monitoring had taken place until now.

Financing Adaptation Actions in Ukraine

Ukraine state budget does foresee adaptation finance and even if adaptation measures are financed under local or state budget, it is not defined as adaptation, but rather as emergency.

State Climate Change Concept Action foresees the preparation of proposals for financial instruments and mechanisms of public-private partnership and approaches to stimulate business entities to implement projects to mitigate and adapt to climate change, taking into account new market and non-market mechanisms under Paris Agreement.

In contrast to climate change mitigation, adaptation has difficulty in getting financing. According to the assessment conducted by the OECD in 2016, mitigation projects in Ukraine received more support than adaptation ones [4].

In addition to bilateral technical assistance, sources of financing for adaptation could be new and existing Multilateral Development Banks and IFIs, Global Environment Facility (GEF), Adaptation Fund under Paris Agreement and potential access to Green Climate Fund (GCF) and other financial institutions initiatives.

SECTION 2. REVIEW OF UKRAINE'S FIRST NDC AND AREAS OF IMPROVEMENT

2.1 OVERVIEW OF UKRAINE'S FIRST NDC

In this Section, we provide an overview of the methodological approaches and assumptions previously used to forecast the GHG emissions in Ukraine. We focus mainly on the review of the approaches used in the preparation of the existing Ukrainian NDC. Where appropriate, we also include an overview of the methodological approaches used in other strategical documents, such as National Communications on Climate Change and Low Emission Development Strategy of Ukraine.

2.1.1 Modelling Approach

First Ukrainian (I)NDC does not contain neither information nor the references to the modelling, tools, scenarios or forecasts used for NDC target estimation. As first Ukrainian NDC was developed under assistance of UNDP project, the assessment of GHG emissions pathways was carried out using several methodological approaches and sets of assumptions as indicated in UNDP Report on First NDC Development. In particular, UNDP report distinguishes two modelling approaches referring for the purpose of the report as "Model 1" and "Model 2".

Model 1: Models involved unknown

Model 1 approach is based on the set of modelling tools and methods of strategic planning. Corresponding UNDP report does not provide any details or accessible references to the models involved into this assessment, so it's challenging to verify the consistency, reliability, advantages and drawbacks of this approach. Report also does not mention whether these modelling tools meet the international best practices or are recognized by the UNFCCC. Model 1 approach is based on the three macroeconomic scenarios – baseline, optimistic and pessimistic. These scenarios already incorporate energy, environmental and other policies, which are described in the report, while there is no link to the conventional Business as Usual (BaU) scenario, which corresponds to the reference case.

Table 2.1. Selected indicators by scenario estimated using the Model 1 approach

Indicators/Scenarios	2011-2030			2031-2050		
	Baseline	Pessimistic	Optimistic	Baseline	Pessimistic	Optimistic
Annual GDP growth rate, %	3.8	2.9	4.5	3.4	3.7	2.8
Annual GHG emissions growth rate, %	1.8	1.6	1.9	0.1	0.1	-0.1
GDP carbon intensity at the end of the period (kg per 2011 PPP $ of GDP)	0.58	0.65	0.52	0.30	0.32	0.29
Change in Ukraine's GDP carbon intensity over the period (kg per 2011 PPP $ of GDP)	-0.27	-0.20	-0.33	-0.28	-0.33	-0.23
GHG emissions at the end of the period relative to the 1990 level, %	58.3	56.2	60.4	59.2	57.4	59.5

Table 2.1 summarizes some of the key indicators of the Model 1 approach. Model 1 assumes relatively high differentiation in the GDP growth rates among macroeconomic scenarios during the 2011-2030 timeframe. It is assumed that during this period depending on the

macroeconomic scenario GDP carbon intensity would reach 0.52-0.65 kg per 2011 PPP $, almost 2-3 times higher than 2014 levels in most Eastern European countries, including Poland (0.31), Hungary (0.18), Romania (0.18) and Slovak Republic (0.21).

As can be seen from Table 2.1, within the Model 1 approach, it is assumed that GDP growth is accelerating over time for the Pessimistic scenario and shows the highest growth rates in the long run compared to other pathways. 2031-2050 timeframe within the Pessimistic scenario also brings the highest reduction in the GDP carbon intensity (Table 2.1), while Optimistic scenario shows the lowest GDP growth rate over this period. At the same time, all scenarios assume much higher decoupling between GDP and emissions growth in the 2031-2050 period than before 2030. According to Model 1, it is assumed that by 2050 even under the Optimistic scenario Ukraine would not reach the 2014 level of GDP carbon intensity of the most Eastern European countries, let alone Euro area 2014 average indicators (0.17 kg per 2011 PPP $ of GDP). In general, Model 1 assumes relatively high carbon and energy intensive pathways for Ukraine in the medium and long run, these assumptions do not change substantially under different macroeconomic scenarios. Model 1 does not provide any assessment of the economic or social impacts of energy and environmental policies by scenarios.

Another specific feature of the emissions pathways within the Model 1 approach is that it assumes the same GHG emissions for three out of four reported sectors under all three macroeconomic/policy scenarios, with only slight difference in case of Agriculture under Optimistic scenario (Table 2.2). Substantial differences in GHG emissions by scenario are observed only in Energy and transportation sector.

Table 2.2. Sectoral GHG emissions under different scenarios reported by Model 1 approach, Mt CO_2-eq.

Sectors\scenarios	2030			2050		
	Baseline	Pessimistic	Optimistic	Baseline	Pessimistic	Optimistic
Energy and transportation	423.4	403.5	442.8	445.9	429.2	448.6
Industrial processes	68.8	68.8	68.8	63.9	63.9	63.9
Agriculture	43.8	43.8	44.0	38.4	38.4	38.4
Waste	6.0	6.0	6.0	2.0	2.0	2.0
Total	541.9	522.0	561.5	550.2	533.5	552.9

Source: UNDP (2015).

Model 2: TIMES –Ukraine + CGE with extended energy sector

Another set of modelling tools that was used to provide an assessment of the different emissions pathways for the First Ukrainian NDC included energy system TIMES-Ukraine model and Ukrainian computable general equilibrium (CGE) model with extended energy sector. In the justification of the Ukrainian NDC contribution, this set of modelling tools is referred to as "Model 2".

TIMES-Ukraine is a typical linear optimization energy system model of MARKAL/TIMES family, which provides a technology-rich framework for estimating energy dynamics in the long-run. Energy system of Ukraine is split in the model into seven sectors: energy supply, electricity and heat generation, industrial users, transport, agriculture, households and services. Industrial users are further divided into two categories depending on the level of energy intensity. Energy-intensive subsectors are represented by product-specific technologies. For other industrial subsectors, a standard representation according to the four

types of general processes is used: electric engines, electrochemical processes, thermal processes and other processes. Energy consumption by households and commercial sector is defined by the most energy intensive categories of consumer needs.

Energy system models, like TIMES-Ukraine, are usually used for long-term analysis of energy system development paths. By changing the assumptions on useful energy demands, technologies, prices or other exogenous variables baseline scenarios are developed. Models of the MARKAL/TIMES family are recognized by the UNFCCC and recommended for the assessment of the GHG mitigation pathways. As TIMES-Ukraine model does not cover non-energy emissions in Agriculture and Waste sectors, Model 2 approach used simplified modelling tools to forecast emissions in those categories.

In contrast with the Model 1 approach, Model 2 also provided assessment of the economic and social impacts of the different NDC pathways. This assessment was performed using the dynamic Ukrainian CGE model with extended energy. In the Ukrainian CGE model, used for the NDC assessment, producers were divided into 40 sectors and households disaggregated into 10 groups according to their income level. Energy sector in the model was represented by 7 subsectors: coal mining, extraction of the natural gas and oil, coke and oven products, petroleum products, electricity production and distribution, distribution of natural gas, heat and hot water supply. Key input data for the model was sourced from Input-Output tables, households' surveys and National accounts.

In the international practice, CGE models are widely used for the assessment of macroeconomic, sectoral and social impacts of the environmental policies, as they provide a top-down view of the national economy. CGE models are also mentioned in the list of UNFCCC-recommended modelling tools.

Model 2 approach considers three macroeconomic scenarios: baseline, optimistic (investment-oriented) and pessimistic (inertial). These three macroeconomic scenarios represent possible development of the Ukrainian economy, but include BaU energy policies. Additional energy policy measures are further imposed on top of these three macroeconomic scenarios. Table 2.3 summarizes key assumptions of these three macroeconomic scenarios under BaU energy policy. Indicators reported in Table 2.3 do not include any additional energy and environmental policies apart from those, currently being implemented in Ukraine.

Table 2.3. Selected indicators by macroeconomic scenarios reported by Model 2 under the BaU energy policy

Indicators\scenarios	2013-2030			2031-2050		
	Baseline	Pessimistic	Optimistic	Baseline	Pessimistic	Optimistic
Annual GDP growth rate, %	1.7	0.8	2.6	3.5	2.2	5.2
Annual GHG emissions growth rate, %	0.5	-0.1	1.2	1.6	1.1	2.2
GDP carbon intensity at the end of the period (kg per 2011 PPP $ of GDP)	0.61	0.65	0.58	0.43	0.53	0.33
Change in Ukraine's GDP carbon intensity over the period (kg per 2011 PPP $ of GDP)	-0.16	-0.12	-0.19	-0.18	-0.12	-0.26
GHG emissions at the end of the period relative to the 1990 level, %	46.8	42.1	52.5	64.9	52.9	80.6

Comparison of Model 1 and Model 2 key assumptions

Even under BaU energy policies, **Model 2 reports much lower GHG emissions in 2030 under all macroeconomic scenarios, compared to the Model 1 simulations** (Tables 2.1, 2.3). In particular, within the Baseline macroeconomic scenario, Model 1 reports 2030 GHG emissions to be 58.3% of the 1990 level (this scenario includes energy efficiency, renewable energy and other target policies), while Model 2 reports GHG emissions to be 46.8% relative to the 1990 level under BaU energy policy. **One of the key drivers behind such differences in GHG emissions is a GDP growth assumption.**

Figure 2.1 compares 2018-2030 GDP growth rates[2] under different scenarios reported by Model 1 and Model 2, as well as gives historical GDP growth rates for selected countries. It also provides some existing forecasts of the Ukrainian GDP by international organizations. As can be seen from Figure 2.1, Model 1 assumes relatively high 2018-2030 GDP growth rates under all scenarios – between 5.1% and 7.5%, which is significantly higher than 2018-2023 IMF forecast (3.2%) and International Futures (IFS) Database 2018-2030 forecast for Ukraine (2.8%). Furthermore, looking at the historical 2000-2014 GDP growth rates for selected countries,[3] there is not a single country with the GDP growth rates consistent with the Model 1 Optimistic scenario and only Armenia has historical GDP growth rates comparable with the Model 1 Baseline scenario. All Model 1 macroeconomic forecasts seem to be highly inconsistent with available GDP forecasts by international organizations, as well as historical data for Ukraine and other countries. At this point, Model 2 forecasts are much more in line with the current GDP projections by IMF and IFS.

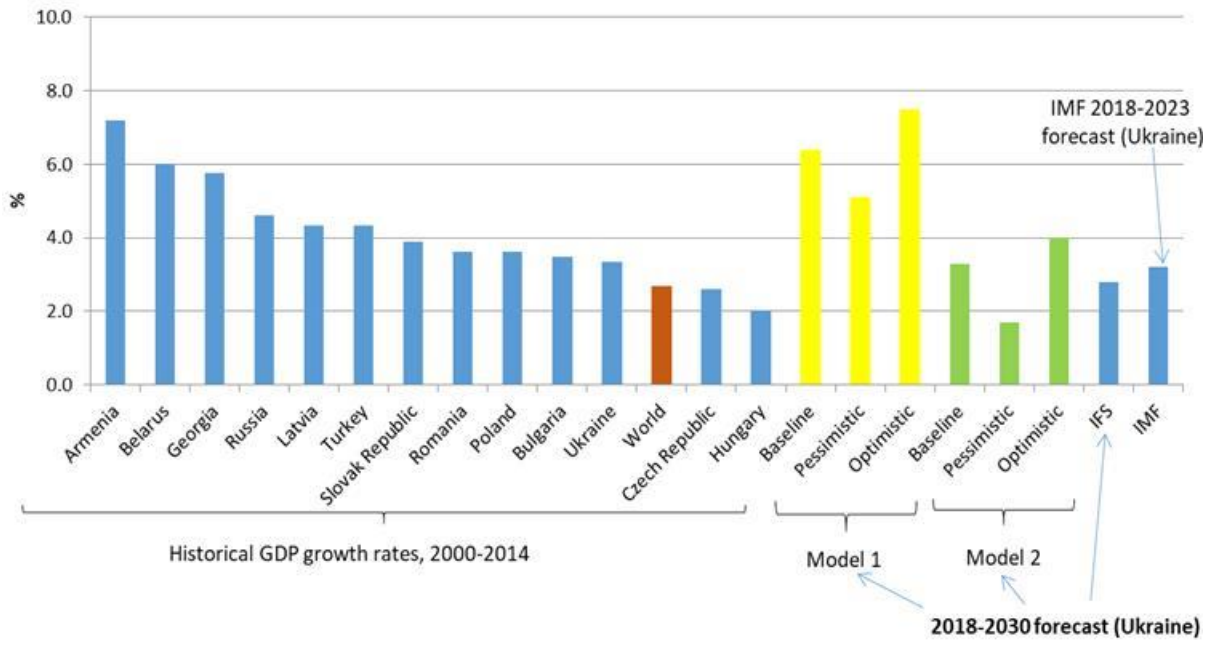


Figure 2.1. Forecasted and historical real GDP growth rates for Ukraine and selected countries, annual growth rate (%)

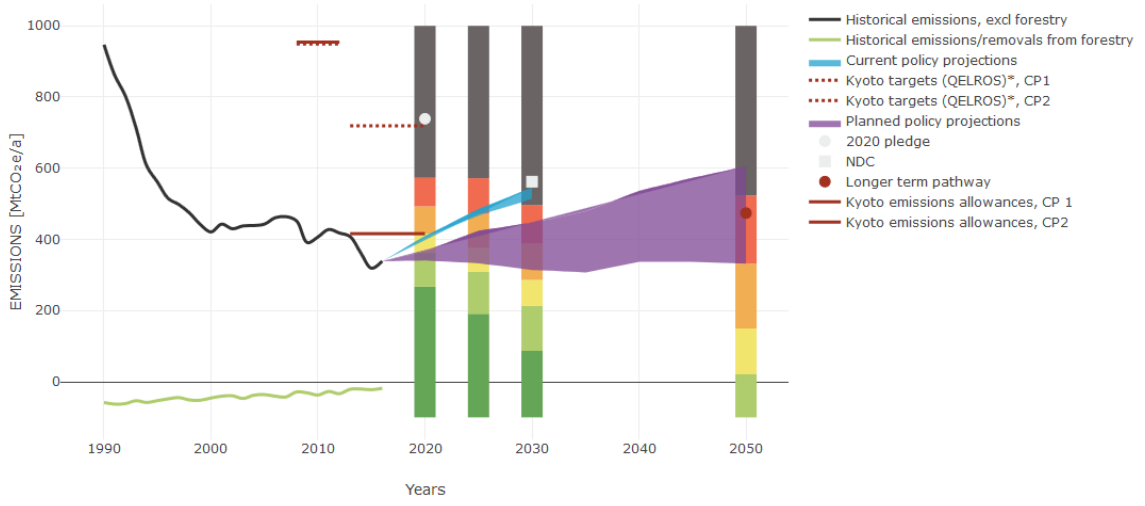
[2] We exclude actual 2010-2017 GDP growth rates from the comparison to make the forecasts consistent with historical trends (actual GDP growth rates).

[3] Most large (net) energy exporters (e.g. Turkmenistan, Kazakhstan, Azerbaijan) are not reported on Figure 1, due to the incomparability in the sources of growth with the net energy importing country like Ukraine. Only Russia and Belarus are reported from this set of countries.

In general, **Model 2 reports significantly lower level of GHG emissions under energy policy scenarios compared to Model 1.** Model 2 considers different energy policy scenarios that are imposed on top of the three macroeconomic pathways. In particular, they include energy efficiency (EE) and renewable energy (RE) measures (specific set of measures to promote renewables and EE improvement, but without specific targets), EE and RE targets (EE improvement by 18% and 18% RE share in the final energy consumption by 2030), different assumptions regarding shale gas availability in Ukraine and different levels of CO_2 taxation.

According to Model 2, under the Baseline macroeconomic scenario, GHG emissions could be reduced in 2030 by 64% relative to the 1990 level if only EE and RE targets are implemented. If further CO_2 taxation is introduced, GHG emissions could be reduced at a much higher pace (Table 2.4). Compared to Model 1 simulations, as well as current Ukrainian NDC target, which states that Ukraine would not exceed 60% of the 1990 GHG emissions level by 2030, these results suggest a much more ambitious target. Social and economic assessment of these policies based on the Ukrainian CGE model (USAID MERP, 2015) suggests that there are significant macroeconomic, sectoral and real income benefits from the implementation of these energy policies. Households real income could increase by around 7% in 2030 (relative to the reference scenario), while real GDP could grow by over 13%.

In general, extremely low level of ambition of the current Ukrainian NDC (do not exceed 60% of the 1990 GHG emissions level by 2030), which is largely based on the Model 1 assumptions and simulations, is widely criticized in the international policy making and research community. In particular, Climate Action Tracker (CAT) project, which provides assessment of the ambitiousness and fairness of the NDC contributions by countries, ranks Ukrainian NDC target as "Critically insufficient" – the lowest possible rank (CAT, 2018). Paris Equity Check (PEC) initiative estimates 2100-warming as a function of NDC contributions. According to PEC, current Ukrainian NDC target is equivalent to the implied global warming of over 5.1ºC (PEC, 2016), while Paris Agreement sets a target to keep the global warming well below 2ºC.



Graph Footnotes * Excl. LULUCF credits and debits, excl. LULUCF base year emissions accounting rules and without application of historical threshold on emissions allowances in 2020 under the Doha decision.

Figure. 2.2. Ukraine in the Climate Action Tracker project

Table 2.4. 2030 GHG emissions estimated using the Model 2 approach under Baseline macroeconomic and different energy policy scenarios, % relative to 1990 level

Energy policies	Emissions in 2030, % of 1990
Business as Usual	46.8
EE and RE measures	46.1
EE and RE targets	36.1
EE and RE measures + CO_2 tax €15/ton in 2030	41.6
EE and RE targets + CO_2 tax €15/ton in 2030	34.0
EE and RE measures + CO_2 tax €30/ton in 2030	36.9
EE and RE targets + CO_2 tax €30/ton in 2030	31.0

This assessment of general approaches to GHG emissions pathways of existing/first Ukrainian NDC would not be complete without assessment of methodological approaches used to model the GHG emissions in LULUCF, Agriculture and Waste.

2.1.2 LULUCF and Agriculture

There is no clear information on approaches and assumptions behind the GHG emissions projections for Agriculture sector in the existing Ukrainian NDC. Considering general description of the sector in the UNDP report, the emissions for BAU scenario were projected based on expert judgment of overall performance and development of Agriculture Sector, as well as more general economic information – industrial production or GDP. Inclusion of activities aimed at the reduction of the GHG emissions, apparently, were based also on their possible impact on performance of agricultural economic indicators.

Such approach has high uncertainty level of GHG emissions estimation, especially for "business-as-usual" scenario. According to Ukraine's National Inventory Report in 2018 GHG emissions structure in Agriculture Sector, the changes in emissions from livestock and crop production since 1990 have different trends in the recent years. Thus, analysis of these two sources of agricultural emissions would allow more in-depth understanding of possible future emission trends in Agriculture sector.

Land Use, Land-Use Change and Forestry sector was not included into projections, and there are no estimates of possible GHG emissions reduction and removal increase in the existing Ukraine's NDC.

2.1.3 Waste Sector

Waste sector covers GHG emissions from the following groups of sources in line with the IPCC 2006 categories:

- 5.A. Solid Waste Disposal (CH_4);
- 5.B. Biological Treatment of Solid Waste (CH_4, N_2O);
- 5.C. Incineration and Open Burning of Waste (CO_2, CH_4, N_2O);
- 5.D. Wastewater Treatment and Discharge (CH_4, N_2O).

For the first time, GHG emission projections for the Waste sector in Ukraine were performed in 1998. Since then, reporting of the historical and projected GHG emissions in this sector has changed considerably, both in terms of historical GHG estimation methods and approaches to their forecasting. Figure 2.3 provides summary of the existing GHG emissions projections for the Waste sector in Ukraine.

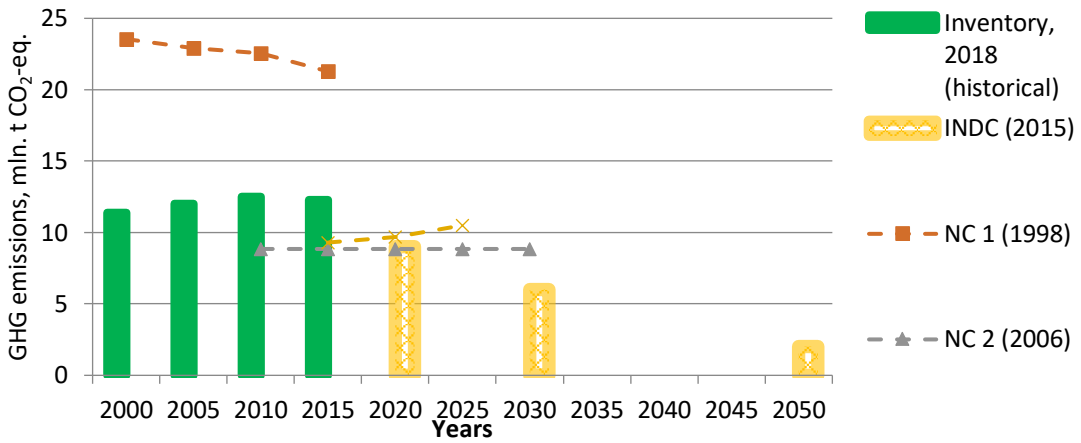


Figure 2.3. GHG emissions projections in Waste sector of Ukraine

Source: Inventory, 2018 (MENR, 2018), INDC (UNDP, 2015), NC 1(MENR, 1998), NC 2(MENR, 2006), NC 3,4,5 (MENR, 2009).

As can be seen from Figure 2.3, available Waste sector GHG emissions projections are not consistent with the historical trends (in case of National Communications on Climate Change) or such consistency is hard to verify, as in the case of INDC forecasts. In addition, comparisons between different available projections are complicated by the difference in methodological approaches and different reference years. It should be noted that INDC report does not provide any clear description of the methodological approach used to forecast the Waste sector GHG emissions under any of the reported scenarios.

As it comes from Figure 2.3, *NC 3, 4, 5* deserves the greatest attention from the point of view of the experience gained in projecting GHG emissions in the Waste sector of Ukraine. This document outlines methodological approaches and includes projections of the GHG emissions in IPCC categories 5.A "Solid Waste Disposal" and 5.D "Wastewater Treatment and Discharge".

To project emissions in the category 5.A, the following indicators were taken into account: the volume of municipal solid waste (MSW) generation and disposal, its composition and management practice. For the category 5.D the following was taken into account: dynamics of changes in population, development of economy sectors and specific indicators of protein consumption. At the same time, in *NC 3, 4, 5* GHG emissions from composting and incineration were not estimated, which significantly reduces the coverage of emission sources in the report.

Only the *NC 1* report provided projections of the GHG emissions from waste incineration taking into account incineration rates and technological re-equipment of incineration facilities.

In the *NC 2* report, GHG emissions projections in the Waste sector were not carried out, because according to its authors, at the time of the report, no correlation was found between the macroeconomic indicators and the amount of MSW disposal.

In the *NC 6* and *INDC* reports GHG emissions projections from the Waste sector were carried out, at the same time, the principle of transparency was totally ignored and these reports did not provide any details on the methodological approach.

LEDS report outlined the likely trends in waste management in Ukraine by 2050, at the same time, these indicators were purely declarative/qualitative and no quantities were provided. GHG emissions projections in the Waste sector were not carried out at all in the *LEDS* report.

Common issue for all of the reviewed documents is that they did not include projections for GHG emissions from waste composting.

From the analysis above, the following key shortcomings of the existing experience for projections of GHG emissions in the Waste sector of Ukraine can be identified:

1. The methods used to account for historical and projected GHG emissions are out of date and do not correspond to what is currently required to compile GHG reporting in the framework of UNFCCC for Annex I countries, namely IPCC 2006 methodologies.
2. None of the reports included projections of the GHG emissions from all IPCC categories in the Waste sector, which is not in line with the principle of full coverage of emission sources.
3. The planned changes in the waste management system are not fully or partially taken into account: changes in the structure of MSW management, modernization of their disposal sites, etc.
4. Implementation of technologies for the MSW composting was not taken into account.
5. Quantitative indicators of the planned amount of MSW incineration and the introduction of modern methods of their heat treatment are not substantiated.

2.2 COMPARATIVE ANALYSIS ON THE METHODOLOGICAL APPROACHES

In this Section, we provide an overview and comparative analysis of different methodological tools and approaches, used for projection and forecasting of GHG emissions in different sectors of Ukraine' economy.

2.2.1. Methodological approaches applied in Ukraine

Strategic planning and long-term projection on sectoral and national levels are usually performed in Ukraine within the process of strategies and plans development and is supported by National Academy of Science institutions, scientific and research institutions under Presidential Administration, under GoU and sectoral ministries. Table 2.5 below provides comprehensive summary of methodological tools and approaches applied for various existing national legislation and policy document.

Table 2.5. Energy and climate modelling applications in Ukraine

	Strategic Documents	Applied methodologies/models	Comments
1.	Ukraine 2050: Low Emission Development Strategy (LEDS) [5; 6]	• *"…Quantitative model calculations of GHG emissions reduction under Baseline scenario are performed with the help of economic-mathematical optimization model of energy flows of Ukraine (**model TIMES-Ukraine**). This very model is also used to calculate reduction in GHG emissions when policies and measures on energy de-carbonization, included into Catalogue of policies and measures of low emissions development (hereafter Catalogue) are implemented..."* (page 36). • *"… **Dynamic General Equilibrium Model** with extended energy block was used to estimate the social and economic outcomes of Ukraine's energy decarbonization policies and measures implementation. Unification of the said two models was performed through application of the same assumptions with regard to economic growth rate, in particular, aggregated GDP growth rate…"* (page 36).	The framework for modelling GHG emissions scenarios in the LEDS does not cover all sectors according to the IPCC classification. The modelling does not include sectors: Waste, Agriculture, Land Use, and Land Use Change.

	Strategic Documents	Applied methodologies/models	Comments
		• *"… Analysis of Ukraine's forestry sector development scenarios was performed with the help of **the model of European Forest Institute EFISCEN** based on processing information for each forest plot, which is included in the database of the State Forest Agency of Ukraine «Forest Fund of Ukraine»…"* (page 66)	
2.	Energy Strategy of Ukraine until 2035 "Safety, Energy Efficiency and Competitiveness" (ESU2035) [7]	"…*To develop the GPES structure **economic and mathematical models**, generalized expert opinions, as well as target values Ukraine has to achieve under its international commitments in the fields of RES development and climate change were used*…" (Page 9).	ESU2035 does not determine which models were used and for which sectors. The analysis of the Annexes to ESU2035 shows the lack of application of an integrated model of the energy sector.
3.	National Energy Efficiency Action Plan (NEEAP) [8]	*"…To prepare the national plan, a linear dynamic optimization **model TIMES-Ukraine** with a given demand was used that describes the entire energy system of Ukraine and allows analysing the long-term dynamics of energy consumption based on the estimated change in the technological structure of consumers..."* (page 2)	
4.	National Renewable Energy Action Plan till 2020 [9] (NREAP)	No information about the economic models that were used	Calculations were made by the Institute of Renewable Energy of the NASU
5.	Sustainable Development Strategy "Ukraine 2020" [10]	No information about the economic models that were used	
6.	Concept of implementation of the state policy in the field of climate change by 2030 [11]	Economic models were not used	The preparation of this document did not foresee the use of economic models
7.	Strategy of the state environmental policy of Ukraine till 2020 [12]	Economic models were not used	
8.	Draft Law of Ukraine "On the Basic Principles (Strategy) of State Environmental Policy for the Period till 2030" [13]	Economic models were not used	
9.	National Strategy for Waste Management in Ukraine till 2030 [14]	No information about the economic models that were used	
10.	The Concept of implementation of the state policy in the field heat supply [15]	No information about the economic models that were used	
11.	Transport strategy of Ukraine till 2020 [16]	No information about the economic models that were used	

	Strategic Documents	Applied methodologies/models	Comments
12.	National Transport Strategy of Ukraine till 2030 [17]	No information about the economic models that were used	
13.	Energy Policy Master Plan for Ukraine [18]	No information about the economic models that were used	
14.	The Sixth National Communication of Ukraine on climate change [19]	• *"… national multi-component model for calculating methane emissions from SDW landfills in Ukraine…"* (page 115) • *"…Implementation of the algorithm [prediction algorithm for economic development and the GHG emissions in the long term] was performed using a system of mathematical models, in which the coordinating role is played by the optimization model of forming coordinated macroeconomic and energy balances. It is based on a synthesis of Leontief's approaches to the study input-output balances, methods of systemic studies of development and operation of large-scale power systems, strategic marketing techniques and expertise, methods of operations research. This model presents options of development of non-energy sectors of the economy, and in detail – energy industries, on an aggregated basis…"* (page 146) • *"…For calculations of the projections of average monthly and annual air temperatures in Ukraine has been applied an ensemble of 10 regional climate models (RCM) of the European FP-6 project ENSEMBLES. …"* (page 169) • *"… Assessing the impact of climate change on forests in Ukraine was based on the calculations of one of the most popular modern climate models - transition model HADCM3 within A2A scenario of the Intergovernmental Panel on Climate Change (IPCC) (which is considered to be the most realistic for Eastern Europe) for three periods: 1950-2000 "Contemporary climate" and forecasts for 2020 and 2080 ("Future climate")…."* (page 197) • *"… An investigation of possible future changes in the water flow of the rivers was conducted by the Hydrological studies department of the Ukrainian Hydrometeorological Institute according to four regional climate models, namely REMO/ECHAM5, RCA3-E/ECHAM5, RCA3-B/BCM, RRCM/HadCM3Q0…"* (page 202)	

2.2.2. UNFCCC recognised methodologies and international best practices

Methodological approach to model GHG emissions pathway is a core component to define targets for the National Determined Contribution according to the goals of Paris Agreement.

Energy System Models

There are a number of proven methodologies for modelling GHG emissions in Energy and Industrial processes sectors (IPCC) that are in use already in different contries, and each of them presents the results differently. These models could be split into either top-down or bottom-up approaches.

The UNFCCC Guidelines [20] for National Communications do not specify which approach is most appropriate as both can yield useful insights on mitigation:

- *Top-down models* are most useful for studying broad macroeconomic and fiscal policies for mitigation, such as carbon or other environmental taxes.

- *Bottom-up models* are most useful for studying options that have specific sectoral and technological implications.

The lack of off-the-shelf top-down models and the focus in mitigation assessments on identifying potential projects has meant that, to date, most mitigation assessments have been conducted using bottom-up approaches. For this reason, the tools examined here are primarily bottom-up modelling approaches.

Bottom-up models comprise three basic types: optimization, simulation and accounting frameworks. There are various hybrid models that combine elements of these three approaches.

Optimization models

- Use mathematical programming to identify configurations of energy systems that minimize the total cost of providing energy services;
- Select technologies based on their relative costs;
- Assume that the cost of providing an energy service is the only factor affecting technology choice;
- Are especially useful where complex technical options need to be analysed and costs are well known;
- Tend to be data intensive and complex, and are, therefore, harder to apply when only limited expertise is available;

The good examples of this type of models are *MARKAL/TIMES models [21], LEAP[22], PLEXOS [23], MESSAGE [24]* (See Annex IV for more information on each of the model).

Simulation models

- Simulate the behaviour of energy consumers and producers under various signals (e.g. price, income levels) and constraints (e.g. limits on the rate of stock replacement);
- Can include non-price factors in an analysis compared with optimizing models;
- Balance demand and supply by calculating market-clearing prices;
- Adjust prices and quantities endogenously, using iterative calculations to seek equilibrium prices.

Example: ENPEP-BALANCE [25], GCAM [26], MAED [27] (See Annex IV for more information on each of the model).

Each type of model has its own features, characteristics and limitations; therefore it is important to compare their capabilities using a simple framework. Comparison of different energy system models and their application worldwide for the climate policy analysis could be found in Annex IV.

Waste Sector Models

Based on 7th NCs of Poland, Germany, Hungary, Bulgaria, Romania, Australia and Japan, analysis of international experience under UNFCCC process has shown the following trends on applied approaches for GHG projection in the Waste sector:

- Estimations are in line with methodologies applied in GHG Inventories, namely 2006 IPCC Guidelines.
- Full coverage of the IPCC categories is provided.

- Applied assumptions are divided into two independent subsectors: solid waste treatment (for categories 5.A, 5.B and 5.C) and wastewater treatment (5.D).
- Projected values of main indicators for solid waste treatment are based on national programmes/plans on municipal solid waste treatment, as well as values for wastewater treatment are based on national wastewater treatment plans/laws. Projections for certain additional indicators are assumed based on national demography projections and expert judgements.

Table 2.6 shows the coverage of sources while projecting. All the projections include full coverage of IPCC categories. For a number of countries such as Germany, Hungary and Romania issues of waste incineration (IPCC category 5.A) are incorporated in Energy sector due to the fact that according to IPCC principles GHG emissions from waste incineration with energy recovery have to be reported under Energy sector.

Table 2.6. – IPCC categories, covered in projections, 7th NC

Category	5.A	5.B	5.C	5.D
Poland[1]	X	X	X	X
Germany[2]	X	X		X
Hungary[3]	X	X		X
Bulgaris[4]	X	X	X	X
Romania[5]	X	X		X
Australia[6]	X	X	X	X
Japan[7]	X	X	X	X

[1]– based on National waste treatment plan till 2022, Updated national wastewater treatment program and forecast on demography changes till 2050; [2]– based on law "|On wastewater treatment", law "On renewable energy", Federal acts on waste treatment; [3]– based on National action plan on waste treatment, law "On waste"; [4]– based on National program on waste prediction till 2020 and National plan on waste treatment till 2020; [5]– based on law "On waste treatment" and Directive EU 2008/98; [6]– based on law "Waste treatment strategy for 2011-2025"; [7]– based on Recycling plan, Law "On recycling" and law "On waste treatment"

Tables 2.7-2.10 below show which indicators were used for GHG emissions projections in Waste sector compiling 7th NCs. The common principles can be obtained where the core indicators are:

a) Category 5.A Solid Waste Disposal: Mass of generated volumes (generation rates and population), mass of MSW landfilled (mass flow), MSW composition (mass flow), type of disposal sites, share of methane recovery.

b) Categories 5.B Biological Treatment of Solid Waste and 5.C Incineration and Open Burning of Waste: Mass of biologically treated and incinerated waste respectively (mass flow).

c) Category 5.D Wastewater Treatment and Discharge: Share of centralized water supply, population, economy sectors development, methane recovery, protein consumption, technologies.

Table 2.7. – Indicators used for projecting GHG emissions for IPCC category 5.A Solid Waste Disposal, 7th NCs

Indicator	Methodology	Generated volumes	Disposed volumes	Methane recovery	MSW compo-sition	MSW treatment methods	Disposal site types
Poland	IPCC 2006	X	X	X	X	X	
Germany	IPCC 2006	X	X	X	X	X	X
Hungary	IPCC 2006	X	X		X		
Bulgaria	IPCC 2006	X	X	X	X		
Romania	IPCC 2006	X	X	X	X		X
Australia	IPCC 2006	X	X	X			
Japan	IPCC 2006	X	X	X		X	X

[1] *incineration without recovery does not occur.*

Table 2.8. – Indicators used for projecting GHG emissions for IPCC category 5.B Biological Treatment of Solid Waste, 7th NCs

Indicator	Methodology	Composted volumes	Technology
Poland	IPCC 2006	X	
Germany	IPCC 2006	X	X
Hungary	IPCC 2006	X	
Bulgaria	IPCC 2006	X	
Romania	IPCC 2006	X	
Australia	IPCC 2006	X	
Japan	IPCC 2006	X	

Table 2.9. – Indicators used for projecting GHG emissions for IPCC category 5.C Incineration and Open Burning of Waste, 7th NCs

Indicator	Methodology	Incineration volumes	Technology
Poland	IPCC 2006	X	
Germany[1]			
Hungary[2]	IPCC 2006		
Bulgaria	IPCC 2006	X	
Romania[2]	IPCC 2006		
Australia	IPCC 2006	X	
Japan	IPCC 2006	X	

[1]*– incineration without recovery does not occur;* [2]*– data for 2015 are used*

Table 2.10. – 5.D Wastewater Treatment and Discharge

Indicator	Methodology	Share of centralized water supply	Popu-lation	Economy sectors development	Methane recovery	Protein consump-tion	New techno-logies
Poland	IPCC 2006		X[1]				X
Germany	IPCC 2006		X	X			X
Hungary	IPCC 2006	X	X				
Bulgaria	IPCC 2006		X		X		
Romania	IPCC 2006	X	X	X	X	X	X
Australia	IPCC 2006		X				
Japan	IPCC 2006		X	X			

[1]*– dynamics of urban and rural population was taken into account*

Models for Agriculture and LULUCF

Before the adoption of Paris Agreement with subsequently adopted rules and procedures for operationalization of it there was no specific legal guidance under UNFCCC on provisions of projections of GHGs in this sector. Except general guidance on reporting required under UNFCCC, established by Decision 4/CP.5 [28] applicable for reporting of National Communications, the Parties are free to decide methods best suitable for projecting its GHG emission level.

Common approach of projecting GHG emissions in the sector is to apply the same methodology as country use in its annual GHG inventory for the activity data, estimated for future time series. For projections of future activity data current policies and measures are taken into consideration, as well as general trends of economy, market and specific sector production projections. Some countries (Denmark, Germany) use specialized studies and software to consider many factors on the future agriculture development. Countries, which do not have these instruments use more expert based assumptions and estimations of quantitative information.

There is a category in the LULUCF sector, which has specific guidelines and guidance for making projections. It is related to Kyoto Protocol reporting, which for accounting purposes requires Parties to establish Forest Management Reference Level (FMRL) to the end of the second commitment period of KP. In order to fulfil requirements of KP reporting Parties have to follow methodological guidance in the decisions 2/CMP.7 and 2/CMP.8, as well as guidelines of IPCC for reporting of KP activities [29].

For the purpose of KP reporting Ukraine selected to use "business-as-usual" projection method of FMRL accounting, which is the most commonly used among other countries as well. Depending on exact data used for projections there are some different approaches (as provided in the IPCC guidelines):

I. Modelled projections under a 'business-as-usual' scenario
   a. Model-based projections using country-specific methodology – development of the country-specific approaches and use of data from national forest inventory as a source of information on future forest resources, combined with projections of future harvest demand from partial equilibrium models or scenario analysis.
   b. Model-based projections using a common methodological approach – use of an approach or model developed by some research or scientific organization to project annual estimates of emissions and removals for FM.

II. Projections based on the elaboration of historical data from greenhouse gas inventories, assumed as proxy for a 'business-as-usual' scenario
   a. Average of historical data - averaging of historical removals under the Forest Land Remaining Forest Land category to construct future level of removals.
   b. Extrapolation from a historical time series trend - use of a linear extrapolation of net historical emissions data to construct the FMRLs.

- ***I.a. Model-based projections using country-specific methodology***

This is a very common approach of projections for Forest Management. Usually developed by scientific and research institutions these models might be applied specifically for GHG inventory or used by specialized agency in the country for its purposes. As an input to the

projections different forestry related data might be used, like areas of Forest Management, different forest management regimes and practices, areas and character of natural disturbances, fires etc. Usually more general information is also considered, like wood demand, development of wood processing and pulp industry, market conditions and others.

- ***I.b. Model-based projections using a common methodological approach***.

The approaches to be used in projections are developed by scientists and researches usually. Quite commonly that these approaches were aimed to be used for other purposes (planning of activities in some sectors of economy, policy making, monitoring and others), but are also suitable to deliver key data for projecting of carbon stock changes in forests. Immediate benefits of this approach are that the models already exist and no need to invest a lot of funds and efforts to invent models. However, some of national circumstances not might be considered, which are caused by more general approach of constructing such a models by its creators.

- ***II.a. Projections based on the elaboration of average historical data***.

More simplified approach of delivering projection of future emissions or removals by forests. Historical emissions or removals from Forest Management are taken into consideration and average value is assumed to be the future level of emissions or removals.

- ***II.b. Projections based on extrapolation from a historical time series trend***.

Linear extrapolation of historical trend of general emissions or removals of the category is considered.

Countries are encouraged to use more detailed and precise projections to include national circumstances to the extent possible.

The rest of activities under LULUCF sector have no obligations on projections. Thus, no specific guidance or guidelines exist, except general requirements established by Decision 4/CP.5 similarly to Agriculture sector.

Assessment of the Social and Economic Impacts of the NDC Implementation

As impacts of NDC implementation go far beyond energy sector, there is a necessity to provide an economic and social assessment of the long-term GHG mitigation scenarios. This requires a modelling tool that would provide us a broad view of the national economy, taking into account inter-sectoral linkages. In this Section, we provide a review of the available modelling approaches to the assessment of economic and social impacts of the environmental policies and describe a methodological approach that would be used in this study.

Literature provides several examples of modelling tools that are used to study macroeconomic and social impacts of the environmental policies. In particular, UNFCCC distinguishes three types of such approaches:

- *Simplified macroeconomic assessment:* seeks consistency between sectoral forecasts and informs baseline scenarios.
- *Input-output*: Captures intersectoral feedbacks but not structural changes in economies (assume no shifts between sectors).
- *Computable general equilibrium*: Captures structural changes, assume market clearing.

Report by Halsnæs et al. (1999), referenced by the UNFCCC, in addition distinguishes macro econometric models and splits simplified macroeconomic approach into aggregated and

disaggregated macroeconomic indicators. Table 2.11 summarizes modelling approaches outlined in Halsnæs et al. (1999). Each of these methodologies has its specific strengths and limitations. (For more information, refer to Annex V).

Table 2.11. Modelling approaches for the assessment of the economic and social impacts of mitigation policies

No.	Model type	Possibilities	Strengths	Limitations
1.	Aggregated macroeconomic indicators	Rough macroeconomic analysis, crude baseline scenarios	Minimum data requirements.	Provide very general picture
2.	Disaggregated macroeconomic indicators	Macroeconomic analysis, baseline scenarios	Low data requirements	Do not account for inter-sectoral linkages
3.	Input-output tables, Social Accounting Matrix	Simple modelling and forecasting, possible refinement of baseline scenarios	Transparency of the modelling framework; representation of intersectoral linkages	Do not account for structural changes
4.	Computable general equilibrium models	Development of models with market mechanism incorporated. Assessment of cost of mitigation options at macroeconomic and sectoral level in the long run	Account for structural changes and factors substitutions	Data extensive. Significant development efforts.
5.	Macroeconometric models	Possible adaptation of existing models to reflect impact of climate change in the long run	Could serve as a guide to develop long-term models	By default provide short-term assessment

2.3 PROPOSED METHODOLOGICAL APPROACH FOR THE SECOND UKRAINIAN NDC

2.3.1. General modelling approach

The proposed methodological approach for assessment of the GHG emissions pathway of Ukraine consists of several mathematical models including **TIMES-Ukraine model,** which covers Energy and Industrial processes Sectors (IPCC), Waste sector model, and modelling tool for Agriculture and LULUCF sectors. Therefore, the proposed methodological approach to the modelling of GHG emissions pathway of Ukraine covers 100% of economy.

As per Figure 2.4, Dynamic Ukrainian General Equilibrium (**UGEM**) model provides an economic assessment of various mitigation strategies, this model will be used to estimate the social and economic impacts of the energy decarbonisation policies and measures.

Visualisation and Analysis tool (**V&A tool**) will be used to ensure comprehensive visualisation of the current national GHG inventory data of Ukraine, existing data at sectoral and sub-sectoral levels with trend analysis and comparison to other Parties.

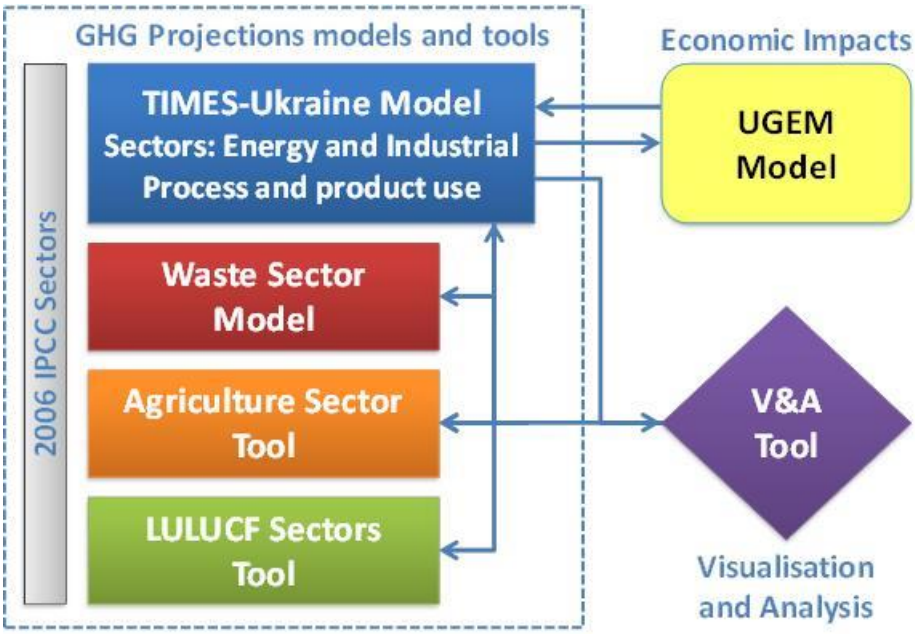


Figure 2.4. Framework of the modelling GHG emissions pathway of Ukraine

As mentioned in Section 1, there are no long-term plans or programs of economic and social development in Ukraine and therefore, for the purpose of preparation of the second NDC, within the Project there will be developed and used two macroeconomic scenarios for Ukraine (endorsed by experts of the Ministry of Economic Development and Trade of Ukraine). On the next step the set of GHG emission reductions scenarios will be developed and applied for these two macroeconomic scenarios (Figure 2.5):

1) WithOut Measures (WOM);
2) With Current Measures (WCM);
3) With Additional Measures, which will meet the Paris Agreement objective by limiting global warming to well below 2.0°C (WAM2.0);
4) With Additional Measures, which will meet the Paris Agreement objective by limiting global warming to well below 1.5°C (WAM1.5). See Figure 2.6.

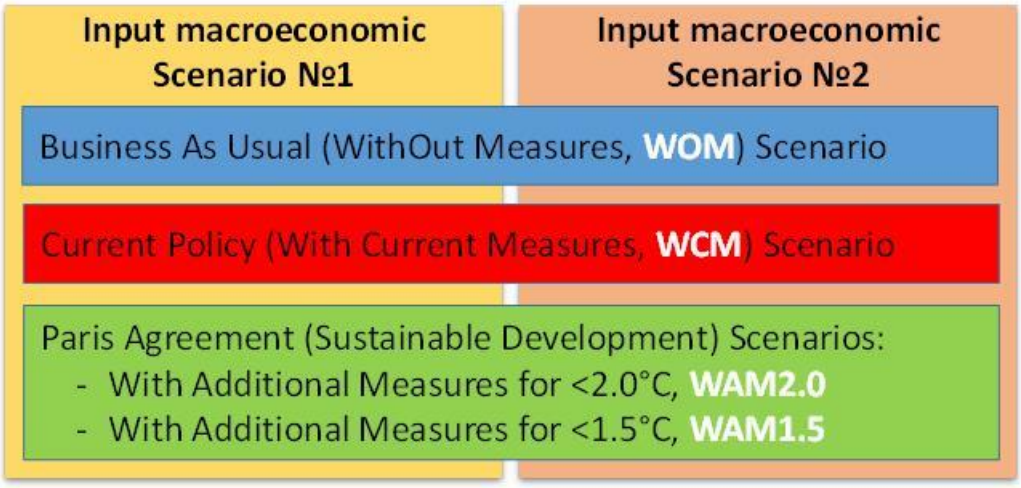


Figure 2.5. Concept of grouping scenarios of GHG Pathways of Ukraine

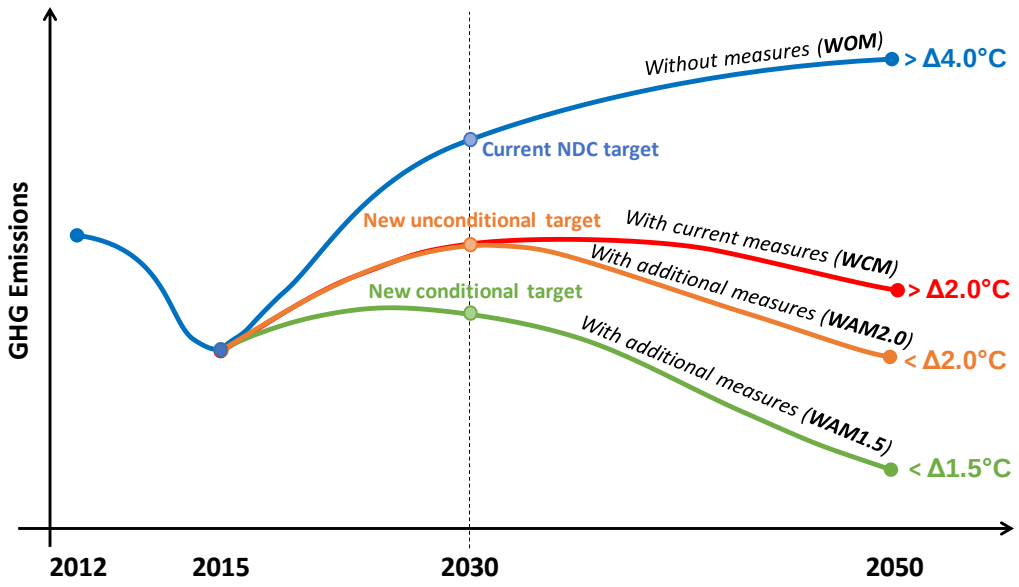


Figure 2.6. Modeling scenarios of GHG Pathways of Ukraine Concept

Scenarios Description

Scenario 1. Business as Usual Scenario (Without Measures, WOM) – this scenario foresees that targeted climate policies for GHG reduction will not be implemented by 2050, including energy efficiency improvements, renewable energy development, market and institutional development, stimulation of attraction of investments and capacity building development in this sphere, etc. BAU scenario is considered as a hypothetical scenario when the characteristics of the most technologies remain unchanged up to 2050, such as they were in 2015. Gradual replacement of technologies takes place only when the life time of certain existing capacities comes to its end. The cost and efficiency of technologies that replace the old ones reflects current trends: the cost decreases with time and the efficiency increases. At the same time, most of the existing technologies still can be used during the modeling period (2015-2050). This approach is useful to assess the implications of the implementation of three alternative scenarios.

Scenario 2. Current Policies Scenario (With Current Measures, WCM) – this scenario is based on the existing legislation, strategies and plans adopted and enacted by April 2019. WCM scenario will include targets and measures in energy efficiency, renewables (including wastes), ecologisation, modernization, electrification, sectorial development, waste management, improvement in land use, growing, farming etc., as well as targets and measures aimed at increased absorption of greenhouse gas emissions in Ukraine that are stated in:

- Ukraine 2050 Low Emission Development Strategy [30]
- The Law of Ukraine on the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030 [31]
- Energy Strategy of Ukraine till 2035 [32]
- Adopted Action Plan for the implementation of the stage "Energy Sector Reform (2020)" of the Energy Strategy of Ukraine till 2035 [33]
- National transport strategy of Ukraine for the period up to 2030 [34]

- Plan for the development of the gas transportation system for 2018-2027 [35]
- Concept of realization of the state policy of heat supply till 2035 [36]
- National Strategy for Waste Management in Ukraine until 2030 [37]
- National Energy Efficiency Action Plan till 2020 [38]
- National Renewable Energy Action Plan till 2020 [39]

This scenario does not include measures and policies that are mentioned, but not yet implemented in Ukraine. Scenario aims to assess the complex impact of only legislatively set and implemented in Ukraine policies and measures, as well as of officially set targets, on the dynamics of greenhouse gas emissions.

Scenario 3. With Additional Measures for <2.0°C (WAM2.0) – this scenario is based on the Low Emissions Development Strategy of Ukraine until 2050. It will contain the limitations of GHG emission (as upper bounds, not GHG pathway, Figure 2.7) from this strategy for the Energy sector and Industrial Processes (in the IPCC terms).

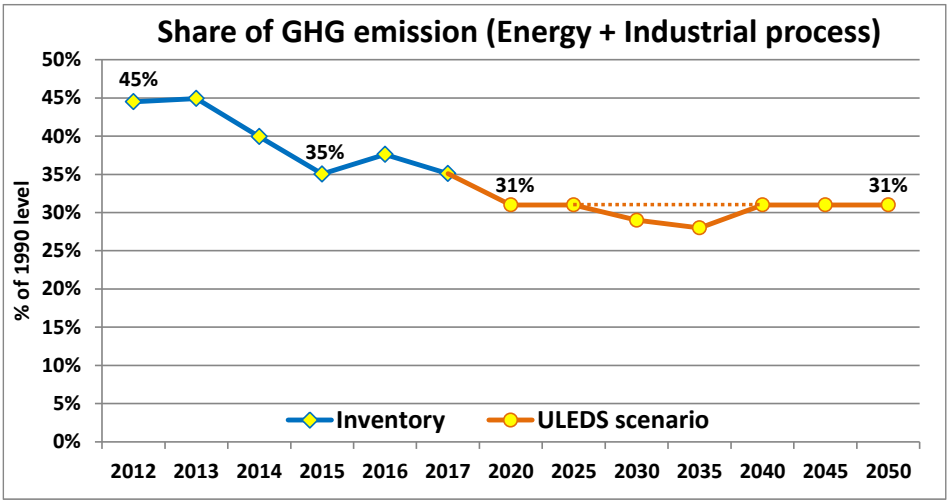


Figure 2.7. The limitations of GHG emission for WAM2.0 scenario

WAM2.0 scenario will include policies and measures of the WCM Scenario, as well as additional policies and measures presented in the LEDS and other strategic documents or their drafts, but which have not yet been implemented in Ukraine. In particular, the strategic documents are the following:

- Draft Strategy of sustainable development of Ukraine till 2030 (based on SDGs) [40]
- Draft Strategy for the Development of the Industrial Complex of Ukraine [41]
- Draft the Integrated Strategy for the Development of Agriculture and Rural Areas for 2015-2020 [42]
- Draft National Energy Efficiency Action Plan till 2030 (*in the process of development*)
- Draft the Transmission System Development Plan for 2019-2028 [43]
- Long-term Nuclear Power Development Program of Ukraine (*in the process of development*)
- Draft Action plan for 2019-2021 on the implementation of the National Transport Strategy of Ukraine till 2030 [44].

This WAM2.0 scenario is intended to assess the comprehensive impact of planned or disputed policies and measures in Ukraine, that directly or indirectly influence the reduction and absorption of greenhouse gas emissions being not formally approved and, accordingly, not implemented in Ukraine.

Scenario 4. With Additional Measures for <1.5°C (WAM1.5) – This scenario will include policies and measures of WAM2.0 Scenario, as well as additional policies and measures that are discussed globally as the best practices (new and innovative technologies such as carbon capture and storage, power to gas, power to heat, power to fuels, power to materials, fuel cells, hydrogen technologies, new technologies in growing, farming, land use etc., as well as market and non-market mechanisms such as high carbon prices, bounds of GHG emissions etc.) to achieve the ambition goal of the Paris Agreement for limiting global warming to 1.5°C.

The WAM1.5 scenario will include greenhouse gas emission limitations in Ukraine up to 2050, based on the Sustainable Development Scenarios of the International Energy Agency and a set of scenarios collected and analyzed by the Intergovernmental Panel on Climate Change (IPCC). Limitations will be defined as the average share of the projected global GHG emissions from the IPCC as compared to 1990 level and would be applied for the respective values for Ukraine (Figure 2.8).

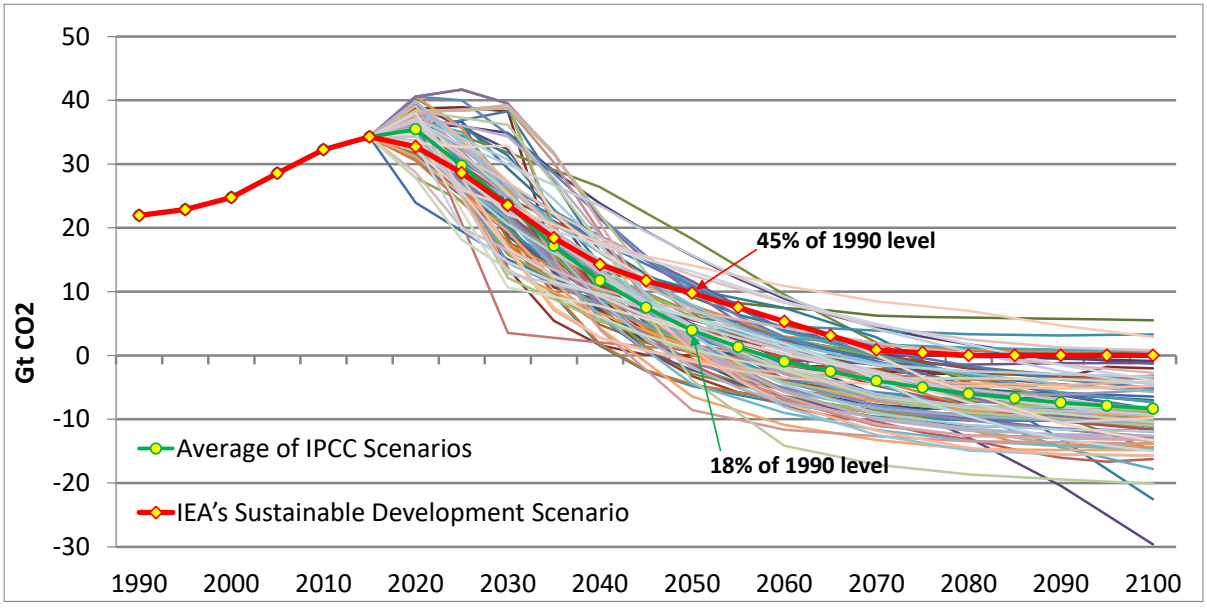


Figure 2.8. IEA and IPCC emission pathways with a 1.5°C global warming

This scenario is intended to assess the ways of transformation in the Ukrainian economy in general and in selected sectors in particular, to identify the benefits and threats of such a scenario for Ukraine, as well as the potential investment level to achieve the most ambitious goal of the Paris Agreement.

The NDC target will be influenced both by internal (domestic) and external (international) options, and adaptation options (Figure 2.9).

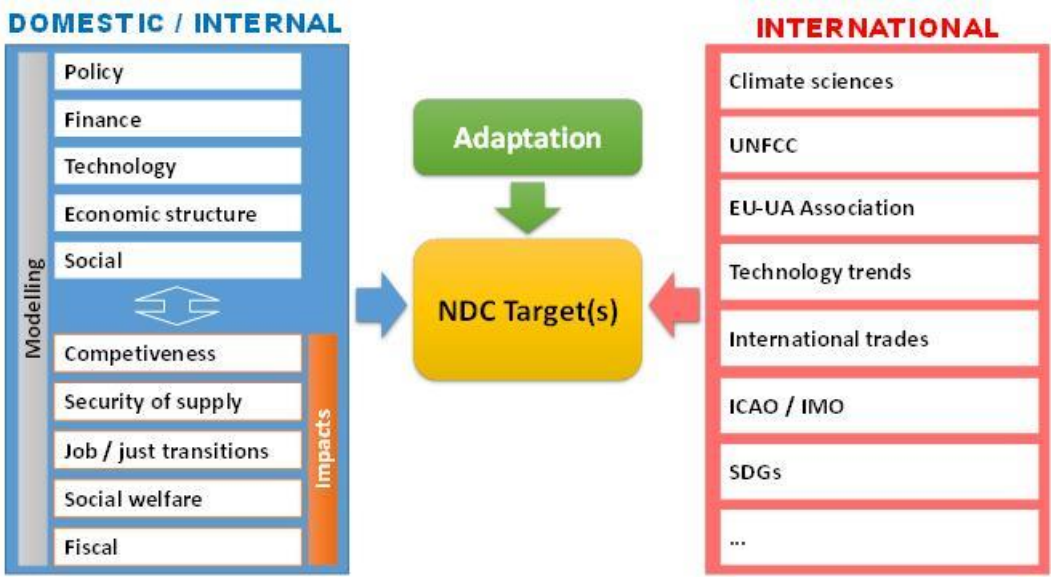


Figure 2.9. Internal and external NDC target(s) options

2.3.2. TIMES-Ukraine Model

TIMES-Ukraine is a typical linear optimization energy system model of MARKAL/TIMES family (Loulou et al. 2004), which provides a technology-rich framework for estimating energy dynamics in the long-run (Podolets and Diachuk 2011). Ukrainian energy system in the model is divided into seven sectors: energy supply, electricity and heat generation, industrial users, transport, agriculture, households and services (Fig. 2.10).

Industrial users are further disaggregated into two categories depending on the level of energy intensity. Energy-intensive subsectors are represented by product-specific technologies. For other industrial subsectors, we use a standard representation according to the four types of general processes: electric engines, electrochemical processes, thermal processes and other processes. Energy consumption by households and commercial sector is defined by the most energy intensive categories of consumer needs.

Energy system models, like TIMES-Ukraine, are usually used for long-term analysis of energy system development paths. By changing the assumptions on useful energy demands, technologies, prices or other exogenous variables scenarios without measures (baseline scenario) are developed. On the next step, policy scenarios are designed by imposing additional constraints or targets to the energy system. In this study, we develop one baseline scenario (WOM) and two policy scenarios – with current measures (WCM) and with additional measures (WAM). For each scenarios the model estimates the least cost (or maximum surplus) trajectory of the system, i.e. energy supply and demand by sector and fuel type, energy prices, the optimal technology mix etc. Differences between WOM and policy scenarios are further analysed.

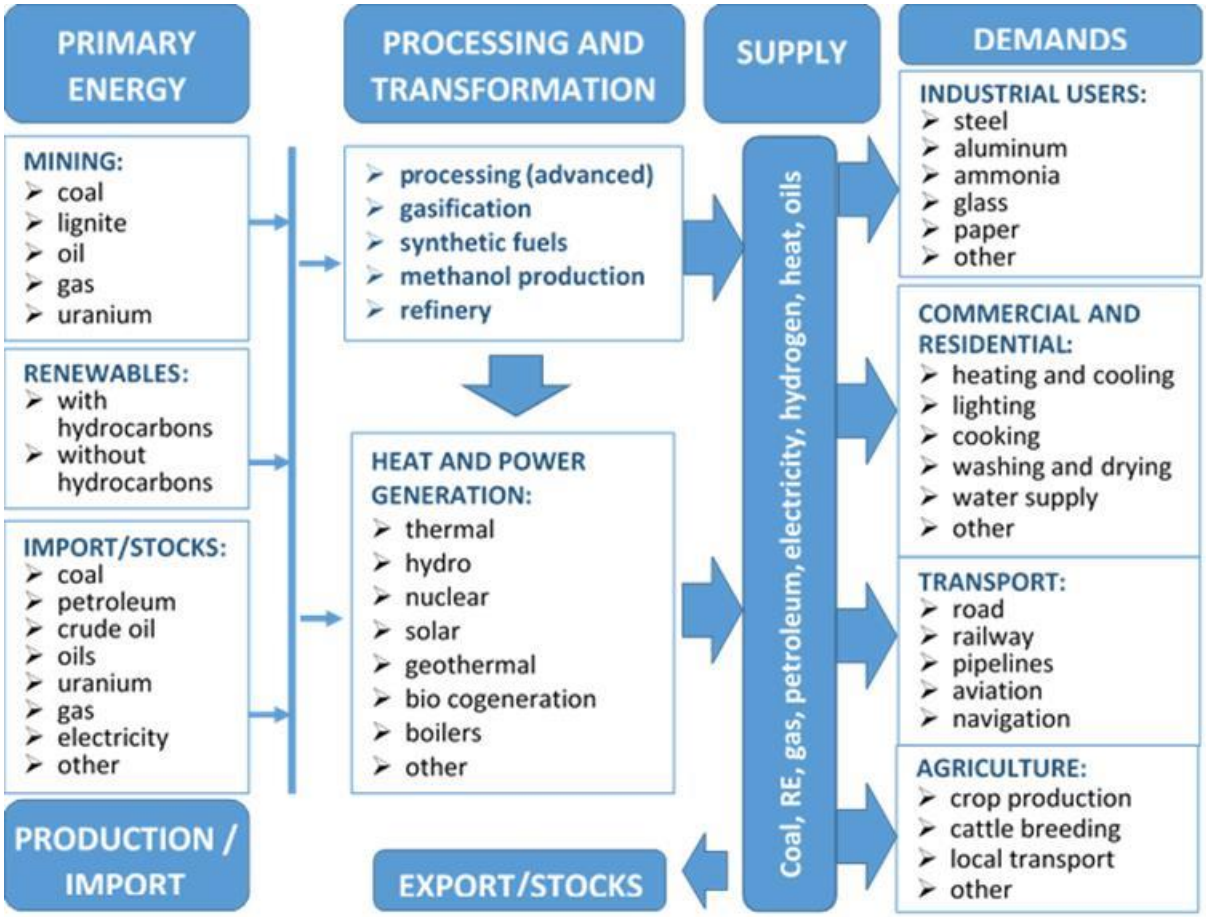


Figure 2.10. Representation of the energy system in TIMES-Ukraine model

2.3.3. Ukrainian General Equilibrium Model

For second NDC development, we will use a dynamic Ukrainian General Equilibrium (UGEM) model to provide an economic assessment of various mitigation strategies. Current version of the model is based on the static model described in Chepeliev (2014), dynamic mechanisms introduced in TRPC (2014), as well as improvements and updates introduced to the model with the current project.

The UGEM model has been widely used in the economic assessment of the various energy and environmental policies in Ukraine. In particular, it was used for the macroeconomic modelling of the carbon taxation and emissions trading in Ukraine within the EBRD "Preparedness for Emission Trading in the EBRD Region" (PETER) Project (TRPC, 2014). The model was involved into the economic assessment of the Low Emission Development Strategy (LEDS) of Ukraine within the USAID "Municipal Energy Reform Project" (MERP) (USAID MERP, 2017). This model was also used for the economic analysis of the different scenarios for the Intended Nationally Determined Contributions (INDC) for Ukraine within the MERP initiative, as well as several other internationally-supported projects.

UGEM model is a single-country recursive dynamic computable general equilibrium model with producers divided into over 89 sectors covering the whole economy. Figure 2.11 represents key economic flows in the UGEM model.

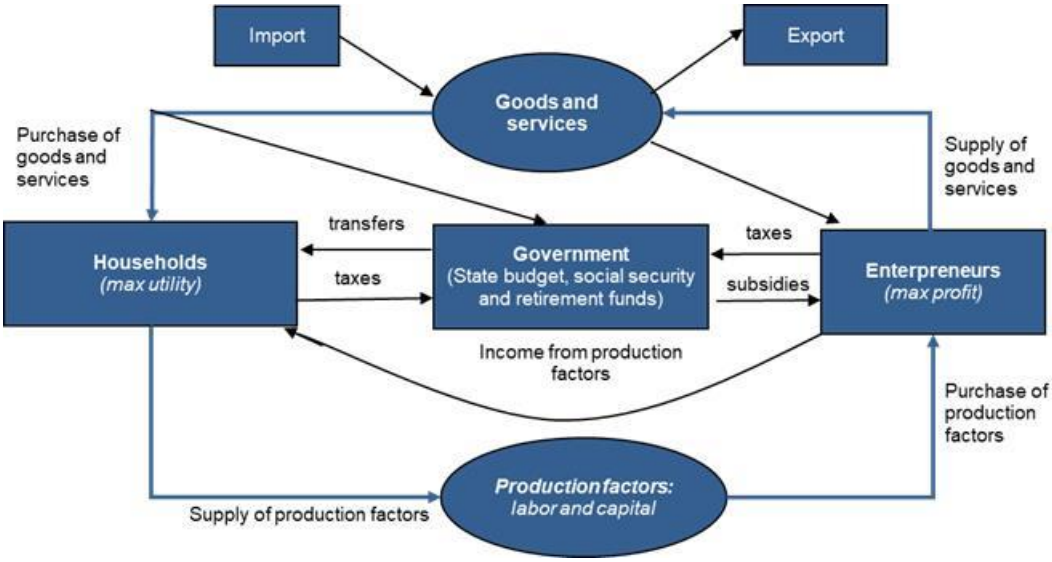


Figure 2.11. Economic flows in the UGEM model

It is assumed that producers are maximizing their profits and households are maximizing utility. Enterprises are producing goods and providing services, using capital, labor and intermediate products. Domestic producers sell their products at the national or international markets. In the domestic market, final goods and services are purchased by households, government or contribute to the gross capital formation. Households receive labor and capital payments, as well as money transfers. Government earns revenue and receives tax payments, providing transfers and subsidies to households and producers. To represent production and consumption processes in the UGEM model, constant elasticity of substitution[4] (CES) production functions are used. In the case of main production block, a multi-nested CES function is used, which distinguishes energy and non-energy commodities, as well as value added component.

UGEM is formulated as a static model and solved sequentially over time. Capital stock is updated in every period based on the capital depreciation rate and investments inflow. Labor supply is changing at the same rate as a total population.

Energy sector in the UGEM is represented by seven sub-sectors: coal mining, extraction of the natural gas and oil, coke and oven products, petroleum products, electricity production and distribution, distribution of natural gas, heat and hot water supply. Electricity generation is further split into transmission and distribution and seven different generation technologies (coal, gas, nuclear, hydro, wind, solar and other power). Key input data for the model is sourced from the Input-Output table, households' surveys, National accounts, energy balances and international trade statistics. Data inputs are organized in the form of Social Accounting Matrix based on the 2015 data.

While UGEM model is able to assess the economy wide impacts of energy and environmental policies (e.g emissions taxation), it does not represent energy sector in such a detailed way as the TIMES-Ukraine model does. To this extent an environmental policy analysis can benefit from the linkage of these two models, which we discuss in the next Section.

[4] Elasticity of substitution indicates relative consumption quantities changes resulting from the corresponding relative price changes.

2.3.4. TIMES-Ukraine model and UGEM Linkage

To provide a social and economic assessment of NDC scenarios for Ukraine, we use a soft-linkage of TIMES-Ukraine and UGEM models (Figure 2.12). First, we calibrate both models to the single set of macroeconomic and demographic assumptions included into the baseline path. In this way, we ensure a harmonized starting point for the model simulations. Second, we provide an assessment of the NDC transition pathway using TIMES-Ukraine model. In particular, we let the model estimate the most cost-efficient way to achieve this target. Apart from energy and environmental effects of such simulation, we estimate the amount of additional investments required to achieve the NDC targets, as well as efficiency improvements that follow the implementation of a new/better technologies. At this stage, TIMES-Ukraine model only estimates the costs of such measures, but does not provide any information on the funding sources or viability of these policies for the national economy. Therefore, as the third step, we feed in estimated investment costs and sector-specific energy efficiency changes to the UGEM model. We assume that additional investments are covered by energy users and producers (households, industrial users, electricity and heat producers, etc.). We do not assume any external funding sources, such as foreign borrowings. We further use this investment and technological changes as exogenous shocks for the UGEM model to provide an economic impact assessment of Ukraine's second NDC scenarios.

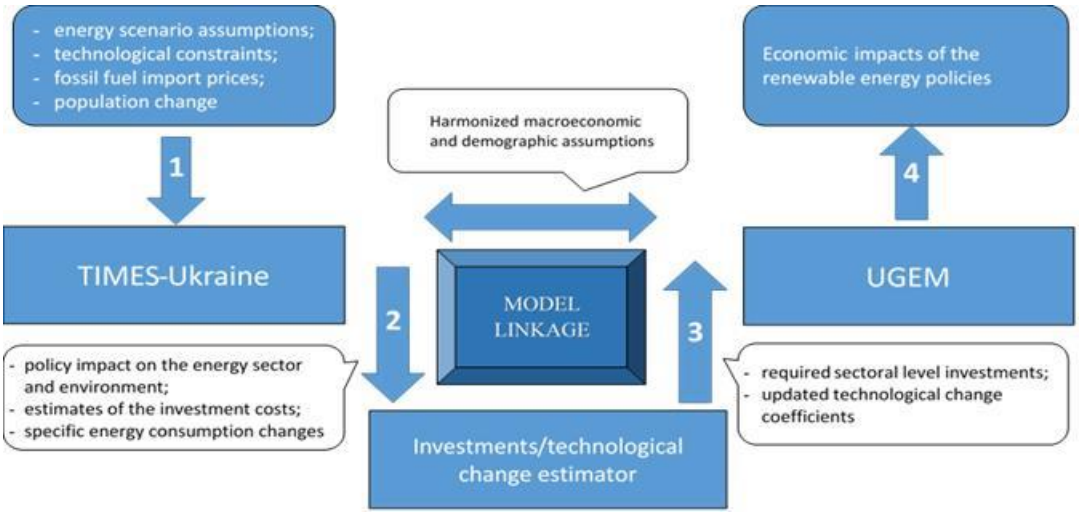


Figure 2.12. TIMES-Ukraine and UGEM models linkage

Such approach is of course not without limitations. Under the current set up, we use only a one-way link – from TIMES-Ukraine to UGEM model. In other words, TIMES-Ukraine simulations serve as a source of policy shocks for UGEM model. A more consistent way of model linkage would include iterative data exchange between models until outputs of the one model would match inputs of the other under the defined level of tolerance. In terms of policy framework, more attention can be given to the sourcing of additional investments. As noted before, we assume that all additional costs associated with NDC policies implementation are covered by internal funds of the energy producers and users, therefore no external funding is introduced. In this context it may be worth exploring some alternative assumptions regarding sourcing of investments. Nevertheless, we consider an approach used in this report to be more inclusive and consistent than a stand alone use of both models.

2.3.5. Waste Sector Model

Applied methodological approach for conducting projections has to meet the following conditions:

- Key projected indicators and drivers are based on quantitatively determined ones in national waste management programs and plans.
- Assumptions are in line with measures and limitations determined in laws and acts.
- Expert judgements are in line with cross-sectoral assumptions such as energy consumption structure, development of economy sectors, demography etc.
- Selected indicators for projections correlate with activity data and emission factors for historical GHG emission estimation indicated in IPCC 2006 Guidelines.

Complexity of applied methodological approach has to take into account the following:

- Availability of the projecting indicators and key drivers.
- Amount of GHG emissions in the category and planned development of the activity in the future.
- Best and typical international practice.

Two main documents determine future development of solid waste management system in Ukraine:

1. Law "On Waste" (1998, – with the latest changes in 2018).
2. National Waste Management Strategy till 2030 (2017).

Law "On Waste" indicates main qualitative measures and drivers for the projected development of solid waste treatment sphere in Ukraine, among which:

a) it's prohibited to mix or dispose solid waste for which utilization technology is available;
b) MSW incineration is allowed only with energy recovery;
c) design, construction and operation of MSW landfills without landfill gas collecting and further utilization is prohibited.

National Waste Management Strategy till 2030 indicates main quantitative measures and drivers for the projected development of solid waste treatment sphere in Ukraine, an expanded list of which is presented in table 2.12.

Table 2.12. Expanded list of drivers: National Waste Management Strategy till 2030

Activity	Driver	Base value, 2016	Value		
			2017-2018	2019-2023	2024-2030
Prevention of solid waste generation	Creation of a network of centers for cleaner production to minimize the amount of waste generation, units	–			
	Reduction of primary raw material usage, %	90	85	80	70
	Development of waste separate collection local systems, which are suitable for reuse and recycling in settlements, units	575	800	2500	5000
Preparation of waste for reusing	Share of MSW reuse, %	5	7	8	10
	Creation of new facilities for recycling, units	65	100	250	800
Solid waste processing	Creation of new facilities for biowaste composting, units	20	70	150	500
	Increasing of MSW processed, %	3.04	5	15	50
	Construction of stationary facilities for MSW incineration, units	1	3	15	20

Activity	Driver	Base value, 2016	Value		
			2017-2018	2019-2023	2024-2030
Other types of MSW utilization	Increasing of MSW incineration, %	2.37	5	7	10
	Increasing of MSW incineration, mln. tonnes	1	1,5	2	3
	Decreasing of solid waste disposal sites	6000	5000	1000	300
Solid waste disposal	Decreasing of solid waste disposal, %	50	45	40	35
	Decreasing of MSW disposal, %	95	80	50	30
	Creation of regional landfill networks, units	–	5	25	50

Unlike solid waste management policy and strategy national policy on wastewater treatment sphere is now on the formation stage. The most corresponding national document for GHG emission projections from wastewater treatment is National report 2017 "Sustainable Development Goals: Ukraine" (2017), in which certain determined goals for wastewater treatment in Ukraine has been identified and are presented in table 2.13.

Table 2.13. Expanded list of drivers: National report 2017 "Sustainable Development Goals: Ukraine"

Goal	Driver	Year			
		2015	2020	2025	2030
Ensure availability of quality services on the supply of safe drinking water, construction and reconstruction of centralized drinking water supply systems with the use of the latest technologies and equipment	Share of rural population with access to centralized water supply, %	17.2	20.0	30.0	50.0
	Share of urban population with access to centralized water supply, %	89.8	90.0	95.0	100.0
Increase of water use efficiency	Water needs for the economy, 1 cubic m per 1000 UAH of GDP (in actual prices)	3.6	3.2	2.9	2.5
	Water needs for the economy, % compared to 2015	100	90	80	70
Ensure accessibility of balanced nutrition level and scientifically substantiated norms for all layers of the population	Meat consumption per capita, kg/year	51	61	71	80
	Dairy products consumption per capita, kg/year	210	270	320	380
	Fruit consumption per capita, kg/year	51	65	78	90

Taking into account determined waste management goals and targets three types of methodological approaches in Waste sector are proposed below: "complex", "typical" and "simplified". It's also not a technical issue to make a mix of them.

Concept of proposed approaches is presented in tables 2.14-2.16.

Simplified approach is based mostly on forecasted based on common socio-economic indicators. This approach do not reflect the technological and management decisions at the specific areas and includes the easiest way to make projections in Waste sector. This approach may be acceptable if according to the legend Waste sector contributes very small amount of GHG emissions to the country's total and do not make any significant influence on the GHG emission trend in future.

Typical approach is based on forecasted socio-economic indicators and main planned measures in waste treatment sphere of Ukraine. This approach is in line with national legislation and state programs and corresponds to common practice used while compiling 7th NCs.

Complex approach as well as typical one is also based on forecasted socio-economic indicators and main planned measures in waste treatment sphere of Ukraine. In addition, complex approach takes into account country-specific issues on GHG emission inventory aspects and national statistics.

Table 2.14. Concept for GHG emission projections in Waste sector for complex methodological approach

Category	Parameter/ Indicator	Driver	Source	Availability
5.A Solid Waste Disposal (key cat.)	Amount of MSW disposal	Population	Cross-sectoral issue	Cross-sectoral issue
		Generation rate per cap.	EJ[1], WMS[2]	EJ is needed
		Share of coverage with centralized collecting system	EJ	EJ is needed
		Share of MSW landfilling	WMS	Available
	Type of disposal sites	Landfill modernization and new ones	WMS	Available
	Methane recovery	Facility building	EJ	EJ is needed
	MSW composition	Changes in mass flows, probably socio-economic aspects	EJ	EJ is needed
5. B Biological Treatment of Solid Waste	Amount of waste composted	Facility building	WMS	Available
5.C Incineration and Open Burning of Waste	Amount of waste incinerated	Economy development in industrial sector	Cross-sectoral issue	Cross-sectoral issue
	Emission factors	New technology	EJ	EJ is needed
5.D Wastewater Treatment and Discharge	Amount of industrial wastewater	Economy development by industrial sectors	Cross-sectoral issue	Cross-sectoral issue
		Water needs for the economy, New technologies	SDGU[3]	Available
	Methane recovery	Construction of methane tanks	EJ	EJ is needed
	Amount of domestic wastewater	Population, including urban and rural	Cross-sectoral issue	Cross-sectoral issue
	Coverage of centralized collecting system	Share of urban population with access to centralized water supply	SDGU	Available
		Share of rural population with access to centralized water supply	SDGU	Available
	Protein consumption per capita	Meat consumption per capita, kg/year	SDGU	Available
		Dairy products consumption per capita, kg/year	SDGU	Available
		Fruit consumption per capita, kg/year	SDGU	Available

EJ[1]– expert judgement

WMS [2]– National Waste Management Strategy till 2030

SDGU [3]– National report 2017 "Sustainable Development Goals: Ukraine"

Table 2.15. Concept for GHG emission projections in Waste sector for typical methodological approach

Category	Parameter/Indicator	Driver	Source	Availability
5.A Solid Waste Disposal (key cat.)	Amount of MSW disposal	Population	Cross-sectoral issue	Cross-sectoral issue
		Generation rate per cap.	EJ[1], WMS[2]	EJ is needed
		Share of MSW landfilling	WMS	Available
	Type of disposal sites	Landfill modernization and new ones	WMS	Available
	Methane recovery	Facility building	EJ	EJ is needed
5. B Biological Treatment of Solid Waste	Amount of waste composted	Facility building	WMS	Available
5.C Incineration and Open Burning of Waste	Amount of waste incinerated	Economy development in industrial sector	Cross-sectoral issue	Cross-sectoral issue
5.D Wastewater Treatment and Discharge	Amount of industrial wastewater	Economy development by industrial sectors	Cross-sectoral issue	Cross-sectoral issue
	Methane recovery	Construction of methane tanks	EJ	EJ is needed
	Amount of domestic wastewater	Population, including urban and rural	Cross-sectoral issue	Cross-sectoral issue
	Protein consumption per capita	Meat consumption per capita, kg/year	SDGU[3]	Available
		Dairy products consumption per capita, kg/year	SDGU	Available
		Fruit consumption per capita, kg/year	SDGU	Available

EJ[1]– expert judgement; WMS [2]– National Waste Management Strategy till 2030; SDGU [3]– National report 2017 "Sustainable Development Goals: Ukraine"

Table 2.16. Concept for GHG emission projections in Waste sector for simplified methodological approach

Category	Parameter/Indicator	Driver	Source	Availability
5.A Solid Waste Disposal (key cat.)	Amount of MSW disposal	Population	Cross-sectoral issue	Cross-sectoral issue
		Generation rate per cap.	EJ[1], WMS[2]	EJ is needed
		Share of MSW landfilling	WMS	Available
	Type of disposal sites	Landfill modernization and new ones	WMS	Available
	Methane recovery	Facility building	EJ	EJ is needed
5. B Biological Treatment of Solid Waste	Amount of waste composted	Average value for 2012-2015	GHG inventory	Available
5.C Incineration and Open Burning of Waste	Amount of waste incinerated	Average value for 2012-2015	GHG inventory	Available
5.D Wastewater Treatment and Discharge	Amount of industrial wastewater	Economy development by industrial sectors	Cross-sectoral issue	Cross-sectoral issue
	Amount of domestic wastewater	Population, including urban and rural	Cross-sectoral issue	Cross-sectoral issue

EJ[1]– expert judgement; WMS [2]– National Waste Management Strategy till 2030

2.3.6 Agriculture

In order to build projections of GHG emissions as well as estimate possible implications of activities for GHG emission reduction it is important to keep methodological consistency between already existing methodology and projections. **According to Ukraine's National Inventory Report submitted in 2018 the GHG inventory in Agriculture in Ukraine is based on the methodologies from 2006 IPCC Guidelines [45]**. Thus in order to develop projections for GHG emission trend, it is important to keep methodological consistency between calculation methods of already existing reporting system and future transparency reporting.

General approach of IPCC methodologies is to multiply activity data (AD) on emission factors (EFs). It is approved to be simple and effective way of estimation of GHG emissions and widely used under UNFCCC. It is also suitable to be used in projections if a time series of data and factors is available.

Building set of data and indicators for agriculture in the future has many advantages. First of all it is easy to track progress of achieving desired level of emission reduction by reviewing data which is already collected by national statistics. Thus, this will simplify Ukraine's commitments of transparency reporting under Paris Agreement.

In addition, it gives better understanding of factors, which have influence on level of emissions. Therefore, in any stage of planning or policy making process in the future there will be different options available of achieving GHG emission reduction goal (for example by setting quantitative or qualitative goals to be reached). Avoiding over complications in projections also will have positive impact on the stage of public discussions since the data will be presented in known and understandable format. Consequently, multilateral considerations will ensure comprehensiveness of estimations.

Lastly, in case of significant changes in the national inventory system of Ukraine this approach will allow to revise easily estimated level of emissions in the sector.

Alternative way of constructing projections in the sector is to use historical GHG emission trend to construct possible future emissions. It is easy and fast method of estimation of GHG emissions. However, it has some drawbacks. As reported in Ukraine's NIR submitted in 2018 historical development of husbandry and crop production in the Agriculture is uneven in terms of emissions. Since 1990 emissions related to livestock has declined on around 70%, but emissions related to agricultural soils have declined on around 20 % and recently this share is decreasing. Consideration of general emission trend would lose these national circumstances. That may cause averaging of future development of these sections which currently have different starting points.

Projecting future emissions based on general historical level of emissions also will lose details that are very important for policy making, planning process and estimation of effect of these activities. For example, setting clear goals or activities to reduce GHG emissions by the Ministry of Agrarian Policy and Food of Ukraine would be difficult without understanding of main emission sources and ways of impact on emission level.

2.3.7 LULUCF

LULUCF in Ukraine is the only sector that has GHG removals. The biggest sink is forests, small amount of carbon is also removed by grassland. However, there are also sources of emissions as well. According to the Ukraine's NIR submitted in 2018 emissions in this sector in cropland category were higher than in agriculture sector in total. Therefore, it is important to keep estimations of GHG emissions and removals in LULUCF separately.

There are different approaches of projecting development of forestry and corresponding carbon stock changes. Some of them are described in chapter 1 as those used for constructing Forest Management Reference Level under KP reporting. Ukraine constructed its FMRL until year 2020 as well, which is reported in NIR. To estimate BAU for forestry until 2020, Ukraine developed its own model using country-specific methodology. Despite it has some drawbacks of high uncertainty of future forestry measures (influence of forest cuttings on age structure, wood cutting volumes, natural disturbances events etc.), this method was recommended by expert review teams, which were reviewing Ukraine's FMRL level [46] and NIR [47] in 2017.

Drawing upon already existing approach will be beneficial to construct possible contribution of forests on entire Ukraine's NDC, since partial data is already available until 2020 what may be analysed and corrected, if needed, and consequently expanded. It also means that already collected data is available, in order to track progress of NDC, plan measures to increase carbon removals or mitigate emissions. That also will allow keeping methodological consistency between current national inventory system and projections, what is important for future reorientation of reporting under Paris Agreement.

Methods of BAU projections are available as well, provided in Section 1. Modelling or extrapolating historical GHG emissions or removals in forests is a simpler way than abovementioned, meaning it requires less data and resources to make calculations. It also mitigates uncertainties of misevaluations of detailed features, like age-class structure, influence of different cuttings on age structure, changes of species etc. But it is also loses advantages of detailed consideration of forest features, which might change in the future, such as increase of wood cuttings due to increased demands of wood, increased frequency and severity of natural disturbances like forest fires, pest and diseases, changes of afforestation areas.

In 2016-2017 Ukraine received assistance from the EU in approaches to climate change mitigation and adaptation. This included expert facility project "Development of the GHG emissions inventory in the forestry sector in order to improve national reporting of Ukraine according to the requirements of the UNFCCC and the Kyoto Protocol". In this report, authors suggested to use carbon fluxes model using inputs from GIS. This model was developed by International Institute for Applied Systems Analysis and allows including assessment of processes in ecosystem in general on carbon budget. This model has big advantage of inclusion of different processes and estimation of overall effect without any possible imbalances between pools.

However, its application in Ukraine has some serious challenges. **The most significant one is data availability.** Despite currently there being different sources of images that can feed

into creating GIS analysis, there is no institution in Ukraine that is using those images and creating national data for the national inventory system to be used for GHG inventory in this category. Application of this model without such data is impossible.

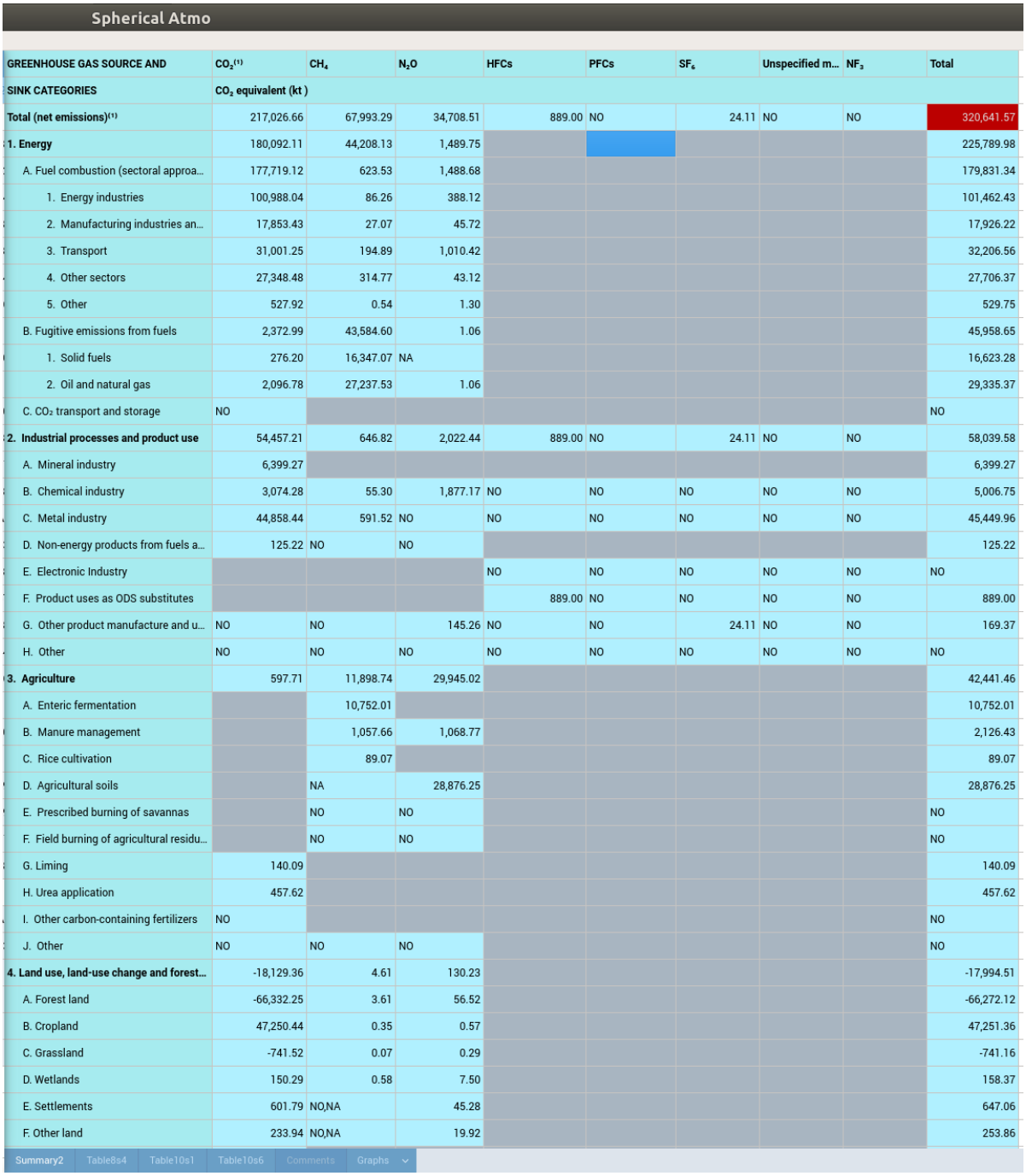
Another drawback of such a complex model is **that it is not simple in use when it comes to less informed subjects related to climate change of different agencies and ministries.** For example, State Forest Resources Agency of Ukraine, responsible for policy making in forestry, as well as forest management, will consider planning activities aimed in carbon removals increase or emissions reduction. Clear understanding of factors that influence the level of GHG removals or emissions in forests will provide more options in possible management practices. Moreover, it is even more beneficial to society, who is usually strongly aware of how forestry is performed and why it is so. Good explanantion of possible activitites and how they are connected to GHG emissions and removals through emission factors will help to better inform people.

Cropland and Grassland categories, despite included into LULUCF sector, cover agricultural activities on corresponding lands. Because of close interconnections with Agriculture sector, IPCC consolidated both sectors into one, when was developing its 2006 Guidelines. However, because UNFCCC reporting count these sectors separately, it is better to keep it separately in projections as well.

Despite different sectors, a lot of activity data is used for Cropland, Grassland and Agriculture sector, or some intermediate calculations are used in another sector (like amount of crop residues, amount of Nitrogen applied with manure or amount of mineralized Carbon in agricultural soils). Thus, for these categories, it is reasonable to keep the same approach as for Agriculture – use the same methodology for estimation of Carbon stock changes what is used currently by Ukraine but project activity data and EFs for the future.

2.3.8. Visualise and analyse data for Ukrainian NDC

The framework of GHG models will predict high level variables appearing in the national inventory and particularly in reporting table Summary2 (Figure 2.13). Spherical Atmo is an inventory software that works with UNFCCC reporting tables “natively”:



GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2[1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified m...	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	217,026.66	67,993.29	34,708.51	889.00	NO	24.11	NO	NO	320,641.57
1. Energy	180,092.11	44,208.13	1,489.75						225,789.98
A. Fuel combustion (sectoral approa...	177,719.12	623.53	1,488.68						179,831.34
1. Energy industries	100,988.04	86.26	388.12						101,462.43
2. Manufacturing industries an...	17,853.43	27.07	45.72						17,926.22
3. Transport	31,001.25	194.89	1,010.42						32,206.56
4. Other sectors	27,348.48	314.77	43.12						27,706.37
5. Other	527.92	0.54	1.30						529.75
B. Fugitive emissions from fuels	2,372.99	43,584.60	1.06						45,958.65
1. Solid fuels	276.20	16,347.07	NA						16,623.28
2. Oil and natural gas	2,096.78	27,237.53	1.06						29,335.37
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	54,457.21	646.82	2,022.44	889.00	NO	24.11	NO	NO	58,039.58
A. Mineral industry	6,399.27								6,399.27
B. Chemical industry	3,074.28	55.30	1,877.17	NO	NO	NO	NO	NO	5,006.75
C. Metal industry	44,858.44	591.52	NO	NO	NO	NO	NO	NO	45,449.96
D. Non-energy products from fuels a...	125.22	NO	NO						125.22
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				889.00	NO	NO	NO	NO	889.00
G. Other product manufacture and u...	NO	NO	145.26	NO	NO	24.11	NO	NO	169.37
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	597.71	11,898.74	29,945.02						42,441.46
A. Enteric fermentation		10,752.01							10,752.01
B. Manure management		1,057.66	1,068.77						2,126.43
C. Rice cultivation		89.07							89.07
D. Agricultural soils		NA	28,876.25						28,876.25
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residu...		NO	NO						NO
G. Liming	140.09								140.09
H. Urea application	457.62								457.62
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forest...	-18,129.36	4.61	130.23						-17,994.51
A. Forest land	-66,332.25	3.61	56.52						-66,272.12
B. Cropland	47,250.44	0.35	0.57						47,251.36
C. Grassland	-741.52	0.07	0.29						-741.16
D. Wetlands	150.29	0.58	7.50						158.37
E. Settlements	601.79	NO,NA	45.28						647.06
F. Other land	233.94	NO,NA	19.92						253.86

Figure 2.13. Ukrainian "Summary2" Table for 2016 reproduced in Spherical Atmo

Atmo provides charting and analysis tools for all numeric variables in the inventory (Figure 2.14-2.15):

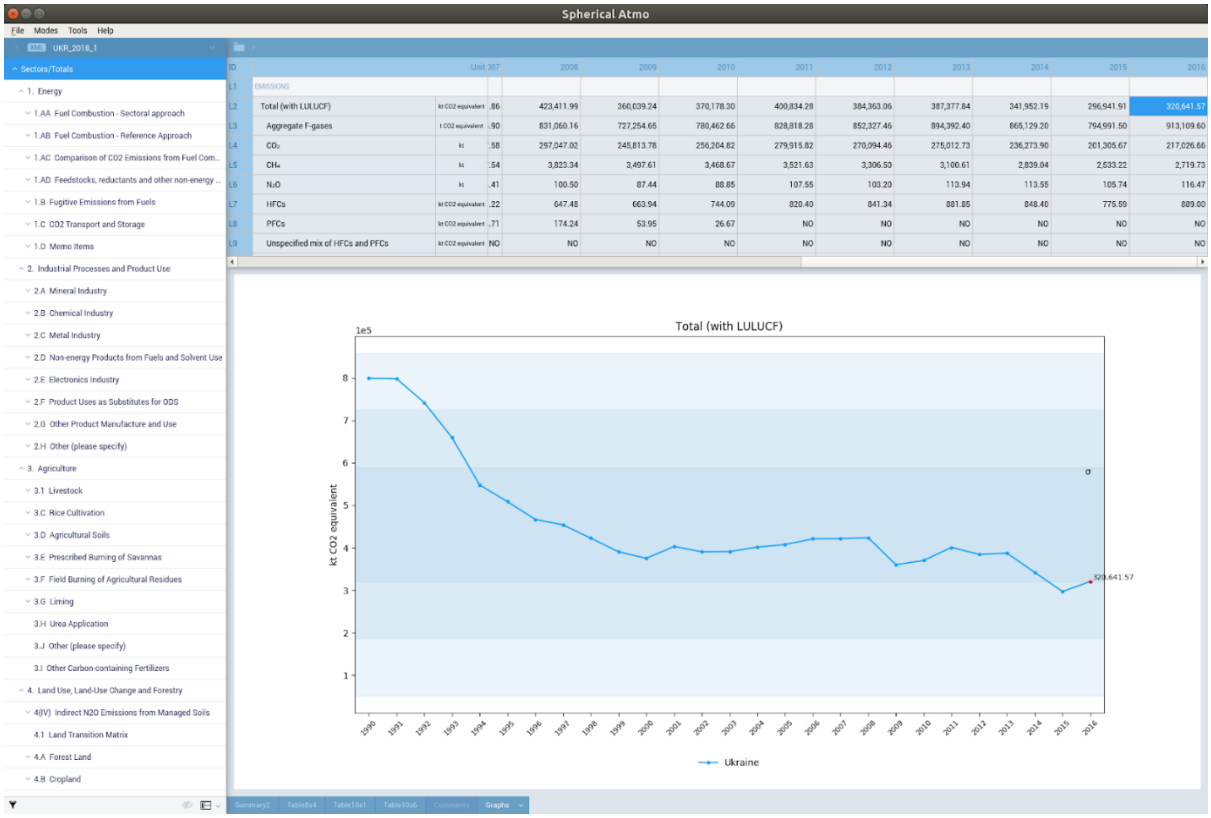


Figure 2.14. Time series chart for one of the Total Emissions with LULUCF with deviation bands

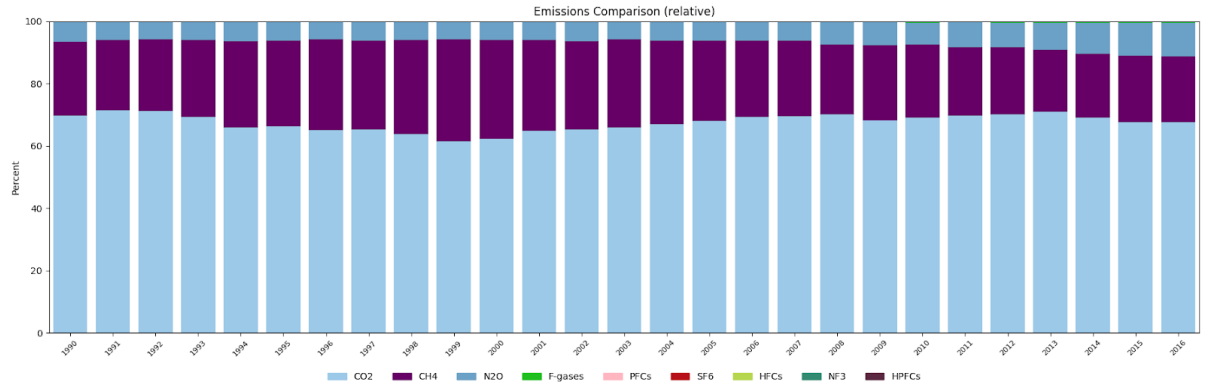


Figure 2.15. Time series of GHG composition of Ukrainian emissions in percent

The national GHG Inventory contains values for all variables starting from the base year (1990 for Ukraine) till the current year minus two. It is possible to load the inventory with values for Summary2 variables predicted by the model in the future and explore them using the same visualization and analysis capabilities in different scenarios. The mapping between reporting tables and inventory data will also help the user understand the contributing factors of each modelled variable and have a meaningful discussion about the accuracy and realism of the model with the national inventory expert community. Going forward, Atmo may be used for ongoing validation of the model and scenarios.

What makes Spherical Atmo the best inventory management tool? How does it achieve compliance with UNFCCC inventory management practices?

The market of generic national GHG inventory software that attempt to deliver to UNFCCC reporting requirements are limited. **In fact, there is UNFCCC CRF Reporter, Spherical Atmo, and the IPCC Software.** Other solutions are bespoke and specific to one country or a small group of countries and may not be easily adapted to Ukrainian data structures (Figure 2.16).

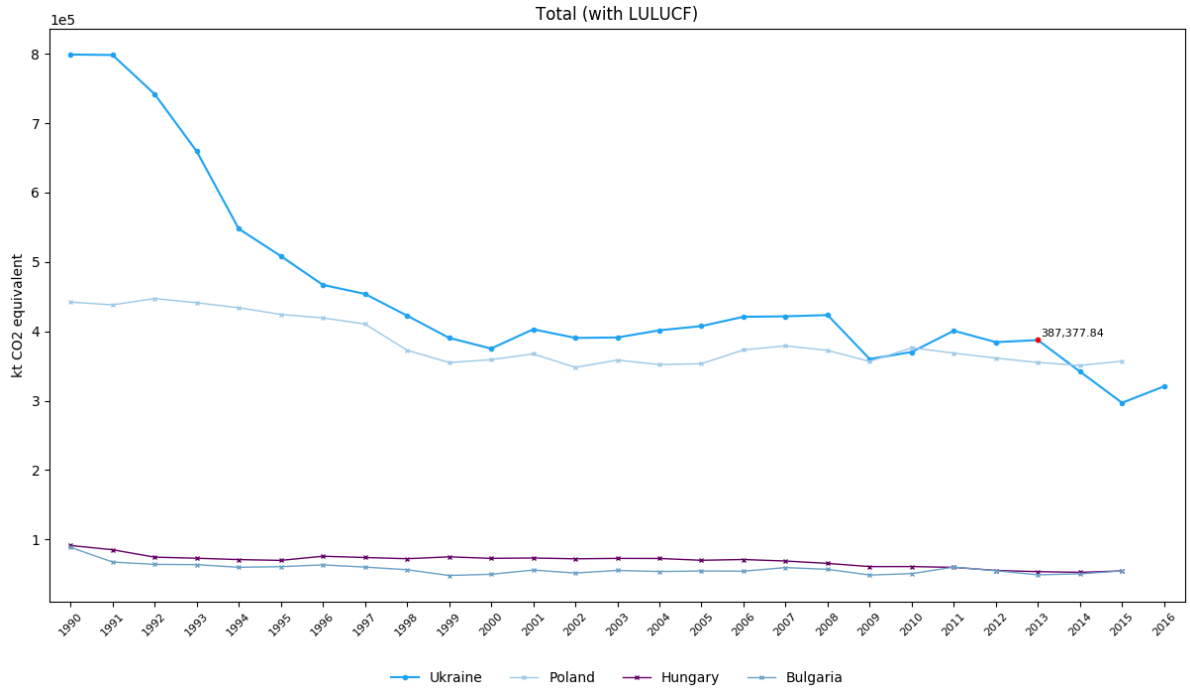


Figure 2.16. Comparison of total emissions of Ukraine and the same variable reported by other countries

UNFCCC CRF Reporter is focused on reporting GHG inventory data of developed countries to UNFCCC for international review. The software contains no visualization or data analysis features except "key category analysis," which is prescribed by the reporting regime, and no features to support forecasting and future data whatsoever. The use of UNFCCC CRF Reporter is made mandatory by UNFCCC, and Ukraine submits its national inventory in the UNFCCC CRF Reporter-compliant format every year. The future of UNFCCC CRF Reporter is uncertain; it is unlikely to survive the implementation of the Enhanced Transparency Framework (ETF) under the Paris Agreement.

IPCC Software is inventory calculation software created by IPCC for developing countries. The software is widely used thanks to its cost-free license and massive investment from IPCC, UNFCCC and various development support agencies but it does not feature a robust data model or support to data analysis. UNFCCC accepts reports generated by IPCC software but due to the fact that the software doesn't have the concept of a "variable", these reports are treated as non-machine-readable data and re-entered into UNFCCC's analysis and review systems manually. The future of IPCC Software is uncertain, it is unlikely to survive the implementation of the ETF

Spherical Atmo is a generic and extensible inventory management software which can be set up to serve, calculate and aggregate any data structure. It is fully compatible with UNFCCC CRF Reporter by formats. For Ukraine, Atmo may be used with UNFCCC CRF Reporter data structures, being directly parametrized with UNFCCC's public inventory metadata which guarantees 100% compatibility with UNFCCC-prescribed data structures and reporting formats. By the same token, it is trivial to load Ukrainian data into Atmo because Ukraine's GHG reports are already in a format which is compatible with UNFCCC CRF Reporter, and therefore with Atmo as well. The examples in provided in figures in this text are generated by importing Ukraine's standard GHG reports to UNFCCC into Atmo.

Atmo features extensive toolkit for data analysis and visualization and may work with forecasted data in different scenarios. Atmo features a unique cross-country comparison feature which allows the user to visually compare time series for any public variable with respective time series of other countries.

Spherical Atmo is actively developed, actively supported and ready for transition to ETF, adaptation for sub-national and corporate reporting or configuration of other, including non-GHG reporting regimes, analysis and visualization needs.

2.4 DATA REQUIREMENTS AND DATA COLLECTION TIMELINE

According to the approach proposed by the Project Team, applied mathematical models established in the IEF together with additional models on Waste, Agriculture and LULUCF sectors are supposed to be used for estimation of perspective energy demand and GHG emissions, as well as for the economic assessment of the proposed NDC target(s). In general, these models are extensively fed upon harmonized national official macroeconomic and energy statistics and available expert information. Within the next month statistical database would be *double-checked* against the possibility of adjustments recently made by respective authorities; besides, existing and planned policies and measures incorporated in models will be also reviewed.

This initial task will enable adequate re-calibration of models for the common base year, which is 2015 as it was described above. In the next step, all the model's databases would be updated with the latest available information (preferably by 2018) to properly reflect current tendencies and reporting documents, such as energy balance of 2017.

Data collection activity would predominantly consist of the desk-based review of statistical reports, other relevant publications, and effective national policies and strategies across different sectors, supplemented by discussion with relevant stakeholders, within methodological workshop and afterwards, primarily of the *State Statistics Service, Ministry of environment and natural resources, Ministry of energy and coal industry, Ministry of regional development and construction, State agency for energy efficiency, TSO Ukrenergo* and others. The Project team will also communicate with the EBRD for the purpose of methodological expertise of energy and economic statistics, as well as data verification for the issues related to the assignment.

Data collection and structuring require maintaining commonly used statistical standards, such as applicability, feasibility and consistency. While economic, social and energy indicators for

the previous years could be grabbed from the official statistical reporting that in most cases is harmonized with the UNFCCC/IEA/EUROSTAT recommendations and internationally comparable, isolated and unrelated official documents and publications can hardly provide a solid basis for systematic description/scenario formulation of the economic and energy system development by 2050. For example, overall energy intensity indicators in 2030 and 2035 specified in the Energy Strategy of Ukraine by 2035 are not supported with consistent sectoral energy intensities, estimated energy consumption (demand) driven by sectoral drivers, such as industrial output (value added) or housing stock.

For this reason we propose to use mathematical models as a framework to structure and correlate perspective targets/statistical indicators derived from various official programs and strategies. Following such approach, we believe we can guarantee the consistency of historical data and projections, as well as the consistency of economic/sectoral, emissions, energy and technological indicators, while formulating modelling scenarios. Energy and emissions projections assessed by such approach would be well grounded and have an analytical background explaining their composition.

The following section provides an overview of the statistical data to be checked and updated.

Energy Supply Sector

The main data source on extraction / production of primary energy resources, as well as non-energy raw materials, such as iron ore, limestone, scrap metal, etc., is the annual primary statistics form 1P-NPP on Production of industrial products collected by the State Statistics Service. Extraction or production processes are represented by variety of technologies, and energy use per such process is derived from the primary statistics form 4-MTP - on the use of energy materials and oil products - and 11-MTP - on the use of fuel, heat and power collected by the State Statistics Service. Data on the RE capacity are derived from the reporting materials of the State Agency for Energy Efficiency.

The information on the preparation and transportation of energy and fuel is also derived from the 4-MPT and 11-MTP forms of the State Statistics Service, and also from the administrative data of the Ministry of Energy and Coal Industry (MECI).

The secondary energy resources production sector covers production of coke, coal briquettes and petroleum products. For this sector the main data source are 1P-NPP, 4-MTP, 11-MTP and 1-gas on the natural (liquefied) gas supply collected by the State Statistics Service.

Data on the international trade of energy and other resources is derived as a ten-digital CN code from the database of the State Statistics Service on the Export and import of certain types of goods by country. Information on the Stock changes of energy resources is derived from the 4-MTP form.

Power and Heat Generation Sector

The main data sources for the electricity and heat generation are 1P-NPP, 4-MTP and 11-MTP forms, statistical reports "Production and consumption of electricity, technical and economic indicators of power plants in Ukraine"; "The main indicators of heating boiler-houses and heating networks of Ukraine" prepared by the State Statistics Service. Besides, additional administrative information of the MECI is used:

- Production and distribution of electricity by power companies and power stations;
- Heat power generation by power companies and power plants;
- Operation of power units 150, 200, 300 and 800 MW;
- Use of fuel at power plants;
- Specific consumption of conditional fuel for electricity production by power companies and power plants of Ukraine;
- Specific consumption of conditional fuel for heat supply by power companies and power plants in Ukraine;
- Technological use of electricity for power transmission;
- Use (losses) of heat for its transportation in heat networks"; "Cost of electric and heat;
- Daily schedules of power consumption of UES of Ukraine.

Energy consumption by **Industry** reflecting composition of the Industrial sector according to the methodological approach of the energy statistics [48] mainly consists of the manufacturing industries, since energy use by energy production/transformation sub-industries is counted in other rows of the energy balance. The main data sources on production of commodities and energy consumption in Industry and **Agriculture** are 1P-NPP, 4-MTP and 11-MTP forms of the State Statistics Service.

Statistical information on the **Transport sector** is derived from the common 4-MTP and 11-MTP forms – on energy use, as well as from 4-TZ – number and technical condition of cars, buses, motor vehicles and trailers; 51-auto – volumes of cargo and passenger-rail transportation by rail transport of common use; 2-TR – work of motor transport; 2-ETR – operation of the city electric transport; 51-CA – main performance indicators of the aviation enterprise; 31-vod – transportation of goods and passengers by water transport; 1-trade (petroleum products) – sales of light petroleum products and gas, collected by the State Statistics Service. Besides, the database is filled in with information derived from the statistical report "Transport and Communications in Ukraine", as well as information from the Ministry of Internal Affairs of Ukraine on vehicles and their owners [49].

Information on the building sector, e.g. **Residential and Commercial sectors,** according to the energy statistics formulation (besides common 4-MTP and 11-MTP forms) is derived from various forms, surveys and reports, such as:

- Housing Stock of Ukraine; Availability of durable goods in households;
- Socio-demographic characteristics of households in Ukraine;
- Hotels and other places for temporary accommodation;
- Preschool education of Ukraine; General Educational Institutions of Ukraine;
- Basic indicators of activity of higher educational institutions of Ukraine;
- Establishments of Culture, Arts, Physical Culture and Sports of Ukraine;
- Establishments of health care and morbidity of the population of Ukraine;
- Network of retail and restaurant enterprises;
- Availability and use of the trading network in the markets;
- The main indicators of the water supply utilities in Ukraine;
- The main indicators of the gas industry in Ukraine issued by the State Statistics Service and Ministry of Regional Development of Ukraine.

The assessment of technology mix will be made using the TIMES-Ukraine model and its **new energy technologies database**, which includes information from the corresponding international and domestic databases, energy companies and sectoral associations:

- Energy Technology Perspectives 2017 (IEA) [50];
- Sustainable Development and the Application of Discounting to the Calculation of the Levelised Costs of Electricity (OECD) [51];
- Projected Costs of Generating Electricity (IEA, IAEA) [52];
- E-TechDS (The Energy Technology Systems Analysis Program, supported by IEA): Demand technologies [53]; Supply technologies [54];
- Current and Prospective Costs of Electricity Generation until 2050 (DIW Berlin) [55];
- DIW Berlin Discussion Papers [56];
- Levelized Cost of Energy and Levelized Cost of Storage 2018 [57];
- Bioenergy association of Ukraine [58];
- Wind energy association of Ukraine [59];
- Ukrainian association of renewable energy of Ukraine [60];
- NAEC EnergoAtom [61].

Statistical data and projections of the main **macroeconomic indicators,** such as GDP, population, number of households, added value and output by sector, etc. would serve as drivers for the energy and environmental projections. The main sources for macroeconomic statistics and projections are State Statistic Service of Ukraine, International Monetary Fund [62] and The World Bank [63]. We will also consider macroeconomic projections of the Institute for Economics and Forecasting, National Academy of Sciences of Ukraine [64], which are systematically updated and available from the IEF website. **Demographic projections** are normally derived from the recent estimations of the Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine, which are quite recent in line with the projection developed by the United Nations Department of Economic and Social Affairs [65].

Actual **energy commodity prices** are available from the reporting bulletins of the State Statistics Service and National Commission for state regulation in the energy and utilities of Ukraine [66], while price projection is commonly derived from the World Bank's Commodity Markets Outlook [67]. **Emission factors** used for calculations are consistent with the Ukrainian Greenhouse Gas Inventories [68] and Directive 2010/75/EU on industrial emissions [69].

Quite a big set of specific data would be collected, verified or updated for the needs of GHG emission projection in sectors other than energy and industrial processes. For the agriculture that is:

- population of main livestock – cattle, swine, sheep, poultry;
- consumption of feeds by livestock in Ukraine – green, coarse, succulent and concentrated;
- share of different manure management systems in manure storage – anaerobic lagoons, solid storage, liquid storage and others;
- areas and amount of crops harvested;

- amount of organic and mineral fertilizers applied;
- perspective development of the Agriculture;
- perspective food demand;
- perspective crop productions with consideration of climate change.

For LULUCF Sector:

- areas covered with forests with anthropogenic influence;
- species and age structure of forests;
- wood harvest rates and structure of forest cuttings;
- areas and severity of forest disturbances;
- areas of afforestation;
- areas and amount of crops harvested;
- amount of organic and mineral fertilizers applied;
- estimation of possible development of forest sector in the future;
- estimation of possible wood and woody products demand in the future

The Project Team has already started preliminary activities on data collection and processing. For example, the Project Team has made a request to the State Statistics Service for additional clarification for adjustments recently made to the energy balances of Ukraine for the years of 2015-2016, as well as regarding the differences on indicators estimated with an IEA and Eurostat approaches.

The statistical information on buildings sector (residential sector) was already checked upon data provided by the State Statistics Service. However, the State Statistics Service does not collect information regarding the non-residential building stock in Ukraine. Indicators relating to a non-residential building stock cannot be verified by any official sources, which greatly complicates the collection of such information and means that such data could only be obtained by indirect estimations. In order to obtain information on energy consumption by functional categories in the Residential and Services sectors, on construction period and construction costs, and on the age of the building stock, the corresponding request has been submitted by the Project Team to the State Statistics Service and the Ministry of Regional Development, Construction and Housing and Communal Services of Ukraine. Meanwhile the Project Team is looking for a ground approach to make own indirect estimations of these indicators.

Another example of the lack of information is that there is no statistical information on the use of the heat pumps in Ukraine. If there is no reliable information, the analysis of the Project team would be based on the available data on imports of heat pumps assuming that there is no domestic production of heat pumps – the approach that is currently used by the State Agency for Energy Efficiency of Ukraine.

Data collection and verification would be provided by the modelling team of the Project, namely – *Oleksandr Diachuk, Maksym Chepeliev, Sergey Shmarin, Igor Onopchuk and Roman Podolets*. Upon discussion of the reliability of available statistics and information gaps within methodological workshop, the Project team is making inquiries to the relevant state statistics and sectoral authorities. Data collection and processing process will be finalised during July 2019 that will allow sufficient time for the model's calibration and conducting modelling analysis.

SECTION 3. SECOND UKRAINIAN NDC METHODOLOGICAL WORKSHOP REPORT

The Methodological Workshop took place on March 13, 2019 and was aimed to present to the broad stakeholders interested in Ukraine's second NDC and to the members of Inter-Ministerial Working Group on Second NDC development, the methodological approach proposed for development of second Ukrainian NDC and to discuss the proposed approach with over 60 participants from ministries, state agencies, Parliament, academia, scientific community, business, NGOs, expert and professional associations, donors and technical assistance projects (see Appendix A for the list of participants). See Agenda of the workshop below and please, refer to the sepaparate file for the presentations.

AGENDA

Second Ukrainian NDC Methodological Workshop

EBRD Project Support to the Government of Ukraine on updating its Nationally Determined Contribution (NDC)

Institute for Economics and Forecasting, National Academy of Sciences of Ukraine

March 13, 2019, 26 Panasa Myrnoho Street, 2nd Floor Conference Hall

9:15 – 9:30	**Registration of Participants**
9:30 – 9:45	**Introductions and Opening Remarks**
	Ministry of Ecology and Natural Resources of Ukraine (MENR) *EBRD Project Support to the Government of Ukraine on updating its Nationally Determined Contribution (NDC)* *Institute for Economics and Forecasting, UNAS (IEF UNAS)*
9:45 – 10:00	**EBRD Project modelling scope and relevant CMA decision** *Project Team*
10:00 – 10:20	**What are the questions we want to be answered by modelling?** *Facilitated discussion*
10:20 – 10:40	**Best international practices in NDC modelling** *EBRD and Project Team*
10:40 – 11:00	**National long-term policies' gaps and how to address it in second NDC** *Project Team*
11:00 – 11:20	**Coffee break**
11:20 – 11:40	**Proposal on Ukraine's second NDC methodological approaches** *Project Team*
11:40 – 12:00	**Energy and the Industrial Process Sectors modelling and methodological approaches for NDC** *Project Team*
12:00 – 12:20	**Agriculture and LULUCF Sectors modelling and methodological approaches for NDC** *Project Team*
12:20 – 12:40	**Waste Sector modelling and methodological approach for NDC** *Project Team*
12:40 – 13:00	**Sustainable Development and NDC (fairness)** *Project Team*
13:00 – 13:30	**Which second NDC questions could be answered by proposed modelling approach?** **What are the questions that need political decisions for second NDC?** *Facilitated Discussion*
13:30 – 14:00	**Luncheon**

ANNEX I – GENERAL FACTS ABOUT UKRAINE, ITS GOVERNMENT AND LEGAL SYSTEM

Ukraine is a sovereign, independent, democratic, social, state with rule of law. Ukraine is one of the largest country in Europe with population of 45.6 million people as of 2012. Ukraine has continuous negative population growth rate since 2000, in 2017 annual population decline was 0.4%. Ukraine is located in Central-Eastern Europe with the territory of 603,550 sq. km, covering 5.7% of Europe.

Ukraine is one of the most populous countries in Europe, endowed with some of the world's most fertile soils which help make it an important agricultural producer and a major exporter of agricultural commodities, particularly grains and oilseeds. Ukraine also manufactures a broad range of industrial goods, mostly a legacy of its industrialization during the time of the Soviet Union. Industrial output has been shifting gradually from heavy to light industries and food processing, while Ukraine has maintained its significant aviation and aerospace sectors. Services sectors have expanded rapidly since the abandonment of central planning following independence in 1991.

The Constitution of Ukraine of 28 June 1996, as amended and supplemented until 2014, proclaims Ukraine a democratic State with power divided between the legislative, executive and judicial branches of government. Legislative power is vested in Ukraine's Parliament (the Verkhovna Rada of Ukraine), which consists of 450 People's Deputies elected by popular vote for five-year terms. Next Parliamentary elections will be held on 31 October 2019.

The Verkhovna Rada promulgates legislation in the form of laws, resolutions and other legislative acts. The laws lay down the basic rules for, *inter alia*, the exploitation of natural resources; the organization and use of domestic energy, transportation, and communication networks; and the protection of property and entrepreneurship. The Verkhovna Rada determines the main directions of foreign and domestic policies, approves economic policy programmes, develops antimonopoly and competition policy.

As Head of State, the President of Ukraine is the guarantor of state sovereignty, territorial indivisibility, and citizens' rights and freedoms. The President is elected directly by the people for a maximum of two consecutive five-year terms. The President approves laws adopted by the Verkhovna Rada, and he may also issue decrees and directives in the areas of international relations, defence, and other issues. He has the right to veto laws, return them to parliament for revision, or dissolve parliament under circumstances stipulated in Article 90 of the Constitution. The mandate of the President includes the negotiation and conclusion of international treaties, many of which are subsequently presented to the Verkhovna Rada for ratification.

The Cabinet of Ministers of Ukraine, headed by the Prime Minister, is formally proposed by the President and approved by the Verkhovna Rada. In addition to the Prime Minister, the Cabinet comprises a First Vice Prime Minister, Vice Prime Ministers, and Ministers that direct and coordinate the activities of 17 ministries and more than 40 state agencies, state services, and other central governmental bodies. Some of these entities report directly to the Cabinet of Ministers, while others are governed and coordinated by the Minister concerned.

The Cabinet of Ministers implements economic and social development programmes, as well as policies with respect to foreign economic activity, customs, taxation, investment, prices, or financial regulation through the issuance of resolutions and orders.

ANNEX II – UKRAINE'S FOREIGN POLICY AND INTERNATIONAL TRADE

CHANGES IN EXISTING FOREIGN RELATIONS AND ITS IMPACT ON ECONOMIC POLICIES

As a result of the temporary occupation of the Autonomous Republic of Crimea and the city of Sevastopol by the Russian Federation and its further military aggression in certain areas of the Donetsk and Luhansk regions, since 2014 slightly over 7 % of the territory of Ukraine temporarily remains out of control of the Government of Ukraine. The ongoing military aggression of the Russian Federation against Ukraine has a strong negative impact on the overall economic situation in Ukraine and has led to the reduction in industrial production.

The temporary occupation of the Autonomous Republic of Crimea and the city of Sevastopol as well as the Russian Federation military aggression in certain areas of the Donetsk and Luhansk regions is steadfastly condemned by international community, territorial changes by force are not recognized, sanctions remain in place till full compliance of the Russian Federation with international law. In particular, the UN General Assembly resolution 68/262 of March 27, 2014 «Territorial Integrity of Ukraine» confirmed the internationally recognized borders of Ukraine and the absence of any legal basis to change the status of the Autonomous Republic of Crimea and the city of Sevastopol. The same stance was confirmed by the UN General Assembly resolution 71/205 "Situation of human rights in the Autonomous Republic of Crimea and the city of Sevastopol (Ukraine)" of December 19, 2016, which unambiguously defines Russia as an occupying power. Besides that, numerous documents in support of Ukraine's territorial integrity within its internationally recognized borders were approved by the Committee of Ministers of the Council of Europe, Parliamentary Assembly of the Council of Europe, OSCE Parliamentary Assembly and other international organizations.

UKRAINE'S PARTICIPATION IN INTERNATIONAL COOPERATION

Ukraine was one of founding members of the United Nations and sign the United Nations Charter in 1945.

Ukraine is a Party to Paris Agreement, Annex I Party to UNFCCC and Annex B Party of Kyoto Protocol (the Doha Amendment has not been ratified yet). Under UNFCCC framework Ukraine is eligible for GEF support.

Ukraine is a member of IMF since September 3, 1992. Ukraine has joined the World Bank in 1992. Under World Bank classification Ukraine is Low Middle Income country with current GDP of US$ 12.9 billion and GDP per capita, current - US$ 2,522. In 2015 in Ukraine Life Expectancy at birth was 71.2 years.

Ukraine has been a member of the WTO since 16 May 2008.

Ukraine is not a member of IEA and not OECD country-member. At the same time Ukraine has worked with OECD for a quarter-century and getting support of Ukraine's efforts to transform its economy and integrate more deeply into international markets and institutions.

Ukraine co-operation with OECD is implemented under a Memorandum of Understanding between the OECD and the Government of Ukraine till 2020. Under the Action Plan agreed for the implementation of the Memorandum, the OECD supports reforms in Ukraine in three key areas identified as priorities by the government: anti-corruption; governance and rule of law, and investment and business climate.

Ukraine also has operational presence of various donors' organizations, IFIs and multilateral development funds that provide technical assistance and financial support in deference areas, including, *inter alia*, economic development, health care, human rights protection, building democratic society, institutional development and humanitarian response to military aggression of Russia. Donors' organizations and development programs that are active in Ukraine - UNDP, UNEP, IFC, IMF, UNHCR, IOM, UNAIDS, ILO, UNICEF, UNOPS, UN OCHA, FAO, WFP, WHO, UNPF, UNWOMEN, UNVolunteer, UN Office of High Commissioner for Human Rights, United Nation Office on Drugs and Crime, World Bank, EBRD, RfW, USAID, GIZ, SIDA, NEFCO, IKI and others.

TRADE POLICY

Ukraine acceded to the WTO in 2008 with wide-ranging commitments on market access for goods and services and few transitional arrangements vis-à-vis the WTO rulebook. Ukraine joined the Information Technology Agreement upon accession and the plurilateral Agreement on Trade in Civil Aircraft in 2010. The terms of Ukraine's accession to the plurilateral Agreement on Government Procurement were approved in November 2015.

After decades of centrally-planned industrial development within the Soviet Union, Ukraine as an independent nation favours market liberalization and economic reform as tools to raise living standards for its population and the further development of Ukraine's industrial, agricultural, scientific, technological, intellectual and cultural potential. Ukraine believes trade should be unhampered, based on transparent rules that are respected by all its trading partners. The period of accession to the WTO was used to push domestic reforms. Ukraine would like to be seen as a reliable, predictable partner for the entire international community. Its WTO Membership, followed by negotiations to forge a closer relationship with the European Union, has been pursued with a view to modernizing and harmonizing Ukraine's business legislation with best international practice, enhancing product standards and the compatibility of such norms across borders, and the creation of new, mutually profitable opportunities for trade.

EU ASSOCIATION AGREEMENT

Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Ukraine, of the other part has been ratified by the Parliament of Ukraine and the European Parliament simultaneously on September 16, 2014. On 1st September 2017, EU - Ukraine Association Agreement entered fully into force after a long period of ratification.

The Association Agreement in its scope and thematic coverage is the biggest international legal document in the history of Ukraine and the biggest international agreement with a third country ever concluded by the European Union. It defines a new format of relations between Ukraine and the EU on the basis of "political association and economic integration" and serves as a strategic guideline for systematic socio-economic reforms in Ukraine.

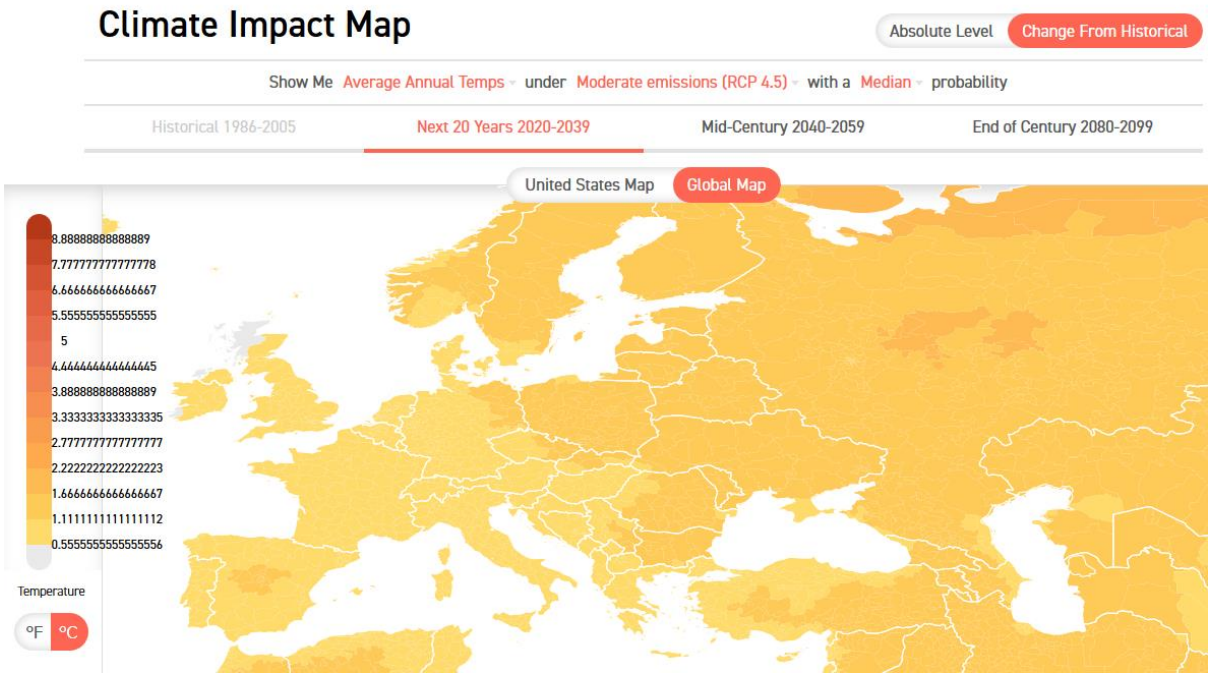
The chapter on Deep and Comprehensive Free Trade Area between Ukraine and the EU defines the legal framework for the free movement of goods, services, capital and partly labour force between Ukraine and the EU. It also defines regulatory convergence aimed at the gradual integration of Ukraine into the EU common market.

Ukraine is a Contracting Party of European Energy Community since 2011. Ukraine is a founding member of the Energy Charter Process and signed the International Energy Charter in May 2015.

CLIMATE

Climate of Ukraine is a temperate continental one, with subtropical Mediterranean climate at the South Coast of the Crimea. Generally, Ukraine gets sufficient amounts of heat and moisture, which create favorable natural and climatic conditions in its territory. However, those conditions have been changing substantially throughout recent decades, bringing about serious threats and challenges for country's sustainable development due to increased risks for human health, life and activities, natural ecosystems, and economy sectors.

The main manifestations of regional climate changes in Ukraine within the global warming processes include significant rise of air temperatures, changes of thermal regime and structure of precipitation, increased number of hazard meteorological phenomena and extreme weather events, which all result in losses for country's population and various economy sectors.



ANNEX III –UKRAINE'S CURRENT CLIMATE CHANGE PROJECTIONS AND RISKS

SUMMARY OF CURRENT CLIMATE CHANGE AND PROJECTIONS

Current climate change in Ukraine is characterized by asymmetric warming over the territory (larger in the north than in the south), pronounced in the winter and summer months.

During the period 2007-2016 annual air temperature were 1-2 °C higher than average temperature for the WMO reference period (1961-1990). Warming is masked by high natural temperature variability: in some years in some regions of the country cooling occurs. However, dynamics of averaged data over large intervals of time (10 years or more) shows warming particularly clearly.

Over the territory of Ukraine the number of days with the high air temperature (higher 30 °C), co-called heat waves, has increased. During 1986-2006 average number of such days in western and northern regions was 6-14, during 2007-2016 it became 13-28 days. In central and eastern regions it was 10-30 days, became – 24-45 days, in southern and south-eastern it was 17-38 days, became 30-60 days.

Frequency of days with maximum temperatures that higher 35 and 40°C almost doubled. Such dangerous hydro meteorological events pose a threat of drought, increased thermal stress and fire hazard.

Annual sum precipitation is one of the climatic indices of territory moistening. In Ukraine average annual sum precipitation for the reference period 1961-1990 makes 578 mm. During the period 1991-2017 it has not reduced, there was a slight increase (about 2%). However, there is a tendency of reducing of annual sum precipitation in southern areas of Forest-Steppe and Polissya.

In monthly sum precipitation there is a strong tendency to reducing on winter months – January and February on 3-11%, December – on 17%, but sum precipitations in summer and spring almost have not changed. On September and October, sum precipitations increased by 19-30%. The number of strong rainstorms has increased.

Rapid temperature rise and almost unchanged precipitations, both annual and during spring-summer period, affects moisterning, contributes to increasing areas and frequency of droughts.

Rising of air temperatures in the warm period is not only observed near the surface, but also in the lower troposphere and leads to an increased convection intensity, and, consequently, to increased frequency and intensity of convective weather events, such as thunderstorms, heavy rainfall, hail, squalls, and whirlwinds. These events are sometimes recorded in the months and seasons, when they did not occur before, and extend to the territories, where they have never been observed.

Due to rising of both the minimum and maximum air temperatures in the cold period, the number of days with sub-zero temperatures, freezing cold days with minimum temperatures dropping below -10, -20, -25^{o}C, as well as the duration of extremely cold periods have decreased. Rising of air temperatures in the cold period has significantly impacted on the frequency and intensity of extreme weather events of the cold period, such as shower snowfall, sleet, glaze and rime deposits. A trend towards their increase is observed in many regions of Ukraine.

With the aim to analyse possible climatic conditions over territory of Ukraine in the 21st century, the ensembles of ten regional climate models (RCMs) for air temperature and four RCMs for sum precipitation from the European project FP-6 ENSEMBLES for the scenario IPCC SRES A1B have been elaborated.

Three 20-year forecast periods have been examined: 2011-2030, 2031-2050, and 2081-2100. The analysis of projections of average air temperatures has shown that in the nearest period of 2011-2030, the average temperature over the territory of Ukraine will rise by 0.4-0.5oC against the current climate, ranging from 0.1oC in the western region in spring and up to 0.8oC in the northeast in summer. In the next 20-year period (2031-2050), the average temperature for the territory of Ukraine will increased by 1.2-1.5oC, ranging from 0.7oC in the west in spring and to 1.9oC in the northeast in winter. By the end of the century (2081-2100), the average temperature for the territory will rise by 2.9-3.3oC, with the minimum value of 2.1oC in the western region in spring, and the maximum temperature increase by 4.3oC in the southern region and in the south of the eastern region in summer. The smallest changes are projected for the western region in all seasons, as well as for all regions in spring for the whole century.

Projections for the moisture regime have greater uncertainty. Both increase and decrease of average monthly and seasonal sum precipitation is projected for the territory in all the reviewed periods. In the nearest period (until 2030), precipitation will be decreasing by up to 20% in the central, northern, and southern regions in summer and autumn, and will be increasing by up to 42% in the west, north, and east in winter and spring. By the middle of the century (2031-2050), precipitation will be decreasing by up to 30% in the central, southern, and eastern regions in summer, and increasing by up to 50% in the western, northern, and eastern regions and in the eastern part of the southern region in winter and spring. By the end of the century (2081-2100), precipitation will be decreasing by up to 40% in the southern, central, and eastern regions in summer and will be increasing by more than 40% and up to 50% in the west and north in the winter and spring seasons. Therefore, the maximum increase of average monthly precipitation is expected in winter and spring in the country's west and north in all the forecast periods. A decrease in the amount of precipitation is projected in the summer and autumn seasons in the central, southern, and eastern regions in all future periods.

OVERVIEW OF VULNERABILITIES / RISKS

Agriculture

The projected increase in the average annual temperature in Ukraine up to 2030 (in addition to the current state) will lead to further reduction of winter, changes in the length of the growing season as a whole, which will lead to further increase of heat resources in all agro-climatic zones of Ukraine. This will allow growing a larger set of crops and their varieties, whose cultivation is currently limited in some regions (west, north of the country) by insufficient heat.

The frequency of such phenomena as "heat waves" is projected to increase by 1.5 times, and prolonged periods of heat with temperatures up to +35°C will spread to the northern and western regions, which will lead to anticipatory maturation of spring crops and decrease their yields.

By 2030 on average in Ukraine, only due to climatic conditions, the average yield of winter wheat can increase by 20-30%. The risks of growing (reducing the yield) of winter wheat by

2030 are the lowest compared to spring crops. Favorable climatic conditions can be expected for growing winter rape in most areas of Polissya, and unfavorable - in the regions of southern Steppe, Polissya and Forest-steppe. By 2030 the yield of spring barley is possible to be increased on average by 15-20%. However, in southern and south-eastern regions, spring barley on average every 3-4 years in the critical period of development may be subject to high temperatures and droughts, which will reduce the period of vegetation and reduce yield by 15-25%. There are low risks of lack of yield (from 0 to 5%) for corn in the Carpathian, Transcarpathian regions and areas of the Western Forest-Steppe. The maximum level of risk (the short received harvest can reach 20-30%) is likely in the Southern Steps. In the period up to 2030, in certain years weather conditions will contribute to the high yield of sunflower seeds, and vice versa, there may be very unfavorable conditions that will cause productivity decline in the southern regions. By 2030, heat supply in all soil-climatic zones will probably meet the needs of sunflower, except for the northern and western regions of Polissya. However, due to the increased need for moisture (more than 350 mm of precipitation during the growing season), the limit of cost-effective cultivation of this crop will shift to the forest-steppe zone. In the Steppe the crop will be very low - the risks (probable lack of harvest) will be 20-30%.

However, after 2030, the risks for growing main crops with a possible yield will decrease by 10-60% in some years will increase due to growing frequency and severity of droughts during the growing season, an increase in the frequency and intensity of extreme hydrometeorological events in the warm season (heavy rains, thunderstorms, tornadoes, squalls, hail, etc.), reducing the frequency of precipitation with increasing intensity of heavy rainfall, the lack of sustainable snow cover, increasing entomological threat.

In animal husbandry, elevated air temperatures will affect thermoregulation processes in animal organisms, which will require additional energy costs and reduce their productivity and reproductive capacity. When warming, there might be probable problems with the availability of adequate feed resources, their variety and quality, availability of drinking water. An increase in the average annual temperature will increase the populations of local carriers of infectious diseases, and warm winters will contribute to the endemization of exotic pathogens in Ukraine, creating the basis for the spread of exotic animal diseases.

Energy sector

The energy infrastructure is mostly obsolete and not designed for the observed and expected climate change. This makes it possible to manifest emergency situations and accelerate the destruction of the elements of this infrastructure in extreme weather events.

In particular, extreme weather events such as squalls, heavy rainstorms, tornadoes, hailstones, and complex sediments will contribute to an increase in emergencies in power grids, which will result in significant economic losses, increased social tensions, and security challenges. Wind power plants (WPP) are negatively affected by the increase in the number of accidents. The increasing rainfall, in conditions of high acidity, will contribute to the corrosion of steel structures of the energy infrastructure.

The high temperatures in summer will reduce the generation of electricity at the nuclear power plants through regime restrictions, reducing power and efficiency in the thermal power plants, combined heat and power plants and nuclear power plants as a result of rising water

temperatures in the cooling systems, and increasing electricity losses in the grids. Reducing river runoff will reduce the potential of hydropower.

The combined effect of these factors leads to the emergence of two groups of risks, namely:

1. Risks caused by the growth of emergency situations in the country's energy supply systems with an increase in the frequency of extreme climatic events and their intensity, which leads to disconnection of consumers from centralized electric and thermal energy supply systems, as well as gaseous fuel; untimely supply of fuel resources, which causes the occurrence of their shortage among consumers.

2. Risks caused by the inconsistency of the energy supply system with the levels and modes of energy consumption, which makes it necessary to impose restrictions on the supply of fuel and energy resources to consumers through regime restrictions, insufficient capacity of production sources and / or transportation (distribution) of fuel and energy resources. The probability of emergency shutdowns of consumers from energy sources and / or the inability to use their own sources of energy supply increases due to the lack of necessary fuel resources as a result of emergency situations.

Water resources

Ukraine currently belongs to a group of countries with limited water reserves, having the lowest water reserves in Europe. Thus, an increase of air temperature with a constant amount of precipitation can lead to a decreased summer runoff of rivers. As a result, water demand will increase considerably (and fresh water supplies will decrease); in summer, hydrological droughts are forecasted to become twice as frequent in the middle of the XXI century. The volumes of precipitation in regions and seasons redistributed: during wintertime, the precipitations generally decrease, during the autumn they increase, while in the summer and spring their volumes do not change. The cases of abnormal amount of rain or snow falling within several hours become more frequent. This increases the intensity of droughts and causes non-accumulation of water in the soil. By 2050, the area of water resources reduction is expected to expand from the south to the north of Ukraine. Due to climate change, destruction of water resources of the steppe zone is probable, and water resources growth will take place in the Carpathians region.

In the context of the average annual flow, only an increase in the runoff of up to 10% can be expected for the Polissya rivers. In the Dnipro River and the rest of Ukraine's rivers, the runoff will decrease, most significantly (over 30%) in the Black Sea rivers. By 2040, some rivers in the south and east of Ukraine may stop flowing. In general, during the XXI century in Ukraine, the reduction of surface water runoff is expected. At the same time, the quality of surface water will deteriorate, which will require both additional measures for water purification and possible transportation of drinking water in the southern and southeastern regions. Quality of drinking water is expected to deteriorate particularly in cities.

In the Carpathian region and in the northern part of Ukraine (the basin of the Desna River) in autumn and, especially in summer months, the intensity of floods will increase significantly. In winter, the probability of flood formation also tends to increase.

Human health

The increased temperature will result in a change in the state of the natural cells of infectious diseases. Existing borders of malaria mosquito ranges will move to the north, possibly replacing the northern populations with the southern ones. Fixation of exotic carriers of infectious diseases in new territories0 is also possible. Due to the sharp fluctuations of weather conditions, the frequency of exacerbations of cardiovascular diseases will increase, and in summer the temperature rise and long periods of hot waves can increase mortality due to overheating and the associated deterioration of chronic diseases.

Climate change, in case of inactivity, can affect human health through drinking water, food and other environmental factors. The more frequent periods of prolonged heat can affect the supply of food and water quality, which will create even more threats to the health of the population. Cases of acute gastroenteritis will be more frequent as the temperature rises and the water quality problem worsens.

Forests

In Ukraine, the productivity of forests decreases mainly due to the effects of high temperatures and water stress. The main problem for forest vegetation with an increase in climate drought is the conditions under which the need for evapotranspiration for a warmer and deeper climate is not balanced by the precipitations.

Due to climate change until the end of the twenty-first century, large enough areas with unfavorable conditions for the growth of almost all main forest species are expected and the probability of changing zonal types of vegetation of plovers due to the shift of areas of natural distribution of forest tree species is expected. In areas with adverse climatic conditions, a significant decline in productivity of forest species, a gradual loss of reproductive capacity and the possibility of natural regeneration, a violation of the cycle of seasonal development and even ontogenesis, reducing resistance to pests and diseases, and increasing the threat of forest fires is projected. Among the investigated tree species, the smallest changes in areas favorable for the growth and development of forests will be observed for oak ordinary and black alder, and the biggest - for European fir, common pine and European beech.

Coastal zones of Black and Azov Seas

Climate change coupled with natural causes lead to level rise of Black and Azov Seas . By 2100, about 0.65-1.5 million ha of coastal territory is expected to be flooded. Overall sea level rise might reach 0.82 m. Due to storms, the level of Black and Azov Seas might additionally rise up to 1 m. 35 cities and towns in Crimean peninsula, Kherson and Odessa regions are expected to be flooded, affecting lives of 110.000 inhabitants. Currently available stone and reinforced concrete anti-wave reinforcements will be fully inefficient, which would worsen the erosion of tall coastal areas. This, in turn, will ruin coastal buildings and infrastructure even in areas free from flooding. About 200 thousand ha of agricultural land, more than 10 thousand ha of forests together Danube and Black Sea biosphere reserves are expected to be fully flooded.

ANNEX IV – MITIGATION ANALYSIS MODELS

OPTIMIZATION ENERGY SYSTEM MODELS

MARKAL was developed in a cooperative multinational project over a period of almost two decades by the Energy Technology Systems Analysis Programme (ETSAP) of the IEA.

MARKAL is a generic model tailored by the input data to represent the evolution over a period of usually 40 to 50 years of a specific energy system at the national, regional, state or province, or community level. The number of users of the MARKAL family of models has multiplied to 77 institutions in 37 countries, many with developing economies, promising to continue and broaden these accomplishments.

The ETSAP executive committee has decided to promote TIMES for new users starting winter 2008. However, MARKAL code will continue to be supported in its current form and it is still an option for new users who may have their own reasons to choose it over TIMES.

The ***TIMES*** (The Integrated MARKAL-EFOM System) model generator was developed as part of the IEA-ETSAP, an international community which uses long term energy scenarios to conduct in-depth energy and environmental analyses (Loulou et al., 2004). The TIMES model generator combines two different, but complementary, systematic approaches to modelling energy: a technical engineering approach and an economic approach. TIMES is a technology rich, bottom-up model generator, which uses linear-programming to produce a least-cost energy system, optimized according to a number of user constraints, over medium to long-term time horizons. In a nutshell, TIMES is used for, "the exploration of possible energy futures based on contrasted scenarios" (Loulou et al., 2005).

TIMES models encompass all the steps from primary resources through the chain of processes that transform, transport, distribute and convert energy into the supply of energy services demanded by energy consumers (Loulou et al., 2005). On the energy supply-side, it comprises fuel mining, primary and secondary production, and exogenous import and export. The “agents” of the energy supply-side are the “producers”. Through various energy carriers, energy is delivered to the demand-side, which is structured sectorally into residential, commercial, agricultural, transport and industrial sectors. The “agents” of the energy demand-side are the “consumers”. The mathematical, economic and engineering relationships between these energy “producers” and “consumers” is the basis underpinning TIMES models.

The TIMES and the MARKAL models share the same basic modelling paradigm. Both models are technology explicit, dynamic partial equilibrium models of energy markets. In both cases the equilibrium is obtained by maximizing the total surplus of consumers and suppliers via Linear Programming. The two models also share the multi-regional feature, which allows the modeller to construct geographically integrated (even global) instances.

However, there are also significant differences in the two models, but these differences do not affect the basic paradigm common to the two models, but rather some of their technical features and properties [70]:

- MARKAL has fixed length time periods. However TIMES allows the user to define period lengths in a completely flexible way.

- In MARKAL, only two commodities (electricity and low temperature heat) have time-slices, but in TIMES, any commodity and process may have its own, user-chosen time-slices.
- In MARKAL processes in different sectors are endowed with different (data and mathematical) properties, but in TIMES, every process has the same basic features, which are activated or not solely via data specification.
- In MARKAL processes are by definition rigid, except for some specialized processes which permit flexible output, and thus outputs and inputs are in fixed proportions with one another. In TIMES, the situation is reversed, and each process starts by being entirely flexible, unless the user specifies certain coefficients to rigidly link inputs to outputs.
- MARKAL has very few commodity related variables, namely exports/imports, and emissions. TIMES has a large number of commodity-related variables. This allows the user many "handles" to put limits, and costs on commodities.
- In MARKAL each investment is assumed to be paid in its entirety at the beginning of some time period. In TIMES the timing of investment payments is quite detailed.

Associated Costs: Model generator source code is free. GAMS/Solver: $640 academic; $12,800 commercial. Model management system (VEDA or ANSWER): $1,800 academic; $12,000 commercial.

PLEXOS has a range of features that seamlessly integrates electric, water and gas systems and is the preferred choice for co-optimization modelling. It uses an innovative approach to problem-solve these sophisticated levels of constraints and uncertainties.

The traditional approach to simulation involves developing a solution to a defined problem. However within the electric industry, there are many unique, overlapping "problems" including long-term capacity planning, system reliability, portfolio optimization and more. The traditional approach is to write a software solution for each problem, which leads to inconsistencies between solutions, duplicated code, slow computing time and increased costs.

Rather than providing a solution to a problem, PLEXOS itself is a problem-solving engine. Across all problems, there are common themes and requirements. PLEXOS expresses these in an 'extensible object model' (a consistent set of building blocks with features that can easily be extended as needed in the future). The intelligence of the simulation engine then reads the user's data and settings to develop a solution method for the exact problem the user defined.

Optimization-based simulation tools, like PLEXOS, benefit from the multiplicative combination of CPU and algorithm improvement, which has improved by approximately 500-fold since 1999. This performance improvement resulted in a natural expansion (both vertically and horizontally) of the market as the number of customers for simulation grew due to more sophisticated solving capabilities. Because of its scalable design, PLEXOS is substantially better placed to capitalize on market expansion due to the multiplicative combination of CPU and algorithm improvement.

LEAP, the Long-range Energy Alternatives Planning System, is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute.

LEAP is not a model of a particular energy system, but rather a tool that can be used to create models of different energy systems, where each requires its own unique data structures. LEAP supports a wide range of different modelling methodologies: on the demand side these range from bottom-up, end-use accounting techniques to top-down macroeconomic modelling. LEAP also includes a range of optional specialized methodologies including stock-turnover modelling for areas such as transport planning. On the supply side, LEAP provides a range of accounting, simulation and optimization methodologies that are powerful enough for modelling electric sector generation and capacity expansion planning, and which are also sufficiently flexible and transparent to allow LEAP to easily incorporate data and results from other more specialized models.

LEAP has been adopted by thousands of organizations in more than 190 countries worldwide. Its users include government agencies, academics, non-governmental organizations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications.

LEAP is fast becoming the de facto standard for countries undertaking integrated resource planning, GHG mitigation assessments, and LEDS especially in the developing world, and many countries have also chosen to use LEAP as part of their commitment to report to the UNFCCC. At least 32 countries used LEAP to create energy and emissions scenarios that were the basis for INDCs: the foundation of the historic Paris climate agreement intended to demonstrate the intent of countries to begin decarbonizing their economies and invest in climate-resilience.

LEAP is an integrated, scenario-based modeling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy. It can be used to account for both energy sector and non-energy sector GHG emission sources and sinks. In addition to tracking GHGs, LEAP can also be used to analyze emissions of local and regional air pollutants, and short-lived climate pollutants (SLCPs) making it well-suited to studies of the climate co-benefits of local air pollution reduction.

MESSAGE is a model designed to formulate and evaluate long term strategies by analysing cost optimal energy mixes consonant with user defined constraints on new investment, market penetration rates for new technologies, fuel availability and trade, environmental emissions, and energy supply security.

Originally MESSAGE was developed by IIASA. In 2001, it was acquired by the IAEA and enhanced by with new features and user interface.

MESSAGE was designed to help energy analysts and decision makers in analysing different supply strategies for building sustainable energy systems. It is an optimization model, applicable for medium- and long-term analysis at country or regional levels. It can help design long-term strategies by analysing cost optimal energy mixes, investment needs, and other costs, energy supply security, energy resource utilization, introduction of new technologies, environmental policies, and other parameters.

Outcomes of the MESSAGE model:

- Primary and final energy mix
- Emissions and waste streams

- Health and environmental impacts (externalities)
- Resource use
- Land use
- Import dependence
- Investment requirements, O&M costs, fuel costs

SIMULATION ENERGY SYSTEM MODELS

The nonlinear, equilibrium ***ENPEP-BALANCE*** model matches the demand for energy with available resources and technologies. It was developed by Argonne National Laboratory in the USA in 1999. The exact number of users is not known but it is in use in over 50 countries. The model is free.

ENPEP-BALANCE uses a market-based simulation approach to determine the response of various segments of the energy system to changes in energy prices and demand levels. The analysis is carried out on an annual basis for up to a maximum of 75 years, typically on national energy-systems. The model relies on a decentralized decision-making process in the energy sector and can be calibrated to the different preferences of energy users and suppliers.

ENPEP-BALANCE simultaneously finds the intersection of supply and demand curves for all energy supply forms and all energy uses included in the energy network. Equilibrium is reached when the model finds a set of market clearing prices and quantities that satisfy all relevant equations and inequalities. The model employs the Jacobi iterative technique to find the solution that is within a user-defined convergence tolerance.

GCAM is a simulation model that combines representations of the economy, energy supply, transformation and demand; agriculture and land use; and climate to examine the scenarios of the coming decades and beyond. The model has been used to inform technology and policy strategy decisions and to create scenarios used in every major IPCC assessment since 1990. GCAM is global, but several regional versions have been constructed.

GCAM produces a wide range of variables contingent on input assumptions for future population, economy, technology, and environmental policies. These include:

- Energy supply and demand by sector, technology, and fuel for 32 geo-political regions
- Land-use and crop production for 283 land regions
- Endogenous price paths for energy and agricultural goods
- Greenhouse gas and pollutant emissions
- Climate policy costs

MAED is a model that provides a systematic framework for mapping trends and anticipating change in energy needs, particularly as they correspond to alternative scenarios for socioeconomic and technological development. It takes into account different types of energy forms (including traditional fuels) in all economic and consuming sectors and subsectors at end-use level.

MAED is designed to help energy analysts and decision makers to analyze future energy demand for building sustainable energy systems. It is a simulation model, best applicable for the medium- and long-term analysis at country or regional levels, based on the bottom-up

scenario approach. It reflects the structural changes in energy demand, by means of detailed analysis of social, economic, and technological factors.

Outcomes of MAED: useful and final energy demand by sectors/subsectors and fuels; electricity demand; hourly electric load; load duration curves.

APPLICATION AND COMPARISON OF ENERGY SYSTEM MODELS

According to the Resource Guide for Preparing the Nationals Communications of Non-Annex I parties of the UNFCCC, the list of the modelling tools for mitigation assessment include a set of four models namely LEAP, ENPEP, TIMES and RETScreen as examples of bottom-up model that can be used in the mitigation analysis of the energy sector.

In this framework different countries chose to utilise different tools depending on the availability of data for the analysis. Indonesia, Thailand and Vietnam used LEAP model to develop their emissions scenarios, because it is easy to use and has manageable data requirements, However, Vietnam is currently using TIMES for contributing to the development of the NDC. Georgia and Costa Rica have also used MARKAL/TIMES based national models for analysing mitigation options. Indonesia developed their INDC using LEAP together with an Asia-Pacific Integrated Model (Computable General Equilibrium model) coupled with agriculture, forestry, and other land use (AFOLU/LULUCF) model.

The limitations to modelling are mainly connected to gaps and uncertainties in the input data. In Bangladesh and Nigeria the LEAP model was used, which ensured a robust and scientific modelling approach, given the data limitations. In Colombia, Peru and Kenya modelling was carried out in MS Excel.

Mexico's NDC was informed by EPPA[5] and POLES[6] as well as sector-specific models. POLES was chosen because the model had already been developed for Mexico and the funding was available to develop it further.

The modelling of the Colombia INDC was carried out using various models, including LEAP for the power sector, MARKAL, and Excel based tools for the transport and forestry sectors. An overall Excel model then brought all sectors together. These sector models were chosen because they were well understood and validated, and best represented the sectors concerned. Some of these models had also been used since 2011 for the development of the national low carbon strategy (Estrategia Colombiana de Desarrollo Bajo en Carbono), so information was available on mitigation scenarios and potential. The outputs from the different sector models provided inputs to an Excel spreadsheet that calculated the overall total baseline CO_2 emissions and the CO_2 reductions under different scenarios.

[5] Emissions Prediction and Policy Analysis (EPPA) developed by the Massachusetts Institute of Technology (MIT). EPPA is a computable general equilibrium (CGE) model of the world economy. It is built on the Global Trade Analysis Project (GTAP) database and additional data about GHG and other pollutant emissions. The EPPA model can be used as a stand-alone model of the global economy for the study of greenhouse gas emissions and environmental policy. It also is a component of the MIT Integrated Global Systems Model (IGSM). EPPA is a regional model that models some of the larger countries individually, including Mexico, Brazil, Russia, India and China.

[6] The Prospective Outlook on Long-term Energy Systems (POLES) model is a world simulation model for the energy sector comprising 66 countries/regions modelled in annual steps to 2050.

In India, TERI contributed energy system modelling using MARKAL to the INDC process. Other models used for the INDC included LULUCF modelling of carbon sinks and a CGE type model. The MARKAL model was 'hard linked' to other models that allow assessment of air pollution, health and other co-benefits, and economic impacts. In this way it could be considered an integrated assessment model rather than just an energy system model. A lesson from the experience in India was that it is important to look at the co-benefits from NDC measures, and so an integrated assessment model is ideal. The model used for the INDC has been further developed since 2015 to include linkages to water and land use.

The following table IV present a basic analysis of the various energy system tools that are used globally.

Table IV.1. Comparison of modelling tools

Model (Developer)	Purposes	Model structure (assumptions)	Geographical coverage	Sectoral coverage	Time horizon	Time step
LEAP (Stockholm Environmental Institute Boston, USA)	General: Exploring, forecasting Specific: Demand, supply, environmental impacts. Integrated approach. the objective includes energy policy analysis, environmental policy analysis, biomass- and land-use assessment, pre-investment project analysis, integrated energy planning, full fuel cycle analysis. Applicable to industrialised as well as developing countries	Supply: simple description of end-uses and supply technologies, including some renewable. Demand: rather high degree of endogenisation and description of all sectors in economy	Local, national, regional, global.	All sectors (incl. industry, transport, household, service and agriculture).	Medium, long term	Annual
MARKAL (International Energy Agency, IEA/ETSAP)	General: Exploring	Focuses only on the energy sector, detailed description of end-uses and (renewable) energy technologies possible. Options are available to model the internalisation of certain external costs, endogenous technological learning and the representation of uncertainty.	Local, national, multi-national.	Energy sector (all subsectors including industry, transport, household, service and agriculture).	Medium, long term	User-defined
MESSAGE-III (International Institute for Applied System Analysis, IIASA, Austria)	General: Exploring Specific: Energy demand and supply, environmental impacts. Modular package. the objective includes generation expansion planning, end-use analysis, environmental policy analysis, investment policy.	Detailed description of energy end-uses and (renewable) energy technologies Supply: Modelled Demand: Exogenous	Local, national, multi-national.	Energy sector.	Short, medium, long term.	User-defined, but a multiple number of years

Model (Developer)	Purposes	Model structure (assumptions)	Geographical coverage	Sectoral coverage	Time horizon	Time step
OSeMOSYS (Open source research community incl. UCL)	General: Exploring Specific: Modular package. Energy supply and demand with constraints. Technologically implicit and very easy to use.	Limited learning curve and time commitment to build and operate Supply: Modelled Demand: Exogenous	Flexible	Energy sector	Medium, long term. 2010–2050. 3 seasons (summer, intermediate, winter), 2 intraday (day, night)	5-year
POLES (European Commission)	General: ForecastingSpecific: Detailed econometric, long-term global energy outlooks with demand, supply and price projections by main region, CO2 emission MAC curves, and emission trading systems analyses, technology improvement scenarios, with exogenous or endogenous technological change	All energy prices are determined endogenously and the endogenous price forming mechanism cannot model the price volatility induced by short term market expectations and/or geopolitical instabilities. Supply: Simulated Demand: Simulated	Global (split into 47 regions)	15 energy demand sectors	Up to 2050	Yearly
PRIMES (National Technical University of Athens, NTUA)	General: Exploring Specific: Provides detailed projections of energy demand, supply, prices and investment to the future	Tariffs and prices are endogenous, reflecting costs and market conditions. Closed-loop between demand and supply. System-wide constraints influence all sectorial sub-models. Self-supply of energy services is also priced. Perceived costs and uncertainty factors are included and are related to policies. Supply: Simulated Demand: Simulated	EU28 member-states and Western Balkans countries (Albania, Bosnia-Herzegovina, FYR of Macedonia and Serbia including UNMIK and Montenegro), Switzerland, Norway and Turkey.	All energy sectors	Medium to long-term	Yearly
TIMES (International Energy Agency, IEA/ETSAP)	General: Exploring Specific: Decarbonisation pathways, technology assessment, least-cost assessment.	Energy supply with constraints. Planning through a least cost approach. Supply: Modelled Demand: Driven by exogenous parameters (GDP, Population etc).	Global, national, regional, local	All energy sectors	Medium, Long term.	Commodities may have their own, user-chosen time-slices. These flexible time-slices are segregated into three groups: seasonal (or monthly), weekly (weekday vs weekend), and daily (day/night).

Table IV.1. Part II

Model (Developer)	Renewable technology inclusion	Storage technology inclusion	Transport inclusion	Residential inclusion	Cost inclusion
LEAP	All technologies	All technologies	Road Rail Air Water	Lighting, Cooking, Heating Appliances, Building shell (split into rural and urban)	All energy related costs
MARKAL/ TIMES	All technologies can be included	Night-day storage and inter-seasonal storage. Storage Plants. Pumped storage. Individual demand devices can be operated as night storage devices	User defined (Any breakdown of the transport sector can be set up based on data availability)	User defined (Any breakdown of the residential sector can be set up based on data availability).	The total cost includes the following elements: 1) Annualized investments in technologies; (2) Fixed and variable annual Operation and Maintenance (O&M) costs of technologies; (3) Cost of exogenous energy and material imports and domestic resource production (e.g., mining); (4) Revenue from exogenous energy and material exports; 5) Fuel and material delivery costs; 6) Welfare loss resulting from reduced end-use demands. (elastic demand); 7) Taxes and subsidies associated with energy sources, technologies, and emissions.
MESSAGE-III	User-defined. Technologies are defined by their inputs and outputs, their efficiency and their variability if more than one input or output exists	Storage and conversion technologies can be simulated in MESSAGE as well as carbon sequestration	Not included	Not included	Economic characteristics include investment costs, fixed and variable operation and maintenance costs, imported and domestic fuel costs and estimates of levelised costs and shadow prices. User defined constraints on new investment rates
OSeMOSYS	Flexible due to modular design (Any combination of input fuels to produce any combination of output fuels)	Flexible due to modular design (Any combination of input fuels to produce any combination of output fuels)	Flexible due to modular design (Any combination of input fuels to produce any combina-tion of output fuels)	Flexible due to modular design (Any combination of input fuels to produce any combination of output fuels)	Costs incurred by each technology, incorporates daily operation of power plants
POLES	Combined Heat and Power Biomass Solar PV Solar Thermal Small Hydro Wind (Onshore & Offshore) Biofuels for transport Fuel Cell Vehicle (PEM) Stationary Fuel Cell (Gas, Hydrogen)	CCS	Road (passenger and goods) Rail (passenger and goods) Air transport	Fuel and electricity costs Renewable technology vehicles	Detailed assessment of the costs associated with the development of low- or zero-carbon technologies
PRIMES	Thermal solar Geothermal Biomass and waste (5 bio-energy types and several feedstock types) Solar PV Solar thermal Wind (Onshore & Offshore) Hydro (lakes, run of river) Tidal Wave energy	Several electricity storage technologies including hydro with reservoir, hydro pumping, compres-sed air storage and hydrogen-based storage	Passenger and goods transport (including subdivisions)	5 categories of dwelling 5 typical ener-gy uses Elect-ric appliances are considered as a special sub-sector	Explicit cost analysis,. Including capital costs, variable costs, O&M, etc Inclusion of taxes, subsidies, certificate prices, congestion fees, tariffs for use of infrastructure

Table IV.1. Part III

Model (Developer)	Analytical approach	Underlying methodology	Mathematical approach	Data Reqs
LEAP	Hybrid	Accounting model	Not available	Quantitative, monetary, aggregated, disaggregated. (Low data requirements due to lack of optimisation)
	(Demand: top-down, supply: bottom-up)	Demand: econometric or macro-economic.		
		Supply: simulation		
MARKAL	Bottom-up.	Optimisation	Linear programming, dynamic programming, Mixed Integer programming.	Quantitative, monetary, disaggregated.
MESSAGE-III	Bottom-up	Optimisation.	Dynamic programming	Quantitative, monetary, disaggregated.
OSeMOSYS	Bottom-up	Optimisation (uses LEAP interface)	Linear Programming, Can be mixed-integer programming	Quantitative, monetary, disaggregated
PRIMES	Hybrid	Agent based	Equilibrium model	Quantitative, monetary, disaggregated
POLES	Hybrid	Cost minimisation, Simulation	Recursive dynamic, Partial Equilibrium framework	Quantitative, monetary, disaggregated.
TIMES	Bottom-up	Cost Optimisation, Toolbox	Linear Programming, Dynamic programming, Mixed integer programming.	Quantitative, monetary, disaggregated

EXAMPLES OF TIMES MODEL USED FOR INTEGRATED ENERGY AND CLIMATE POLICY ANALYSIS

The TIMES energy system modelling framework has been applied in a number of countries for National energy and climate policy analysis (Table IV.2). The following table gives an overview of the European and non-European countries that are using the model:

Table. IV.2. The TIMES energy system modelling by country

Country	Model	Relevant Policy supported by the model analysis.
Greece	TIMES-GR: 14 geographical regions national TIMES model developed and used in CRES. It includes detailed RES potential for each region, consumption and energy efficiency actions in all the demand side sectors, together with a simplified representation of the transmission grid.	National Energy and Climate Plan (December 2018) submitted to the European Commission. National Energy Planning. Roadmap to 2050, Min. of Environment and Energy (March 2012) [71]. National Renewable Energy Action Plan, Min. of Environment and Energy (2010) [72]. National Energy Efficiency Action Plan, Mon. of Environment and Energy (2014) [73].
UK	UKTM: UK TIMES Energy System model [74] developed in UCL [75], used for policy advice to Department of Energy and Climate Change (DECC).	5th Carbon budget to 2030 (DECC 2016). CCC Budgets 1-4 (DECC 2010-2015). Carbon Plan (DECC 2012-2014).
Ireland	Irish TIMES: Ireland TIMES energy system model developed by University College Cork (UCC) and used for providing	

Country	Model	Relevant Policy supported by the model analysis.
	advice to Sustainable Energy Authority Ireland (SEAI).	Negotiations of the emissions allocation for Ireland (SEAI 2015).
Spain	TIMES-Spain: A TIMES model for Spain developed by CIEMAT [76].	Synergia: Development of the Spanish integrated **National Energy and Climate Plan** in compliance with the 2030 policy framework of the EU´s Energy Union strategy. (Ministerio de Industria, Energia y Turismo 2016-2018)
Portugal	TIMES-PT: A single region TIMES model for Portugal developed by CENSE FCT/UNL [77].	Contribution to the **National Energy and Climate Plan** (Jan 2019). Green Tax Reform (Min. Environment Spatial Planning and Energy 2014). PNAC 2020 - Programa Nacional para as Alterações Climáticas (Ministry of Environment Spatial Planning and Energy 2014). Low Carbon RoadMap: Portugal 2050-Energy and Waste Greenhouse emissions (Executive Committee of the Climate Change Commission 2012).
Finland	TIMES-Finland: A TIMES model developed by VTT [78] used in the analysis of scenarios for the relevant Ministry.	Used together with other models in the preparation of the National Energy and Climate Plan (Dec. 2018) submitted to the EU Energy and Climate Roadmap 2050 (Min. of Employment, Economy, Energy and Climate 2014).
Sweden	TIMES-Sweden: A single region TIMES model for Sweden developed in the Univ. of Lulea [79] and Chalmers University. MARKAL-NORDIC has been used for modelling the power and district heating sectors in the official Swedish long-term energy scenarios. Most recent. TIMES-NORDIC are used for modelling the power and district heating sector in the official long-term energy scenarios for Sweden by the Swedish Energy Agency. TIMES-Sweden was used for modeling climate pathways for the comprehensive Swedish energy system in 2016, ahead of deciding on long-term national climate target. TMES-Nordic was used to assess the power and district heating sector in the previous National Biennial report to UNFCCC During 2018, TIMES-Sweden has been used for different scenario analysis for the Swedish Environmental protection agency, as input to the new national climate plan.	Supporting policy formulation by the Swedish Energy Agency.
Denmark	TIMES-DK: A multi-regional TIMES model developed by Danish Technical University (DTU).	Supporting the Danish Energy Agency for the achievement of the 100% renewable energy by 2050 policy target.
Belgium	TIMES-Belgium: A TIMES model for Belgium which is developed by VITO [80] is used for policy analysis.	Beleidsnota energie 2014-2019 (Flemish Government 2014).
Non-EU countries		
Ukraine	TIMES-Ukraine: A TIMES model developed by the Institute of Economic Forecasting , National Academy of Sciences, Ukraine	National Energy Strategy to 2030 Scenarios.(2017). National energy Efficiency Action Plan (Government Resolution, Nov. 25, 2015

Country	Model	Relevant Policy supported by the model analysis.
Kazhakstan	TIMES-KZ: A 16 regions TIMES model for Kazakhstan developed in the Nazarbayev University [81].	Sixth National Communication to the UNFCC (2013).
South Africa	South African TIMES (SATIM): A TIMES model developed by the Energy Research Center, Univ. of Cape Town,	National Climate Change Response, Green Paper (Government of South Africa 2012).
Egypt	TIMES-EG: A TIMES model developed in the framework of the TARES project funded by the EU.	National Energy Strategy to 2035 (Gov. of Egypt, Supreme Energy Council 2016).
USA	EPAUS9r: A nine regions MARKAL model for the USA developed and used by the Environmental Protection Agency (EPA) [82]. The model is currently being migrated to TIMES. FACETS: A detailed TIMES model for the power sector of USA[83] funded by EPA.	Analysing effects of policies for the Office of Air Quality Planning and Standards, the Office of Air Quality Planning and Standards, and the Office of Air and Radiation.
Australia	TIMES-Australia	Part of the national modelling teams working on the COMMIT project (Climate pOlicy assessment and Mitigation Modeling to Integrate national and global Transition pathways).

ANNEX V – MODELS TO ESTIMATE SOCIO ECONOMIC IMPACT

Aggregated or disaggregated macroeconomic indicators provide examples of the simplified macroeconomic analysis (Table 2.8). In general, these approaches should be used when national statistics are incomplete and do not provide sufficient information for the development of the consistent macroeconomic models (Halsnæs et al., 1999). For instance, this could be the case for countries with unavailable input-output tables, where intersectoral linkages could not be quantified. Nevertheless, an approach of aggregated or disaggregated macroeconomic indicators could provide a valuable background for the development of baseline and mitigation scenarios.

Macroeconometric models are usually used to deliver short-run forecasts (Halsnæs et al., 1999) and can serve as a guide for developing the long-run models. At the same time, macroeconometric models are not suitable for the long-run assessment of the economic pathways, which is particularly relevant for the energy and environmental modelling. While additional modifications to the macroeconometric models could be applied to ease these restrictions, this type of models is not widely used for the assessment of the long-term mitigation policies.

With available input-output tables, which capture the intersectoral linkages within the national economy, application of the two other modelling approaches provide a more consistent way for the assessment of economic impacts. First of these approaches is an input-output modelling (Table 2.8). It is based on the input-output table, as a key data source and provides a detailed picture of the economy. Contrary to the computable general equilibrium (CGE) models discussed below, in general, input-output models assume no structural changes in the economy over the modelling horizon. In particular, this includes fixed intermediate and final consumption structure, fixed shares of exports and imports, etc. There are some versions of the input-output models that introduce price elasticities and thus account for the changes in consumption/production structure, but this is not a general case.

Another modification of the input-output framework includes construction of the Social Accounting Matrix (SAM), [84] which is an extended version of the input-output table complemented by national accounts data. SAMs include a detailed set of transactions between economic agents (producers, households, government, etc.) and allow for a more disaggregated assessment of the environmental policies. One of the complications in using the input-output framework is the availability of the desired sectoral disaggregation (e.g. coal, oil, gas, different technologies of electricity generation, etc.). Not all input-output tables have such level of details, therefore additional assumptions should be used to split the sector of interest. Some examples of the studies that use the input-framework for the assessment of economic and social effects of the environmental policies include Gemechu et al. (2013), Ogarenko and Hubacek (2013) and Perese (2010).

Strengths of the input-output assessment include transparency of the modelling framework and representation of the key intersectoral linkages. This approach also does not require significant implementation efforts if an input-output table is available. At the same time, this modelling approach also has some substantial drawbacks. In particular, as mentioned before,

it does not account for structural changes in the economy, factor substitution between different economic activities (e.g. labor and capital redistribution) and does not represent all economic flows between agents (this is particularly the case for the input-output modelling). In general, input-output framework assumes linearity in the production and consumption specification, which might not be the most flexible approach in the long run (e.g. there could be output structural shifts, shifts in final consumption structure/preference etc.).

This set of limitations is mostly overcome by the CGE models, which on the other hand, require more development efforts. CGE models use input-output tables and/or SAMs as a key input data and apply additional assumption to describe the behavior of economic agents and assure equilibrium conditions.

In general, within the CGE methodology, it is assumed that producers are maximizing profits, while households – utility. Nonlinear constant elasticity of substitution[7] (CES) production functions, are usually used to represent production and consumption processes within the CGE framework.

Equilibrium is defined using the system of nonlinear equations, which is derived through solving the optimization problems for production/consumption. For example, under changing/new policies, enterprises must define optimal structure of the intermediate consumption. A cost minimization problem is solved to minimize the costs of production under the new policy measures (e.g. emissions tax change, energy subsidies elimination, etc.).

In general, most CGE models distinguish three types of equilibrium conditions:

zero profit – no producer earns an "excess" profit, i.e. unit cost of production must not be lower than unit revenue. Production costs include capital earnings, so this condition does not exclude the case of positive gross profit;

market clearance – market demand must not exceed market supply (for each commodity);

income balance – income equals expenditures.

CGE models are usually used for "What-if" type of analysis. After the input data is collected and model is calibrated to replicate the base year equilibrium, policy scenarios are designed in a way that change values of the exogenous variables of the model. As a result, an initial equilibrium is altered and a new equilibrium (or set of equilibriums in the case of dynamic model) is estimated.

A substantial advantage of the CGE models over the input-output framework is the possibility of the non-linear specification of the model and potential to introduce and analyze structural changes. Specification of the equilibrium conditions, which could be implausible in the short-run or in case of the specific sectors, could be regarded as one of the drawbacks of the CGE framework. At the same time, there are different techniques that allow to overcome these limitations, for instance, introducing imperfect competition to the model (e.g. Roson, 2006).

With the necessity to parametrize a large set of production functions, another point of concern around CGE modelling is the dependence of results on the values of the exogenous parameters. As has been shown by numerous studies, results of the CGE model simulations could

[7] Elasticity of substitution indicates relative consumption quantities changes resulting from the corresponding relative price changes.

significantly depend on the values of elasticities of substitution and transformation. In some cases, variation of these parameters can even change the qualitative nature of results, for instance, by turning net welfare gain into loss under the trade policy experiment (Taylor and von Arnim, 2006). To overcome this potential issue, many studies use the sensitivity analysis approach to estimate the confidence intervals of the modelling results (Arndt and Pearson, 1998).

Numerous studies have used CGE models to provide economic and social assessment of the national and regional environmental policies, including assessment of the GHG emissions pathways (see e.g. Capros et al., 2013; Château et al., 2014; Paltsev et al., 2005).

Apart from the stand-alone use of the modelling approaches listed in the Table 2.10, there is a number of applications, where CGE or macroeconomic models are linked to the energy system models to exploit the benefits of both methodologies. Examples of such hybrid modelling approaches include MARKAL-MACRO model (UNFCCC, 2008), Böhringer and Rutherford (2009) and Messner and Schrattenholzer (2000). While a hybrid modelling framework could be considered as a more inclusive approach than the use of either energy system or CGE/macroeconomic models on their own, development of such methodology requires significant efforts and data inputs.

ANNEX VI – STATE CLIMATE CHANGE POLICY CONCEPT TEXT

APPROVED BY
Cabinet of Ministers of Ukraine Decree
of 7 December 2016, # 932-p

CONCEPT
of State Climate Change Policy Implementation
until 2030

Problem to be Resolved

The international community recognized at the outset of the 21st century that climate change is one of the key problems of world development with potentially serious threats for the global economy and international security due to increased direct and indirect risks related to energy security, food and potable water supplies, and sustainable existence of ecosystems, and risks to human health and life.

The countries' poor ability to adapt to such manifestations of climate change as floods, droughts, coastal erosion, and prolonged periods of abnormal heat could lead to social and economic upheavals. During the last two decades, the issue of climate change has evolved into one of the most acute problems of the global economy and politics in the context of development of strategies to reduce greenhouse gas emissions and to gradually transition to low-carbon development of all economy sectors and elements of human vital activity.

Taking urgent actions to combat climate change and its effects is one of the objectives stated in a new agenda of sustainable development for the period until the year 2030 approved at the sustainable development summit held in New-York on 25 September 2015.

The Intergovernmental Panel on Climate Change has found that anthropogenic impact on the climate system is the dominant cause of warming observed since the middle of the 20th century. To avoid catastrophic consequences of climate change it is necessary to achieve such a reduction of greenhouse gas emissions, as to restrain the increase of average global temperature at significantly below 2°C over the preindustrial levels.

At the global level, the issues related to climate change are currently regulated by the UN Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement.

As party to the UN Framework Convention on Climate Change and the Kyoto Protocol thereto, Ukraine ensures implementation of its obligations under these international treaties; however, the state policy on climate change is fragmentary and is considered as a component of the environmental policy only. Lack of a systemic approach to the climate change problem in general makes it impossible to take management decisions to ensure mitigation and adaptation to climate change within the entire national economy.

At the same time, performance of the new tasks arising from Ukraine's ratification of the Paris Agreement and subsequent implementation of its provisions will require developing a comprehensive and consistent state policy on climate change in accordance with the policy of international organizations and with due account for advanced world technologies and practices, as well as the specific national circumstances, needs, and priorities.

The urgency of addressing the climate change problem is due to the following:

- the need of improving the legislative framework in this area;
- insufficiently clear distribution of functions, poor coordination of actions and low institutional capacity of government agencies with regard to planning and implementation of activities in this area;
- lack of coordination between the climate change policy and the legislative and other regulatory acts in other socioeconomic areas;
- lack of a systemic approach to creating a scientific basis for activities on climate change;
- insufficient awareness of the civil society and government agencies about all aspects of the climate change problem and low-carbon development of the country.

The development and subsequent implementation of a comprehensive state policy on climate change harmonized with the international legislation is a complex task due to multidisciplinary nature of the problem. Politically, economically, and scientifically substantiated decisions on climate change should be made for all economy sectors, including energy, industry, agribusiness, transport, water economy, forestry, and housing and communal services, land use, as well as healthcare, and preservation and regeneration of ecosystems.

Concept Goal and Implementation Period

The Concept goal is improving the state policy on climate change in order to achieve country's sustainable development, creating the legislative and institutional prerequisites for ensuring a gradual transition to low-carbon development with economical, energy, and environmental security and improved well-being of citizens.

The Concept determines the grounds for development of draft laws and other regulatory acts, strategies and their action plans for various components of state policy on climate change.

The Concept will be implemented until the year 2030.

Areas, Ways, and Methods of Resolving the Problem

The main areas of Concept implementation are as follows:

- strengthening the institutional capacity for development and implementation of state policy on climate change;
- prevention of climate change through reduction of anthropogenic emissions and increased greenhouse gas absorption to ensure gradual transition to low-carbon development of the country;
- adapting to climate change, increasing the resilience and reducing the risks linked to climate change.

Strengthening the institutional capacity for development and implementation of state policy on climate change shall be achieved by:

- ensuring coordination of the state policy on climate change with the legislative and other regulatory acts, which set forth the strategic decisions for achieving country's sustainable development, development of the energy sector, industry, housing and communal services, and other sectors of the economy, and increasing the energy efficiency and use of renewable energy sources;

- ensuring an efficient distribution of functions and effective mechanism of coordination between the central and local executive authorities and local self-government bodies in the development and implementation of components of the state policy on climate change in accordance with their competences;
- ensuring implementation of climate-related provisions of the Agreement on Association between Ukraine and the European Union, European Atomic Energy Community, and their Member-States;
- ensuring implementation of Ukraine's obligations with regard to reporting under international agreements on climate change;
- identifying and implementing effective mechanisms for integration of policy components on climate change into regional development strategies and their implementation plans with due account for the development priorities of regions within respective oblasts, as well as of cities, communities, and villages;
- ensuring mobilization of financial resources at the national and local levels, promoting external and internal investments;
- increasing the technical and technological capacity of climate observing system and implementing the program of research into climate of Ukraine;
- supporting the creation and continuous updating of forecasting models for greenhouse gas emissions under different development scenarios of country's economy and its individual sectors;
- supporting an ongoing evaluation of actual expected climate changes and their consequences, including regional distribution, identification of risks and vulnerability to climate change at the level of territorial communities and economy sectors;
- ensuring equal access of citizens to the information about all aspects of addressing the problem of climate change and low-carbon development of the country, including the performance of educational and outreach work;
- ensuring participation of the public in making management decisions on climate change;
- identifying and implementing a mechanism of public private partnership on climate change;
- ensuring implementation of national initiatives on climate change as part of international processes and activities, including those involving implementation of ecosystem approaches.

Prevention of climate change through reduction of anthropogenic emissions and increased greenhouse gas sequestration to ensure gradual transition to low-carbon development of the country shall be achieved by:

- reducing anthropogenic greenhouse gas emissions and meeting the obligations under international treaties on climate change and pursuant to the Intended Nationally-Determined Contribution of Ukraine approved by Ordinance of the Cabinet of Ministers of Ukraine dated 16 September 2015, #980, while ensuring follow-up review of the level of ambitiousness of this contribution, taking into account the indicators of country's socioeconomic development;

- reducing the energy intensity of Gross Domestic Product pursuant to the Sustainable Development Strategy Ukraine-2020 approved by Edict of the President of Ukraine dated 12 January 2015, #5;
- expanding the plan of activities to improve energy efficiency pursuant to the National Energy Efficiency Action Plan for the Period until the Year 2020 approved by Ordinance of the Cabinet of Ministers of Ukraine dated 25 November 2015, #1228;
- increasing the share of energy produced from renewable energy sources in the overall structure of country's energy consumption according to the National Renewable Energy Action Plan for the Period until the Year 2020 approved by Ordinance of the Cabinet of Ministers of Ukraine dated 1 October 2014, #902;
- increasing the amount of greenhouse gas sequestration by implementation of forestry and land use activities;
- developing and implementing domestic greenhouse gas emission trading scheme in accordance with the provisions of Directive 2003/87/EC;
- appointing a special authorized agency on domestic emission trading scheme;
- setting up and ensuring operation of a system for monitoring, reporting, and verification of greenhouse gas emissions;
- improving approaches to environmental taxation with regard to greenhouse gas emission, including establishment of a mechanism for targeted allocation;
- introducing market and non-market mechanisms intended to reduce anthropogenic emissions or increase sequestration of greenhouse gases;
- determining the role of nuclear energy based on findings of an in-depth analysis of possible risks and benefits of achieving the country's targets of reducing anthropogenic greenhouse gas emissions;
- development and implementation of a medium-term low-carbon development strategy of Ukraine for the period until the year 2030 coordinated with the strategies and development plans of economy sectors and regional development strategies.

Adapting to climate change, increasing the resilience and reducing the risks linked to climate change shall be achieved by:

- developing and implementing effective climate change adaptation activities and strengthening the resilience to climate related risks and natural disasters in the areas of healthcare, human life and activities, economy sectors, and natural ecosystems;
- developing and implementing a mechanism of adaptation policy creation based on the principle of proceeding from the local/regional to the national level, giving the priority to activities of those communities and sectors of economy, which are the most vulnerable to climate change effects;
- determining and implementing the approaches and technologies, which provide for a balanced management of natural ecosystems;
- establishing a nationwide system of managing the risks caused by change of frequency and intensity of extreme weather effects and natural disasters in the territory of Ukraine, as well as human migration due to climatic factors;
- implementing cross-border projects of climate change adaptation with neighboring partner countries;

- developing and implementing a medium-term strategy of climate change adaptation of Ukraine for the period until the year 2030, coordinated with the strategies and development plans of economy sectors and regional development strategies.

Expected Results

Implementation of the Concept will make it possible to:

- improve the state policy on climate change and strengthen the institutional capacity for its implementation;
- ensure implementation of all the obligations of Ukraine under the UN Framework Convention on Climate Change and other international treaties on climate change, Agreement on Association between Ukraine and the European Union, and the European Atomic Energy Community, and their Member-States;
- ensure achievement in 2030 of the Intended Nationally-Determined Contribution, which will not exceed 60 percent of the baseline year 1990 level, and envisage review by the year 2020 of the level of its ambitious, taking into account the indicators of country's socioeconomic development;
- ensure reduction of energy intensity of Gross Domestic Product by 20% by the end of 2020 and provide for the energy intensity to gradually approach the respective indicators of the developed countries with similar climatic, geographic, and economical conditions;
- ensure achieving in 2020 of the indicative national energy saving target of 9 percent of the average internal end use of energy;
- ensure achieving by 2020 of the share of energy produced from renewable energy sources of 11 percent of the overall structure of country's energy consumption, and provide for gradual increase of such share;
- increase the amount of sequestration of greenhouse gases by implementing forestry and land use activities;
- ensure the legislative and regulatory regulation of market and non-market instruments of reducing anthropogenic emissions and increasing sequestration of greenhouse gases, including implementation of an domestic emissions trading scheme and improvement of environmental taxation with regard to greenhouse gas emissions;
- increase the efficiency of climate change adaptation activities aimed at minimizing the current and anticipated negative effects and introducing a nationwide system of managing the risks caused by the change of frequency and intensity of extreme weather and natural disasters in the territory of Ukraine;
- strengthen the capacity of local executive authorities and local self-government bodies to develop and implement the activities of climate change prevention and adaptation;
- ensure systemic scientific, methodological, and educational support to all aspect of activities related to climate change;
- increase the educational and professional level of managerial staff in the field of climate change;
- raise awareness of the civil society in all aspects of the climate change problem and country's low-carbon development;
- increase the level of public participation in the management decision-making on climate change;

- mobilize additional resources for implementation of the state policy on climate change as part of public private partnerships, including at the expense of internal and external investments;
- improve the image and raise the role of Ukraine in international negotiations on climate change;
- implement medium-term strategies of low-carbon development and adaptation to climate change.

The Scope of Financial, Material and Technical, and Labor Resources

The scope of financing, material and technical, and labor resources needed for implementation of the Concept shall be determined annually with due account for the capacity of the state and local budgets and the amount of international technical assistance.

ANNEX VII. EXISTING NDC RELATED CLIMATE LEGISLATION AND POLICIES

1. State Climate Policy Concept till 2030 [85] and its Action Plan

The Concept was adopted in 2016 and its Action Plan in 2017 by GoU Cabinet of Ministers Decree. § The Concept goal is to enhance state policy on climate change in order to achieve Ukraine's sustainable development, creating the legislative and institutional pre-conditions for ensuring a gradual transition to low-carbon development with economical, energy, and environmental security and improved well-being of citizens.

The Concept defines national state climate policy goals/areas:

- **Strengthening institutional capacity for development and implementation of state climate change policy,** by:
  - ensuring an efficient distribution of functions and an effective mechanism for coordination of central and local executive authorities, local authorities in shaping and implementing state climate change policy;
  - ensuring implementation Ukraine's commitments to report on international climate change agreements;
  - identification and implementation of effective mechanisms for integrating climate change policy elements into regional development strategies and plans for their implementation, taking into account the priorities of development of the regions of the region, as well as cities, villages and villages;
  - contributing to the creation and continuous updating of models for forecasting greenhouse gas emissions by different scenarios for the development of the country's economy and its individual sectors;
  - contributing to the ongoing assessment of the actual expected climate change and its effects on the provision of mobilization of financial resources at the national and local levels;
  - promoting the attraction of foreign and domestic investment;
- **Mitigating of climate change impact by reduction of GHG emissions and increasing GHG absorption to ensure gradual transition to low-carbon development of the country;** by
  - reducing GHG emissions, in particular in accordance with first NDC of Ukraine, approved by the Decree of the Cabinet of Ministers of Ukraine from 16.09.2015 No. 980, with a view to further revision of the level of ambition of this contribution, taking into account indicators of socio-economic development of Ukraine;
  - reducing the energy intensity of the gross domestic product in accordance with the Sustainable Development Strategy "Ukraine 2020";
  - enhancing actions for increasing energy efficiency in accordance with the National Energy Efficiency Action Plan till 2020;
  - increase of the share of energy produced from renewable energy sources in energy consumption in accordance with the National Renewable Energy Plan Action till 2020;
  - increase GHG absorption by implementing measures in forestry and land use sectors;

- establishment of domestic ETS in accordance with the provisions of Directive 2003/87/EC;
- improvement of approaches to environmental taxation in terms of GHG, including the creation of a mechanism for the targeted use of revenues;
- development and implementation of Low Emission Development Strategy up to 2030 coordinated with the strategist economic development plans and regional development strategies;

- **Adapting to climate change, increasing the resilience and reducing the risks linked to climate change by;**
  - development and implementation of effective measures to adapt to climate change and increase the resilience of climate-related risks and natural disasters for health, people's livelihoods, sectors of the economy and natural ecosystems;
  - identification and implementation of approaches and technologies that provide for balanced management of natural ecosystems;
  - establishment of nation-wide risk management system, frequency and intensity of extreme weather events and natural disasters in Ukraine;
  - development and implementing National Adaptation Strategy till 2030, coordinated with the strategies and plans of sectors and regional development strategies and more.

The Concept and its Action Plan outlines the timeframe for MRV and domestic ETS legislation development, foresees the development of National Integrated Energy and Climate Plan up to 2030 and provides for development of National Scientific and Technical Climate Change Program.

The Concept Action Plan defines the bodies responsible within GoU and local authorities, but with state budget limited financing, the complete fulfilment of provisions is possible with international technical assistance only.

See the full text of State Climate Policy Concept and its Action Plan in Annex VI.

2. Ukraine's 2050 Low Emission Development Strategy (LEDS)

In accordance with State Climate Policy Concept and its Action Plan provision, Ukraine's 2050 Low Emission Development Strategy was developed and submitted to UNFCCC in September 2018.

Ukraine LEDS is the only long term strategic policy document developed and communicated by Ukraine, even though it does not have legislation status in Ukraine. LEDS defines national climate change policy vision in mitigation in order to ensure gradual decoupling of economic social growth and GHG emissions. LEDS aims to reduce GHG emissions and increase GHG removals and absorption, implementing environmentally sound and climate friendly technologies using "green" technologies across the economy.

LEDS mostly covers Energy and Industrial Processes Sectors (IPCC) and based on four development scenarios for these sectors, LEDS defines Ukraine's mid-century target – GHG emission reduction by 31-34% in 2050 compared to 1990 level.

LEDS also estimates forestry sector potential contribution to 2050 target based on expert judgement estimation.

3. Sustainable Development Strategy "Ukraine 2020" [86]

Sustainable Development Strategy “Ukraine 2020” adopted by Presidential decree in 2015 outlines core development vectors for Ukraine. The Strategy does not cover sustainable development pathways as per UN 2030 Sustainable Development Goals, but at the same time it foresees major infrastructural changes and achievement important indicators:

- GDP energy intensity reduction by 20% by 2020, while ensuring 100% commercial metering of energy consumption, transition to energy efficient technologies and equipment;
- ensuring the widest possible diversification of primary energy supply sources;
- liberalization and implementation of new electricity, heat, coal and natural gas market model;
- Ukrainian Energy System integration with ENTSO-E; Naftogaz of Ukraine restructuring in accordance with Third EU Energy Package provisions;
- reforming of the pricing and tariff systems for energy and fuel;
- attraction of foreign investments into the Ukrainian energy sector.

The Strategy implementation is under MinEnergy mandate. As of early 2019 the following achievements could be highlighted:

- draft Law of Ukraine "On the Electricity Market" has been developed;
- coal sector reforms under implementation aimed at efficient state social support program for phased-out coal mines employees;
- Law of Ukraine "On the Natural Gas Market" adopted and natural gas transmission system separation model established as per Energy Community obligations fulfilment.

4. Sustainable Development Strategy of Ukraine by 2030 [87]

In accordance with UN 2030 Sustainable Development Goals, Ukraine developed Sustainable Development Strategy by 2030. The Strategy does not have official legal standing in Ukraine’s legislation framework and has the status of Communication only.

The Strategy goals are to ensure a high living standard in Ukraine, to create favourable conditions for different generations and to prevent the degradation of natural ecosystems by introduction of new model of economic growth. Accordingly, the following indicators have been proposed in order to ensure Ukraine’s SDGs achievements:

- ensure annual growth of the GDP at an average of at least 7% by 2030;
- reach 15% share of products of high-tech sectors of the economy in exports by 2030;
- create a viable infrastructure, follow the inclusive energy efficiency and innovation industrial development;
- sustainable development of the agriculture;
- ensure energy dependence on the external fuel supplies not more than 30% by 2020 by means of development of domestic energy production and diversification of primary energy supply;
- reach 17,1% of renewables in the total final energy consumption by 2030;

- active introduction of energy saving and energy efficiency programs and programs aimed at producing energy from renewable sources;
- reduce energy intensity of GDP by at least 60% by 2030 by implementing programs and measures aimed at energy saving and energy efficiency improvements;
- ensure 30% reduction of heat losses in supply networks by 2030;
- ensure 15% reduction of heat and electricity losses by 2030 by using more energy efficient equipment and appliances, as well as the complex thermo-modernization of buildings;
- ensure sustainable regional development on the basis of preserving national cultural values and traditions, combating poverty, reducing inequality, and ensuring gender equality;
- ensure public health and welfare for all at any age;
- ensure the transition to models of balanced consumption and production;
- introduction of urgent measures to prevent climate change and its consequences, namely, reduction of greenhouse gas emissions in all sectors to the level not exceeding 60% of 1990 by 2030;
- provision of conservation of terrestrial and marine ecosystems and promotion of the balanced use of their resources;
- ensure security and free access to justice, create accountable and inclusive institutions.

5. Law of Ukraine "State Environmental Policy Strategy of Ukraine till 2030 [88]

State Environmental Policy Strategy of Ukraine till 2030 foresees the enhancement of the environment protection policies by responding to environmental challenges, increasing energy efficiency, increasing clean energy production, utilizing low-carbon, climate-friendly and energy effective technologies, reducing GHG emissions and pollutants in the air by utilizing climate-friendly construction technologies.

Environmental Strategy foresees three stages of implementation and relevant indicators for each of the stage:

- **by 2020:**
  - reforming state ecological management system, including differentiation of environmental protection and economic control functions in the use of natural resources
  - European environmental norms and standards implementation,
  - environmental accounting and control systems improvement,
  - introduction of financial and economic mechanisms and incentives for environmentally-friendly structural transformations in the economy,
  - widespread environmental knowledge;
- **by 2025:**
  - ecological situation stabilization through public administration changes that took place during the first phase, and changes of ecological behaviour patterns of people and society;

- **by 2030:**
  - balanced approach to both socioeconomic needs and natural environment protection goals,
  - ensuring environmentally effective partnership between state, business and people;
  - development of "green", resource-efficient, low-carbon economy, that will create additional benefits for socio-economic development of Ukraine.

ENERGY SECTOR EXISTING AND PLANNED LEGISLATION

1. Law of Ukraine "On Commercial Metering of Heat and Water Supply"

adopted by the Parliament of Ukraine on June 22, 2017 (No. 2119-VIII) - defines the main concepts of commercial, including distributional, accounting for heat, hot water and centralized water supply and providing correspondent accounting information to the consumers of such services.

2. Law of Ukraine "On the Energy Efficiency Fund"

adopted by the Parliament of Ukraine on June 8, 2017 (No. 2095-VIII) defines the legal, economic and organizational principles for the establishment and operation of the Energy Efficiency Fund. As such, the Energy Efficiency Fund should support energy efficiency initiatives via supporting schemes on energy saving and improving energy performance of buildings. This should be done by mean of diverse tools, such as:

- grants and partial reimbursement of the costs for energy efficiency projects implementation;
- programs of partial reimbursement of the costs of economically feasible energy efficiency measures;
- development of financial criteria for the project compliance with energy efficiency goals, technical evaluation of projects;
- cooperation with partner banks and donors;
- technical training in the field of energy efficiency;
- permanent monitoring and quality analysis of the energy efficiency measures;
- implementation of marketing and communication campaigns, market research;
- carrying out communication activities related to the raising awareness of population in the field of energy saving and energy efficiency.

3. The Law of Ukraine "On the Energy Efficiency of Buildings"

adopted by the Parliament of Ukraine on June 22, 2017 (No. 2118-VIII).

The law identifies the set of the most important measures to improve the energy efficiency of buildings and relative financing tools to support these policies, creates preconditions for the implementation of the national plans to increase the number of near zero energy buildings, and regulates the introducing energy efficiency certificates of buildings that will let to establish publicly available inventory of the Ukrainian stock of building. This law comes into force on July 23, 2018.

4. Public Building Energy Management System Implementation Action Plan

adopted by the Cabinet of Ministers of Ukraine on April 26, 2017 (No. 732-p).

Action Plan outlines the development of the following documents:

- the draft Law on energy efficiency, which would include provisions for the introduction of energy management systems, including in institutions funded by local budgets;
- certification Scheme of the energy management systems and energy managers in public institutions;
- regulation on the energy monitoring in public institutions.
- in addition, Action plan entrusts on the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE) and local governments:
- to establish and make operational of publicly available database of energy use and performance characteristics of public buildings;
- to promote activities (seminars, trainings, etc.) on the implementation of energy management systems in public institutions;
- to establish professional development programs;
- to perforrm activities to promote the introduction of energy management systems in public institutions and to promote certification of such systems;
- to introduce energy management systems in public institutions.

5. DRAFT Law of Ukraine "On Energy Efficiency"

aimed at the implementation of the EED and defines the schemes and mechanisms to stimulate reduction of energy use by energy suppliers and consumers. The Draft Law was approved by the Ministry of Regional Development, Construction and Utilities of Ukraine and is going through inter-service consultations with Ministries and national energy regulator (NEURC).

In the scope of energy labelling implementation in Ukraine there were several regulation adopted that establish requirements for the following types of equipment:

- Technical regulation on energy labelling of energy related products (Resolution of the Cabinet of Ministers of Ukraine dated 07.08.13 No.702);
- Technical regulation on energy labelling of domestic electric refrigerators (Resolution of the Cabinet of Ministers of Ukraine dated 07.08.13 No.702);
- Technical regulation on energy labelling of household washing machines (Resolution of the Cabinet of Ministers of Ukraine dated 07.08.13 No.702);
- Technical regulations on energy labelling of electric lamps and luminaries (Resolution of the Cabinet of Ministers of Ukraine dated 27.05.15, No.340);
- Technical regulation on energy labelling of household dishwashers (Resolution of the Cabinet of Ministers of Ukraine dated 17.07.15, No. 514);
- Technical regulation on energy labelling of air conditioners (Resolution of the Cabinet of Ministers of Ukraine dated 24.05.17, No. 360);
- Technical regulations on energy labelling of televisions (Resolution of the Cabinet of Ministers of Ukraine dated 24.05.17 No. 359);
- Technical regulation on energy labelling of vacuum cleaners (Resolution of the Cabinet of Ministers of Ukraine dated 31.05.17, No. 381);
- Technical regulation on energy labelling of household tumble driers (Resolution of the Cabinet of Ministers of Ukraine dated 31.05.17, No. 380).

- draft Technical Regulation on energy labelling of household ovens and range hoods.

With regard to establishment of eco-design requirements, the SAEE keeps working with EBRD experts to prepare the following Technical Regulations: industrial fans; water pumps; transformers; electric motors; lamps; circulators.

6. National Renewable Energy Action Plan till 2020. [89]

developed in accordance with the requirements of the Directive 2009/28/EC on the promotion of energy from renewable sources. The main objective of the National Renewable Energy Action Plan till 2020, developed by the State Agency for Energy Efficiency and Energy Saving of Ukraine, is to achieve 11% share of energy from renewable sources in the total final energy consumption in 2020. In addition, the NREAP provides the following targets and projections:

- the share of renewables in the gross final energy consumption in 2020 should reach 11%;
- expected total adjusted energy consumption in 2020 is 78080 ktoe;
- the amount of energy from renewables, which corresponds to the indicative target for 2020, makes 8590 ktoe.

7. National Energy Efficiency Action Plan till 2020 [90]

The State Agency for Energy Efficiency and Energy Saving of Ukraine has developed the National Energy Efficiency Action Plan till 2020, which provides the following targets and projections:

- the national energy efficiency target was identified as the amount of energy saved in 2020 on the level of 9% from the average energy consumption for 2005-2009;
- the intermediate energy efficiency target for 2017 was established at the level of 5%;
- an interim national indicative energy efficiency target was set as 3612 ktoe in 2017, and the total national indicative target of energy saving – 6501 ktoe in 2020;

NEEAP addresses two scenarios for the development energy efficiency policy in Ukraine. The baseline scenario does not provide any radical changes in the technological structure of the energy sector, in particular, increase of working time of existing capacities with certain changes in their operation in accordance with the schedule of repairs and reconstruction. According to the baseline scenario primary energy intensity (in 2009 prices) in 2017 will decrease by 31.4and in 2020 – by 37.2% compared to the corresponding average for 2005-2009. At the same time, it is projected to reduce the final energy intensity by 32.3% in 2017 and by 37.6% in 2020.

The energy efficient scenario includes new standards and requirements for boiler efficiency, as well as the assumption that government policies and programs will promote the penetration of energy saving appliances. It is assumed that the energy consumption after implementation of energy efficiency measures in 2017 will be 61.8 mtoe, in 2020 - 62.9 mtoe, while the expected end-use energy consumption under the baseline assumptions of market development in 2017 will be 65, 4 mtoe, in 2020 - 69.4 mtoe.

The National Energy Efficiency Action Plan till 2020 aims at introducing regulatory, financial and other measures for the full implementation of the provisions of the Energy Saving Directive, while focusing on energy saving measures in industry, residential and transport sectors.

8. New Energy Strategy of Ukraine by 2035: "Security, Energy Efficiency, Competitiveness [91]

The New Energy Strategy of Ukraine (NES) by 2035 defines the purpose and objectives of the energy policy of the state for the long-term period, as well as outlines the ways and mechanisms for its implementation, taking into account the European integration aspirations. NES is aimed at supporting and expanding generating capacities, diversifying energy suppliers and building a transparent and efficient electricity market. That is, NES is a document aimed at cross-sectoral cooperation for the efficient and reliable satisfaction of the needs of the national economy and citizens with the necessary forms of energy.

The strategy outlines three stages, each of which has target benchmarks. In particular, it is envisaged to ensure:

Energy sector reform (until 2020):

- transition of Ukraine's energy sector to market principles of functioning and competition, which will stimulate increase of efficiency of economic activity of the subjects of the energy sector and efficiency of energy resources use;
- reduction of energy intensity of GDP;
- creating conditions for end users to receive quality services;
- compliance with high environmental standards of production, transportation, transformation and energy consumption in the field of environmental protection;
- increase in the share of renewable energy in final consumption up to 11% (8% of total primary energy supply) by the implementation of a stable and predictable policy in the field of stimulating the development of RE and in the field of investment attraction.

Optimization and Innovative Development of Energy Infrastructure (by 2025):

- integration of the Ukrainian energy sector into the energy markets of the European Union and the European energy security system;
- increasing the efficiency of existing district heating systems;
- intensive investment in the RE;
- development of a plan for the introduction of Smart Grids, development of electric transport.

Sustainable development (until 2035):

- full participation of the energy sector of Ukraine in the functioning of the European energy market with the free movement of energy resources, investments and technologies, which will ensure the sustainability of the development of energy sectors and increase the level of security of own extractive energy resources;
- completion of technological renovation of the energy sector;
- introduction of passive home construction standards, achievement of target values for SO2, NOx and dust emissions reduction in the field of energy efficiency and environmental protection;
- increase in the share of RE in TPES to 25%.

9. The Concept of implementation of the state policy in the field heat supply [92]

The concept provides for 2017-2035:

- consumers of heat supply services;
- energy independence and security of Ukraine;
- reduction of negative impact on the environment;
- improvement of financial and economic condition of enterprises;
- introduction of a transparent, efficient system of settlements between the parties of provision and consumption of services;
- stimulation of attraction of investments in the field of heat supply.

Implementation of the Concept is foreseen in three stages:

2017-2018:

- optimal combination of different types of heat supply within the settlement (centralized, autonomous or individual (apartment) by developing schemes for the development of heat supply systems of settlements;
- simplification of procedures for the implementation of investment projects aimed at reconstruction, modernization and development of enterprises;
- promoting the use of more effective forms of enterprise management;
- level of losses of heat during its production - 8%, transportation - 12%;
- 100% commercial accounting of consumed heat;
- establishment of tariffs covering capital and operating expenses of enterprises at the expense of completion of the procedure for improving tariff policy and introduction of a mechanism for stimulating tariff formation;
- settlement of the transfer of part of the authority to establish tariffs for heat supply to local self-government bodies;
- promoting the transition of enterprises to dual tariffs;
- increase the level of payments for consumed utilities through the implementation of appropriate measures.

2019-2025:

- average annual energy heat consumption 80-60 kWh per m2;
- share of the alternative energy sources in heat production - 30%;
- stimulation of bringing the technological state of enterprises into line with the needs of consumers in the case of thermo-modernization of buildings (40-50% of buildings);
- introduction of a market mechanism for the heat production and supply;
- development of a competitive environment for heat supply.

2026-2035:

- average annual heat consumption 60-20 kWh per m2;
- share of alternative energy sources for heat production - 40%;
- heat losses in heat networks during its transportation to the consumer - 10%;
- modelling of bringing the technological state of enterprises into line with the needs of consumers in the case of thermo-modernization of buildings (100% of buildings).

Consequently, it should be noted that in the event of a timely and competent implementation of the Concept, safe, high-quality and financially feasible for the customer to provide services for centralized heating and hot water supply, as well as increase energy independence of Ukraine due to increased use of alternative and renewable sources of energy, the introduction of energy saving measures and a 100% commercial accounting for heat supply.

OTHER RELEVANT LEGISLATION

Transport strategy of Ukraine till 2020 [93]

Among the priorities of the sector identified in the Transport Strategy of Ukraine till 2020 are the development of transport infrastructure, its modernization and alignment with European standards, the development of a network of international transport corridors and a network of border crossing points. At the same time, it is envisaged to stimulate the sustainable development of transport, giving preference to clean and energy efficient modes of transport; to implement vehicles whose service, technical and economic indicators of operation correspond to the modern European requirements for safety, environmental and energy efficiency of transport; Improve taxation systems depending on the environmental and energy efficiency of vehicles; reducing the techno genic loading of transport to the environment, etc.

At the same time among the results that are planned to be achieved under the condition of the Strategy implementation, one can note:

- reduction of 30% of the emissions of harmful substances into the atmosphere;
- decrease of 15-20% of the energy intensity of transport, in particular road transport – from 43.6 to 34.8 gr. conventional fuel per tkm, rail - from 10.32 to 8.75 gr. conventional fuel per tkm.

National Transport Strategy of Ukraine till 2030 [94]

National transport strategy of Ukraine till 2030 goal is to create an efficient transport system in Ukraine that will be integrated into the world transport network by meeting the needs of the population and business.

The strategy foresees the following steps and indicators:

- high-tech transport system with multimodal international and trans-European transport network TEN-T, including rail network of 1435 mm;
- integration into the Common Aviation Area with the EU;
- mass regular transport of containers (at least 1 million TEUs per year) and other goods by multimodal transport, in particular in the transit connection "Europe-Asia";
- reconstructed network of the main roads;
- regular bus service 90% of rural settlements;
- renewed maritime and river merchant fleet, including the developed "naval highways" of the Black Sea, the entry of Ukrainian seaports into the "Blue Bay" in the seas around Europe and in the Top 100 largest container ports of the world;
- increase of volumes of transportation on the Danube, the Dnieper, Southern Bug 5 times;
- renewed rolling stock of railways, public passenger transport, sea and river fleet;

- degree of wear and tear of fixed assets in the form of economic activity "Transport and storage" will be 50%, thus it will be 50% lower than in 2015;
- integration of Ukrainian navigation systems into the European Common Navigation Satellite System (Galileo) and developed research and innovation partnership with the EU, the USA, China and other countries (OESD, Horizon , Erasmus , etc.);
- conditions for introduction of high-speed passenger traffic on railways, express delivery of valuable cargoes, accelerated delivery of containers;
- use of electric vehicles, electric buses, bicycles, which will reduce the total amount of greenhouse gases and pollutants in the air from mobile sources by 60%;
- increase the level of application of alternative types of fuel up to 50%;
- reduction of specific fuel consumption by 10 tkm by 30%.

One of the core principle of the Strategy is harmonization of transport legislation of Ukraine and EU and effective administrative reforms in the transport sector.

National Strategy for Waste Management in Ukraine till 2030 [95]

The strategy is aimed at defining the state policy on waste management in the coming decades, laying the foundations for European approaches in the field of waste management, which should be based solely on the principles and provisions of the relevant acts of European legislation, taking into account Ukrainian realities.

General measures Strategies are implemented in three stages: short-term (2017-2018), medium-term (2019-2025 years), long-term (2026-2030 years).

The objectives of the Strategy are:

- identification and solution of key issues of waste management development in Ukraine, priority areas of activity of central and local executive authorities, local governments, organizations, institutions, enterprises, public organizations and society as a whole in relation to the transition of the waste management system to the innovative model;
- definition of tasks aimed at ecological and resource security, which play a role in ensuring sustainable development of Ukraine;
- reduction of the administrative burden on business entities, improving the quality of providing administrative services and ensuring the legality and predictability of administrative actions.

The guidelines of the Strategy are the *hierarchy of waste* (prevention of formation, recycling (reuse), recycling, utilization, removal in specially equipped places); *integration* (environmental protection should be an integral part of the development process); *Sustainable development* (waste generation minimized); *"The polluter pays"; proximity* (elimination of pollution should be as close as possible to the source of its occurrence); *prevention*; *joint responsibility* (participation in the achievement of the goals of environmental policy as bodies of state power, local self-government, economic entities, and the public); *expanded liability of the manufacturer; Self-sufficiency* (introduction of an integrated and adequate network of objects for waste disposal and disposal).

Thus, the implementation of the Strategy will ensure: implementation of the waste management system on an innovative basis, which will ensure the consumption of natural resources in the

form of closed cycles (natural resources - useful products - waste - secondary resources - useful products - waste); development of national waste management legislation based on the requirements of the relevant European Directives and waste management in accordance with best European practices; improvement of the environment; compliance with environmental safety requirements during the operation of waste management facilities; attraction of investments in the field of waste management and creation of modern waste management infrastructure; introduction of the latest technologies of utilization and removal of solid domestic wastes, reduction of their disposal at landfills; creation of a system of information provision of waste management; increasing the efficiency of using state and local budgets to implement waste management measures to prevent negative environmental and human health impacts.

Table VII.1. National Legislation on Mitigation

Title	Objectives	GHG	Status	Responsible (GoU)
Sustainable Development Strategy "Ukraine 2020"	reduction of energy intensity of GDP by 20% by the end of 2020; Integration of Ukraine's grid with ENTSO-E	CO_2	Implementation in 2015-2020	Ministry of Energy and Coal Industry
National Renewable Energy Action Plan for the period up to 2020	The share of RE in the gross final consumption of energy in 2020 - 11%	CO_2	Implementation in 2015-2020	Ministry of Energy and Coal Industry
National Action Plan for Energy Efficiency until 2020	achieving the amount of energy saved in 2020 at 9% of the average end-of-year energy consumption index for the period 2005-2009	CO_2	Implementation in 2016-2020	Ministry of Energy and Coal Industry
New Energy Strategy of Ukraine until 2035: "Security, Energy Efficiency, Competitiveness"	Energy sector infrastructural changes	CO_2	Implementation in 2017-2035	Ministry of Energy and Coal Industry
State Environmental Policy Strategy of Ukraine till 2030	With less spare volume along with emissions of polluting substances , increase energy production by 25% by 2015 and to 50% by 2020.	CO_2	Implementation in 2020-2030	Ministry of Environment and Natural Resources, Ministry of Energy and Coal Industry
Heat Supply State Policy Concept	Optimization of heat supply, reducing heat losses, reducing average energy consumption	CO_2	Implementation in 2017-2035	Ministry of Energy and Coal Industry
National Waste Management Strategy until 2030	National waste management policy and goals till 2030	CO_2, CH_4	Implementation in 2017-2030	Ministries of Environment and Natural Resources
State Climate Policy Concept till 2030	National climate change policy goals		Implementation in 2017-2030	MinEcology
State Climate Policy Concept till 2030 Action Plan	National climate change policies goals implementation steps and responsible authorities with timeline		Implementation in 2017-2030	MinEcology

Table IV.2. Power Generation Sector

Title	Description	GHG's	Type of tool	Status	Responsible body
Changes in the feed-in tariff coefficients Law of Ukraine from 16.07.2015 No. 514-VIII «On introducing amendments to some laws Of Ukraine concerning the provision of competitive conditions for the production of electricity from alternative energy sources"	Introduction of the feed-in tariff for biogas. From 2013 to the end of 2014 its coefficient was 2.30, from 2015 to 30.06.2015 the coefficient decreased to 2.07, and from July 2015 and by the end of 2019 the coefficient is 2.30, so the tariff is 0,1238 euro/kWh. Similarly, the increase of feed-in tariff for biomass from 2.07 to 2.30 from July 2015 and until the end of 2019. The introduction of feed-in tariff for geothermal energy from July 2015 to the end of 2019 with a coefficient of 2.79.	CO_2	Economic	Existing from 2013	Ministry of Energy and Coal Industry
Feed-in Tariff for households	With the adoption in 2015 of the Law of Ukraine No. 514-VIII "On Amendments to Some Laws of Ukraine Concerning the Establishment of Competitive Conditions for the Production of Electricity from Alternative Energy Sources" and the Resolution of NERC from 27.02.2014 No. 170 "On Approval of the Procedure for the Sale, Registration and Settlement for electrical energy, produced from solar energy electric power facilities (generating facilities) private households "introduced the feed-in tariff for households that generate electricity from solar energy in 2013 till the end of 2014 with a coefficient 6.66, with a gradual reduction to 3.36 (or 0.1809 Euro/kWh). Introduction of the feed-in tariff for power generation on the basis of wind energy with a coefficient of 2,16. Growth of the maximum installed capacity from 10 to 30 kW.	CO_2	Economic	Existing from 2015	
Law of Ukraine from 01.11.2016 No. 1711-VIII "On making amendments to the Law of Ukraine" On alternative sources of energy" on assignment heat pumps to equipment that uses renewable sources of energy"	The assignment of heat pumps to RE	CO_2	Economic	Existing from 2016	Ministry of Energy and Coal Industry
Stimulate the production of heat from RE. The CMU Decree from 29.07.2014 No. 293 "On stimulation of replacement of natural gas in the	It is envisaged that in the case of heat production for the population, the difference between the tariff for heat production at the heat generating units (except for CHPs, TPPs and NPPs) other than natural gas and the tariff for heat production for the	CO_2	Economic	Implementation in 2014-2017	Ministry of Energy and Coal Industry

Title	Description	GHG's	Type of tool	Status	Responsible body
field of heat supply".	population using RE is subject to compensation from the state budget. The amount of compensation for the difference in the specified tariffs for the production of heat cannot be higher than the difference between the actual established tariff for heat for the population and its cost, taking into account the marginal level of profitability not exceeding 21%.				
CMU Decree from September 10, 2014. No. 453 "On stimulating the substitution of natural gas at the time of production of thermal energy for institutions and organizations, which are funded from state and local budgets". **Stimulate the production of heat from RE**	Recommends that the National Commission, which carries out state regulation in the areas of energy and utilities, establish a tariff for heat production for budgetary institutions and organizations at heat generating units (except for CHPs, TPPs and NPPs) using any types of fuels other than natural gas at the level tariff for using natural gas.	CO_2	Economic	Implementation in 2014-2016	Ministry of Energy and Coal Industry
CMU Decree No. 491 from October 1, 2014 "On Amendments to the Procedure for Using the Funds Envisaged in the State Budget for Implementation of Measures for the Efficient Use of Energy Resources and Energy Saving". **Stimulate the production of heat from RE**	Imposes a refund of a part of the body of a loan involved in the purchase of boilers using any kind of fuel and energy (other than natural gas) purchased by the population. The compensation is made to each borrower - an individual in the amount of 20% of the loan amount.	CO_2	Economic	Implementation in 2014-2017	Ministry of Energy and Coal Industry, Ministry of Infrastructure
Decree of the Cabinet of Ministers of Ukraine from October 16, 2014 No. 1014-p "On approval of the plan of short and medium term measures for reduction of natural gas consumption for the period till 2017". **Stimulate the production of heat from RE**	Replacing natural gas with other types of energy; in 2015-2016, reimbursement of parts and loans to enterprises and population issued for the purchase of energy saving equipment and non-natural gas boilers development of the terms of adoption of bio-methane in the gas transportation system; Development of me-chanism in which would envisage making heat generating orga-nizations that produce heat using RE contracts to 5 years in the field of heat; Simplification of land allocation for RE objects	CO_2	Economic	Implementation in 2014-2016	Ministry of Energy and Coal Industry, Ministry of Infrastructure
Law of Ukraine "On the Natural Gas Market" from April 9, 2015, No. 329-VIII	Biogas producers have access to gas transmission and distribution systems, gas storage facilities, LNG plants, and to join gas and gas distribution systems.	CO_2	Economic	Implementation from 2015	Ministry of Energy and Coal Industry, Ministry of Agrari-an Policy and Food

Title	Description	GHG's	Type of tool	Status	Responsible body
Law of Ukraine "On amendments to the Law of Ukraine "On heat supply" regarding stimulation of the production of heat from alternative energy sources "from March 21, 2017 No. 1959-VIII	Establishment of a tariff for heat with RES in the amount of 90% of the tariff for heat from gas with acceptance	CO_2	Economic	Implementation since 2017	Ministry of Energy and Coal Industry, Ministry of Agrarian Policy and Food
Concept of realization of the state policy in the field of heat supply	Optimization of heat supply, reduction of heat loss, reduction of the average annual energy consumption	CO_2	Planning	Implementation in 2017-2035	Ministry of Energy and Coal Industry
Law of Ukraine from 22.05.2017 No. 2222-VIII "On the Accession of Ukraine to the Statute of the International Agency for Renewable Energy "IRENA"	Accession f Ukraine to the Statute of the International Agency for renewable energy «IRENA»	CO_2	Economic	Implementation since 2017	Ministry of Energy and Coal Industry

Table VII.3. Transport Sector

Name	Description	GHG's	Type of tool	Status	Responsible body
Transport strategy of Ukraine 2020	Development of transport infrastructure. Development of environmentally friendly and energy efficient modes of transport	CO_2	Planning	Implementation in 2011-2020	Ministry of Infrastructure
Mandatory blending of biological component to gasoline	Law of Ukraine No. 4970-VI "On Amending Certain Laws of Ukraine on the Production and Use of Motor Fuels with Content of Bio-components"	CO_2	Economic	Existing in 2014-2015	Ministry of Energy and Coal Industry, Ministry of Infrastructure

APPENDIX A. METHODOLOGICAL WORKSHOP (KYIV, UKRAINE, MARCH 13, 2019)

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ДУ "Інститут економіки та прогнозування НАН України"

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53.	Масюков Павло	Senior Project Coordinator проект технічної допомоги GIZ "Підтримка встановлення схеми торгівлі викидами парникових газів (СТВ) в Україні"	pavlo.masiukov@giz.de 0507736820	
54.	Матющенко Дмитро Олександрович	Начальник відділу міжнародного галузевого та інвестиційного співробітництва Управління економічного співробітництва МЗС	dmytro.matiuschenko@mfa.gov.ua (044)238-18-88 (098)792-85-41	

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55.	Медведенко Інесса Вікторівна	Державний експерт Управління з питань енергетичної та техногенної безпеки Служби з питань економічної, соціальної та енергетичної безпеки Апарату Ради національної безпеки та оборони України	miv@rnbo.gov.ua (044)255-07-60	
56.	Мельник Юлія Олександрівна	Голова Ради ГО «Еколтава»	julia.pashkovska@350.org	
57.	Мозолевич Григорій Якович	Керівник експертної групи з питань розвитку дослідницької інфраструктури МОН	mozolevych@mon.gov.ua	
58.	Оночук Ігор Миколайович	Заступник начальника управління інвентаризації та моніторингу-начальник відділу інвентаризації Бюджетної установи «Національний центр обліку викидів парникових газів»	(044) 2810611 imo@nci.org.ua	
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61.	Подолець Роман Здиславович	Завідувач сектору Державної установи "Інститут економіки та прогнозування НАН України"	podolets@ief.org.ua (067)240-96-50	
62.	Порєва Віра	Магістрант кафедри Європейської інтеграції та формування нацбезпеки Національної Академії державного управління при Президентові України	por2be@gmail.com 095-310-60-07	
63.	Поєдинок Микола Сергійович	Заступник Голови – керівник виконавчої дирекції всеукраїнської асоціації сільських та селищних рад	vassr@vassr.org 585-90-12	
64.	Прокопенко Олег Миколайович	Директор департаменту статистики сільського господарства та навколишнього середовища Держстату	o.prokopenko@ukrstat.gov.ua 289-72-80	
65.	Рабошук Ярослав Олексійович	Директор Аналітичного центру Всеукраїнської асоціації органів місцевого самоврядування «Асоціація міст України»	raboshuk@auc.org.ua	
66.	Радченко Роман Миколайович	Начальник відділу енергозбереження в сфері житлово-комунального господарства Департаменту систем життєзабезпечення та житлової політики Мінрегіону	radchenkoRM@minregion.gov.ua 207-18-77 06704107188	
67.	Роговий Максим	Директор Укренергомережпроект	eltakharkov@gmail.com +380505950311	
68.	Рябчин Олексій Михайлович	Голова підкомітету з питань енергозбереження та енергоефективності Комітету Верховної Ради України з питань паливно-енергетичного комплексу, ядерної політики та ядерної безпеки	Ryabchyn.Oleksii@rada.gov.ua	

№ п/п	ПІБ	Посада	Контактні дані (E-mail, телефон)	Підпис
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70.	Саприкіна Тетяна Анатоліївна	Молодший науковий співробітник державної установи "Інститут економіки та прогнозування НАН України"	saprykina.tan@gmail.com (097)438-40-01	
71.	Сафаров Фарід Каміл огли	Керівник експертної групи з питань цифрової інфраструктури на транспорті Директорату державної політики у сфері цифрової інфраструктури на транспорті та послуг поштового зв'язку Мінінфраструктури	safarov@mtu.gov.ua +38(093) 688-44-44	
72.	Семків Ольга	Проектний менеджер (напрямок - впровадження Директиви 2010/75) КПР при Мінприроди	olga.semkiv@gmail.com +38 050 132 0161	
73.	Семенюк Андрій	modeller 350.org	semeniuk.and.i@gmail.com +380669260070	
74.	Сеперович Наталія Володимирівна	Державний експерт групи стратегічного планування Директорату стратегічного планування та євроінтеграції Мінагрополітики	nataliia.seperovych@minagro.gov.ua	
75.	Симоненко Олена	Technical Professional проект технічної допомоги GIZ "Підтримка встановлення схеми торгівлі викидами парникових газів (СТВ) в Україні"	Olena.Symonenko@giz.de +380 44 594 07 63 +380 96 462 36 09	
76.	Скоблик Олег	Директор Грін Райз Інвест	oleg.skoblyk@gmail.com 0731004807	
77.	Сошенко Юлия Владимировна	Головний спеціаліст апарату Генерального директора ДТЕК Енерго	SoshenkoYuV@dtek.com +38 050 428 1880	
78.	Сусак Олег Васильович	Державний експерт експертної групи з питань сталого розвитку ПЕК, екології, захисту клімату та енергоефективності ПЕК Директорату стратегічного планування та європейської інтеграції Міненерговугілля	oleg.susak@mev.gov.ua 531-34-50 097-166-45-37	
79.	Тарасенко Олександр Володимирович	Заступник директора Департаменту стратегії та європейської інтеграції - начальник відділу координації між народних проектів Мінприроди	o.tarasenko@menr.gov.ua 206-20-28	
80.	Тіторук Галина Миколаївна	головний фахівець Відділу розвитку екологічних програм та екологічного аудиту НАК «Нафтогаз України»	Titoruk@naftogaz.com	
81.	Толкачов Василь	Deputy Project Manager UNOPS	vasylt@unops.org +380 50 446 5005	
82.	Трипольська Галина Сергіївна	Старший науковий співробітник державної установи "Інститут економіки та прогнозування НАН України"	g.trypolska@gmail.com (096)797-25-70	

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84.	Хакимзянов Айрат Khakimzianov Airat	Директор ТОВ "УкрЕвроКонсалтинг"	ukreuroconsulting@gmail.com +380504465949	
85.	Хоменко Юрій Іванович	Начальник відділу енергетики та відновлювальних джерел Управління технічної політики в АПК Мінагрополітики	khomenko@minagro.gov.ua 280-41-66	
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87.	Черних Олександр Олександрович	Директор департаменту промислової політики Мінекономрозвитку	chernykh@me.gov.ua 067 625-53-11 200-45-28	
88.	Чиженко Михайло Іванович	Начальник відділу кліматичної політики та звітності Департаменту з питань зміни клімату та збереження озонового шару Мінприроди	chyzhenko@gmail.com 245-47-18	
89.	Шаповалова Олеся	Senior Specialist Міністерство екології та природних ресурсів України	alesia.shapovalova@gmail.com	
90.	Шлапак Микола	консультант	m.shlapak.ua@gmail.com +380669529735	
91.	Шмідт Галина Борисівна	Член Правління ГС "Українська вітроенергетична асоціація", головний експерт зі стратегічних питань щодо декарбонізації за рахунок ВДЕ	uwea@i.ua	
92.	Шмурак Анатолій	senior expert Міністерство екології та природних ресурсів України	shmurak@i.ua 380974501467	
93.	Шутяк Софія Володимирівна	Провідний юристконсультант Міжнародної благодійної організації «Екологія-Право-Людина»	s.shutiak@epl.org.ua 097 981 23 43	
94.	Ярова Світлана Михайлівна	Заступник завідувача відділу промислової та енергетичної політики департаменту реального сектору економіки Головного департаменту з питань економічної політики Адміністрації Президента України	svitlana.iarova@apu.gov.ua	
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96.	Радійчук Любава Володимирівна	перекладач	0677616920 radiychuk.Liubava@gmail.com	
97.	Юхимець Роман Сергійович	н.с. Інст. "Економіки і прогн." НАНУ	063-578-81-42 r.uhimets@gmail.com	
98.	Корнієнко Ганна Сергіївна	PMR Ukraine	063-180 64 93 hanna.kornienko@gmail.com	
99.	Платонова Антоніна Євгеніївна	Лікар-фізіолог	095 301 2319 platonovaantonina@gmail.com	
100.	Бабенко Тарас Анатолійович	команда проекту PSPP		
101.	Серебрянська Д.М.	ДУ "Інст ек. та прогн НАНУ" к.е.н., наук. співроб.	0971029677 dina_89@ukr.net	
102.				
103.				

PART 2. PRESENTATION

Методологічний семінар щодо розробки другого Національно-визначеного внеску України до Паризької угоди

Second Ukrainian NDC Methodological Workshop

Київ
13 березня 2019

European Bank
for Reconstruction and Development

Проект ЄБРР "Підтримка Уряду України щодо оновлення національно-визначеного внеску"

Sweden
Sverige

Зміст

1. Про проект ЄБРР
2. Загальні принципи та методологічний підхід до розробки другого НВВ України
3. Методологічний підхід до розробки другого НВВ

Перерва на каву

4. Методологічні підходи до моделювання по секторах
5. Обговорення
6. Обід

Проект ЄБРР “Підтримка Уряду України щодо оновлення національно-визначеного внеску”

Проект технічної допомоги “**Підтримка Уряду України щодо оновлення національно-визначеного внеску**” впроваджується ЄБРР в рамках “Програми підтримки розробки та імплементації Паризької угоди та Національно визначених внесків в регіоні ЄБРР” за фінансової підтримки уряду Швеції

Метою Проекту є підвищення рівня готовності України до участі у першому Глобальному Підведені Підсумків (Global Stocktake) в рамках Паризької угоди

Проект ЄБРР в цифрах

Термін впровадження проекту:

Початок проекту – 12 листопада 2018 року

Закінчення проекту – 30 грудня 2019 року

Команда проекту:

Інститут економіки та прогнозування Національної академії наук України, національні та міжнародні експерти

Статус проекту на поточний момент

Завдання проекту ЄБРР

Надати допомогу уряду Україні щодо розробки її другого НВВ шляхом:

- Побудови макроекономічних сценаріїв та відповідних сценаріїв скорочення викидів ПГ в контексті діючого та запланованого законодавства та існуючих економічних та секторальних прогнозів
- Оцінювання національного вуглецевого балансу (бюджету) відповідно до розроблених сценаріїв
- Визначення відповідних цілей із адаптації до зміни клімату
- Оцінювання потреб у кліматичному фінансуванні заходів із запобігання та адаптації та доступі до ринкових механізмів
- Підтримання процесу консультацій з зацікавленими сторонами
- Розробки проекту другого НВВ України

Основні очікувані результати проекту ЄБРР

- ✓ Огляд діючих та запланованих стратегій, планів та заходів з запобігання та адаптації до зміни клімату
- ✓ Сценарії викидів ПГ до 2030
- ✓ Оцінка вуглецевого балансу (бюджету)
- ✓ Визначенні цілі та заходи із запобігання та адаптації в рамках розроблених сценаріїв
- ✓ Оцінка рівня необхідного кліматичного фінансування
- ✓ Проект другого НВВ України

Загальні принципи та методологічний підхід до розробки другого НВВ України

Зміна клімату – міжнародний контекст

- ✓ **Рамкова конвенція ООН про зміни клімату**, загальна мета якої є стабілізація концентрації парникових газів в атмосфері на рівні, якій дозволить запобігти небезпечного антропогенного втручання в кліматичну систему
- ✓ **Кіотський протокол**, як інструмент досягнення мети РКЗК ООН
- ✓ **Паризька угода**, яка, в контексті сталого розвитку та викорінення бідності, передбачає підхід знизу-вгору до формування внесків кожної країни-сторони до боротьби зі зміною клімату в рамках посилення імплементації РКЗК ООН та досягнення її мети

Міжнародні зобов'язання щодо НВВ

СТАТТЯ 4 Паризька Угода

9. Кожна **Сторона зобов’язана повідомляти національно-визначений внесок кожні п'ять років** відповідно до рішення 1/CP.21 та будь-яких відповідних рішень Конференції Сторін, що є нарадою Сторін Паризької угоди, та бути проінформована щодо результатів глобального підведення підсумків, зазначеного Статті 14.

Рішення X/CMA.1 Конференції Сторін, яка є нарадою Сторін Паризької угоди

“7. Постановляє, що у свої **другі** та наступні **національно-визначені внески Сторони повинні** включати інформацію згідно з **Додатком I** (Інформація для сприяння чіткості, транспарентності та розуміння національно-визначених внесків відповідно до пункту 28 рішення 1/CP.21), яка стосується їх національно-визначених внесків… “

Національне законодавство та передумови

- ✓ Концепція реалізації державної політики у сфері зміни клімату на період до 2030 року
- ✓ План заходів щодо виконання Концепції реалізації державної політики у сфері зміни клімату на період до 2030 року
- ✓ Стратегія низьковуглецевого розвитку України на період до 2050 року
- ✓ Енергетична стратегія України до 2035 року
- ✓ Національний план управління відходами до 2030 року
- ✓ Національна транспортна стратегія до 2030 року
- ✓ Стратегія державної екологічної політики до 2030 року
- ✓ **проект** Стратегії адаптації до зміни клімату сільського, лісового та рибного господарства України до 2030 року

Мінприроди створено **Робочу групу** щодо розробки другого НВВ України (перше засідання відбулось 4 лютого 2019)

Координація та співпраця

- ✓ Світовий банк, Партнерство заради ринкові готовності
- ✓ Проект GIZ щодо створення системи торгівлі квотами на викиди парникових газів
- ✓ Проект USAID Енергетична безпека України
- ✓ Інтегровані кліматичні та енергетичні плани в рамках Енергетичного співтовариства
- ✓ Ініціативи FAO, UNIDO та ПРООН
- ✓ EU4CLIMATE
- ✓ EU4ENERGY
- ✓ Угода мерів

Стратегічні питання

- Якою може бути довготермінова ціль/цілі другого НВВ України? На якій період?
- Який внесок України зі скорочення викидів може вважатися ”справедливим” в рамках довготермінових глобальних зусиль відповідно до останніх наукових висновків?
- Які політики та заходи є технологічно доцільними для швидшого скорочення викидів? Які структурні перетворення є необхідними?
- Які потенційні витрати є виправданими задля досягнення довготермінової цілі/цілей? Існуючі переваги та протиріччя на шляху досягнення цілі/цілей

Методологічний підхід

Для розробки другого НВВ пропонуємо наступні кроки:

- Розробити низку (не менше двох) **макроекономічних сценаріїв** розвитку України
- Розробити низку **сценаріїв скорочення викидів ПГ** (не менше трьох для кожного макроекономічного сценарію)
- Визначити цілі та політики з адаптації

Результати методологічного підходу

Запропонований **методологічний підхід** наддасть можливість визначити для другого НВВ:

1. Потенційну ціль/цілі
2. Заходи та політики для досягнення цих цілей/цілі
3. Найбільш ефективні та фінансово привабливі шляхи досягнення цілей/цілі
4. Супутні вигоди при досягненні цих цілі/цілей
5. Цілі з адаптації та передумову їх досягнення

Надалі проект презентує

- Визнанні світові практики моделювання НВВ
- Переваги та недоліки існуючих моделей
- Запропоновані моделі для другого НВВ України
- Підходи до відбору вхідних даних
- Питання для обговорення

Proposed methodological framework for modelling

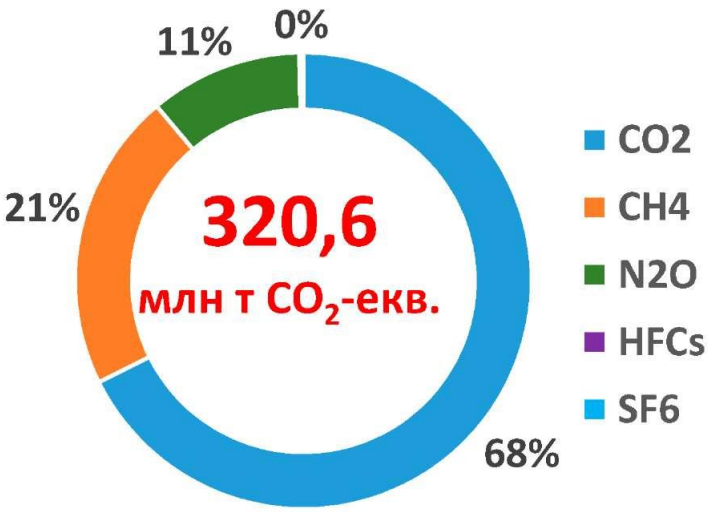
Запропонований методологічний підхід до моделювання

Пропонований методологічний підхід для другого НВВ України

Proposal on Ukraine's second NDC methodological approaches

Структура викидів ПГ в Україні в 2016 році

Сектори викидів ПГ	Частка
1. Енергетика	67%
2. Промислові процеси та використання продукції	17%
3. Сільське господарство	12%
4. Землекористування, зміна землекористування та лісове господарство	-5%
5. Відходи	4%
6. Інше	-
ВСЬОГО	**320,6 млн т CO_2-екв.**



Ми пропонуємо комплексний підхід до моделювання динаміки викидів ПГ у всіх секторах їх продукування!

Застосування модельних засобів в Україні

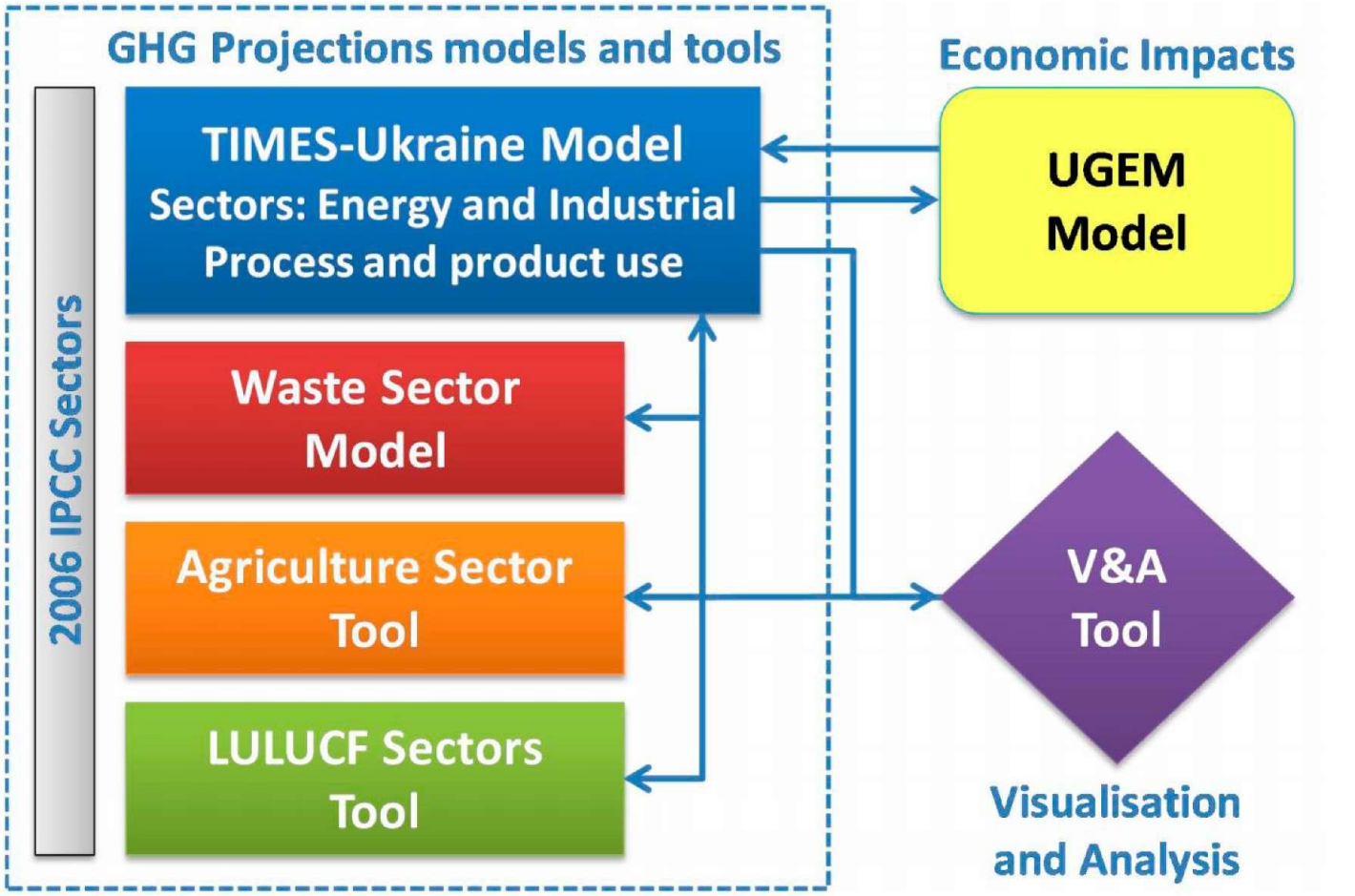
Стратегічні документи, що впливають/впливатимуть на рівень викидів парникових газів при підготовці яких були застосовані модельні засоби:

1. Стратегія низьковуглецевого розвитку до 2050 року
2. Енергетична стратегія України на період до 2035 року
3. Національний план дій з енергоефективності на період до 2020 року
4. Національний план дій з відновлюваної енергетики на період до 2020 року
5. Шосте Національні повідомлення України з питань зміни клімату

Стратегічні документи, що впливають/впливатимуть на рівень викидів парникових газів, які готувалися без модельних засобів

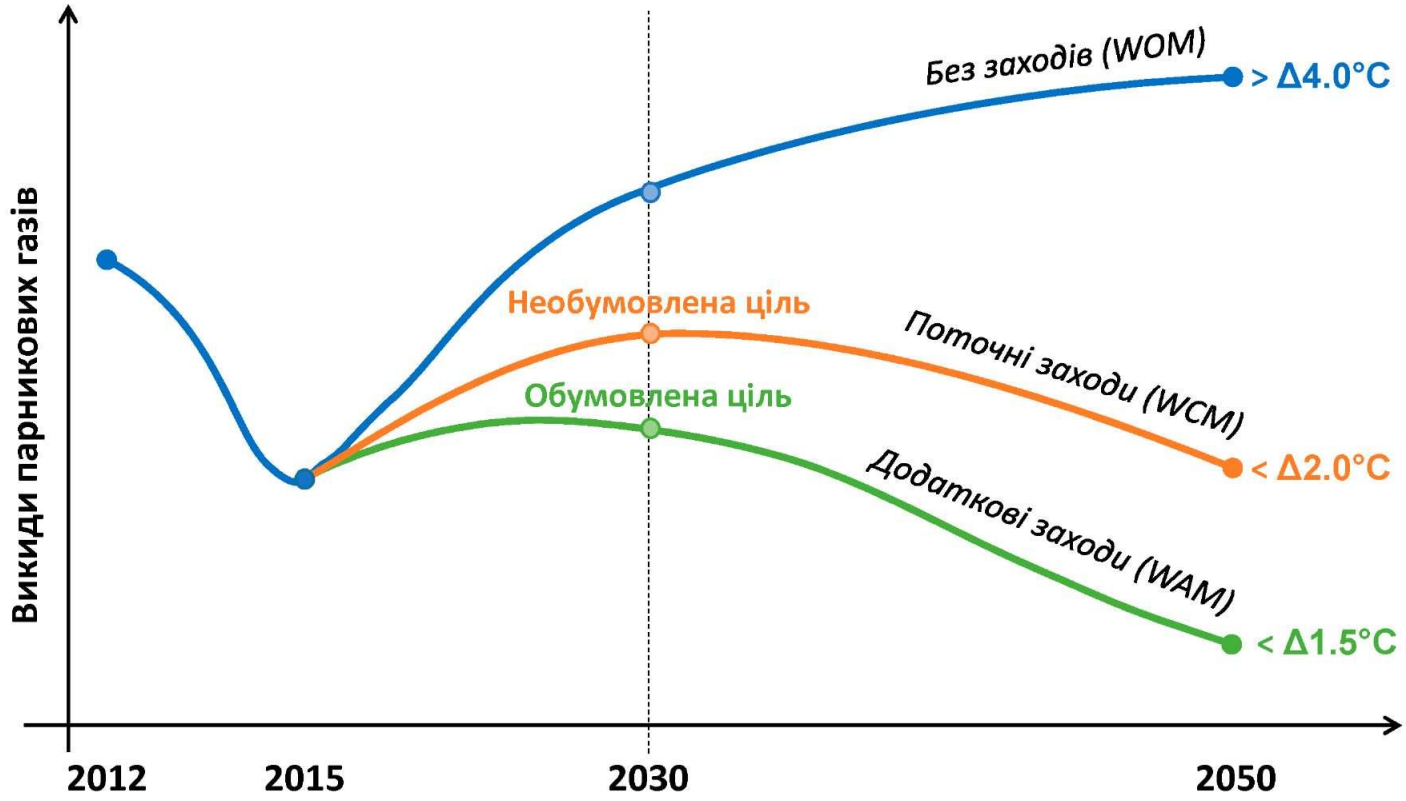
1. Концепція реалізації державної політики у сфері зміни клімату до 2030 р.
2. Стратегія державної екологічної політики України до 2030 року
3. Стратегія державної екологічної політики України на період до 2020 року
4. Національна стратегії управління відходами в Україні до 2030 року
5. Концепція реалізації державної політики у сфері теплопостачання (до 2035 р.)
6. Транспортна стратегія України на період до 2030 року
7. Національна транспортна стратегія України на період до 2030 року
8. Єдина комплексна стратегія розвитку сільського господарства та сільських територій на 2015-2020 роки

Комплекс засобів моделювання динаміки викидів ПГ в Україні



Зв’язування моделей TIMES-Ukraine та UGEM моделей

Модельні сценарії скорочення викидів ПГ



Розробка умов та припущень низки сценаріїв буде відбуватись в рамках Робочої групи з підготовки другого НВВ та публічно дискутуватиметься!

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Швеція
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Другий НВВ і сталий розвиток: методологічні аспекти

Second NDC and Sustainable Development: methodological aspects

Основоположні документи

Порядок денний в області сталого розвитку на період до 2030 року

(Вер. 2015)

ЦСР

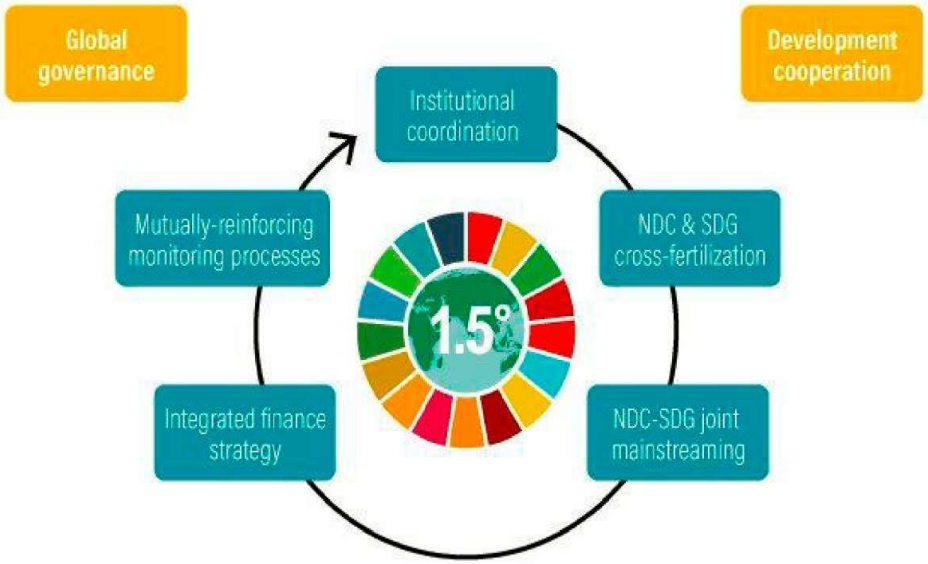
Паризька Угода

(Гру. 2015)

НВВ

Інтегрований підхід

Integrated Approach to the SDG and NDC
Implementation through the Policymaking Cycle



WORLD RESOURCES INSTITUTE

Source: WRI Author

Важливе зауваження № 1

Визначення сталого розвитку в аспекті зміни клімату, має **національний** характер.

Важливе зауваження №2

NDC ≠ QUELRO

Де:

NDC – Національно визначені внески

QUELRO - Зобов'язання щодо кількісного обмеження викидів та скорочення викидів за КП)

Методологічні аспекти

- Основа – людяність та сталий розвиток.
- Партнерство між інституціями.
- Інституційна підтримка міжнародних партнерів (Інтегровані кліматичні партнерства).
- SCAN Tool?

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Швеція
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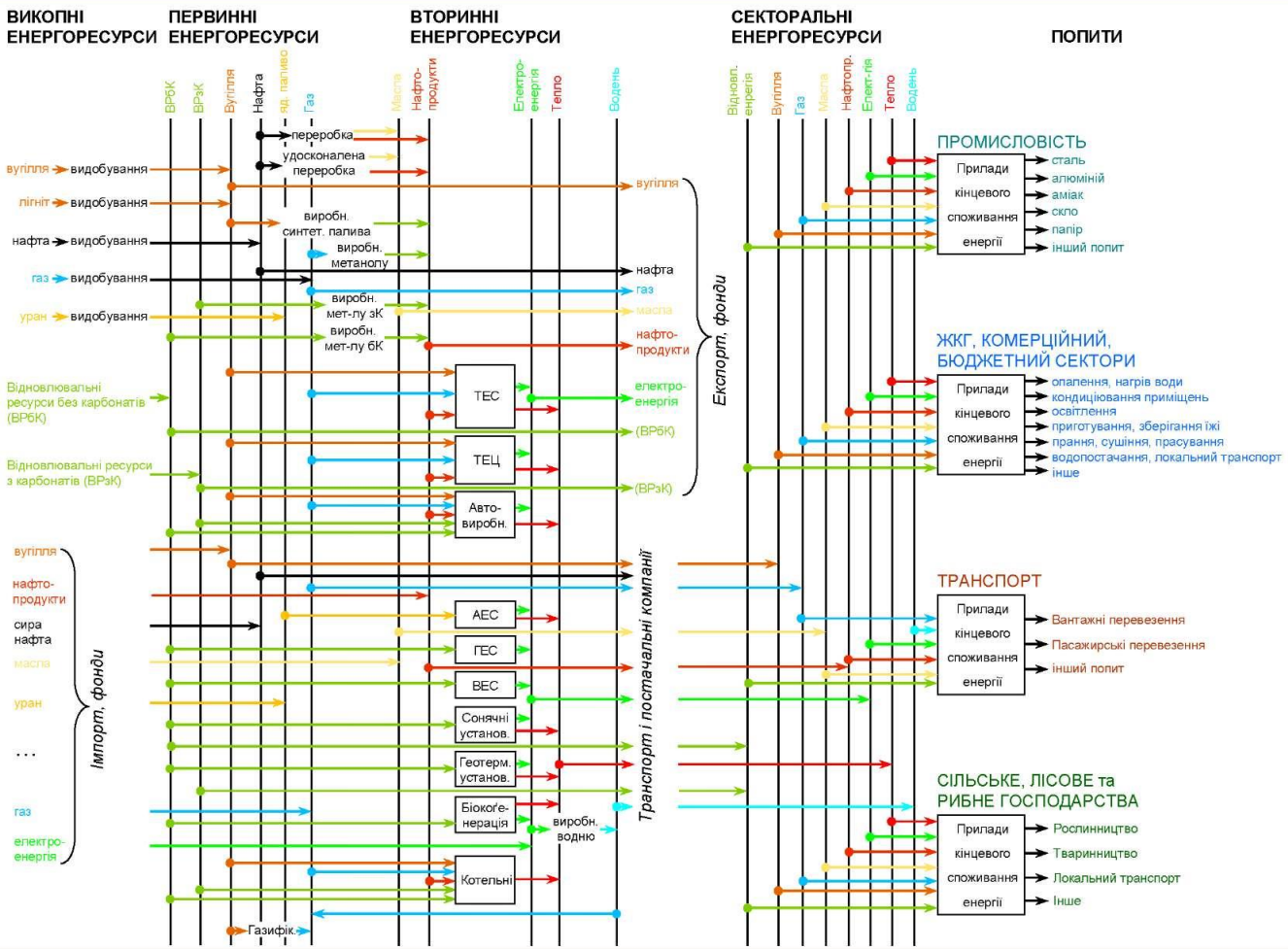
Моделювання динаміки викидів ПГ в секторах Енергетика та Промислові процеси

Modelling of GHG emissions pathway in Energy and Industrial Process Sectors

Структура енергетичної системи в моделі TIMES-Україна
Structure of energy system in TIMES-Ukraine model



Загальний опис моделі TIMES-Україна
General description of TIMES-Ukraine model

- ✓ Модель TIMES-Україна є оптимізаційною моделлю енергетичних потоків України (bottom-up модель).
- ✓ Результатом моделювання є оцінка найменших витрат на функціонування усієї енергетичної системи країни при заданих умовах та обмеженнях.
- ✓ Енергетична система України в моделі TIMES-Україна представлена єдиним регіоном і складається з семи секторів: сектор постачання енергії (виробництво, імпорт, експорт тощо); виробництво електроенергії і тепла; промисловість; транспорт; побутовий сектор (населення); торгівля та послуги; сільське господарство (в т.ч. рибальство).
- ✓ Структура моделі відповідає структурі енергетичного балансу України.
- ✓ В моделі TIMES-Україна враховано понад 1,6 тис. технологій.
- ✓ База даних моделі відкалібрована за даними 2012 року і оновлено основні дані за 2013-2017 роки.
- ✓ **Модель TIMES-Україна відповідає методичним рекомендаціям міжнародних організацій з розробки енергетичних й екологічних прогнозів, зокрема, рекомендаціям секретаріату Рамкової Конвенції ООН зі зміни клімату стосовно розробки національних повідомлень.**

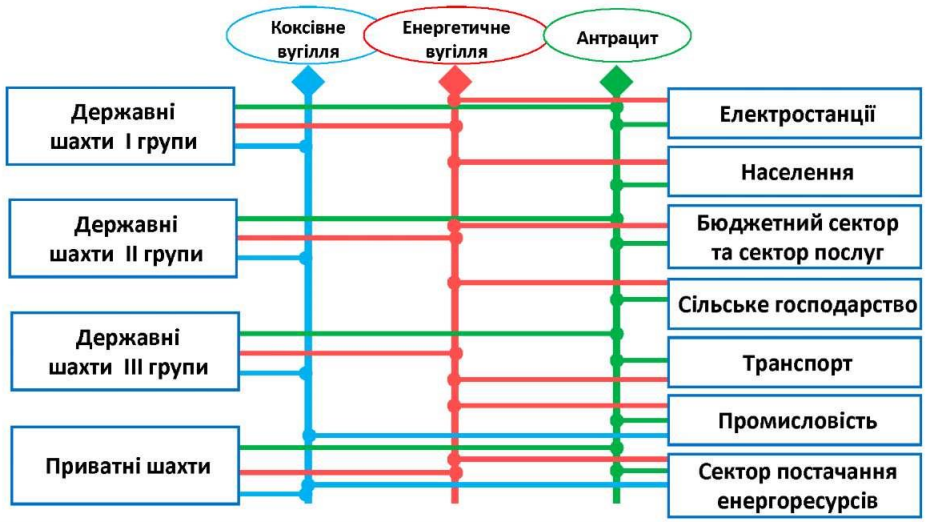
Для яких цілей використовується модель TIMES-Україна?
For what purposes is the TIMES-Ukraine model used?

Модель TIMES-Україна зорієнтована, зокрема, на дослідження таких задач:

- ✓ Оцінка оптимальної технологічної структури енергосистеми за критерієм мінімізації зведених витрат;
- ✓ Аналіз структури енергетичних, матеріальних та фінансових потоків із урахуванням факторів взаємозаміщення ресурсів;
- ✓ Оцінка потенціалу енергозбереження, відновлюваних джерел енергії, нових видів енергії та палива і визначення пріоритетності заходів їх реалізації;
- ✓ Прогнозування динаміки обсягів викидів парникових газів;
- ✓ Виявлення можливих загроз в енергозабезпеченні країни та визначення заходів для їхнього попередження;
- ✓ Оцінка впливу енергетичної, економічної, екологічної, кліматичної, промислової, аграрної, транспортної, інноваційної та інших політик на розвиток енергетики;
- ✓ Дослідження переваг та ризиків інтеграційних процесів та міжнародних зобов’язань в енергетичній, екологічній, кліматичній та інших сферах.
- ✓ …

Основні процеси в секторі постачання енергоресурсів
Key process in energy supply sector

Для нафти і природного газу технології видобутку розділені на чотири типи за основною профільністю компаній (нафтовидобувні, газовидобувні, видобування на морському шельфі та інші), що характеризують різні умови видобутку та собівартість сировини.



Видобуток вугілля розділено на чотири категорії: три групи державних шахт і приватні шахти.

Така дизагрегація була необхідна для розробки сценаріїв видобутку вугілля при розробці Плану заходів з реформування вугільного сектору у рамках проекту ЄС за програмою TACIS.

Виробництво електроенергії та тепла
Electricity and heat production

** Блок-станції включають заводські і відомчі електростанції та котельні переважно для власних потреб*

Теплові електростанції *детально представлені за блоками або групами однотипних блоків і згруповані за належністю до однієї з п’яти генеруючих компаній.*

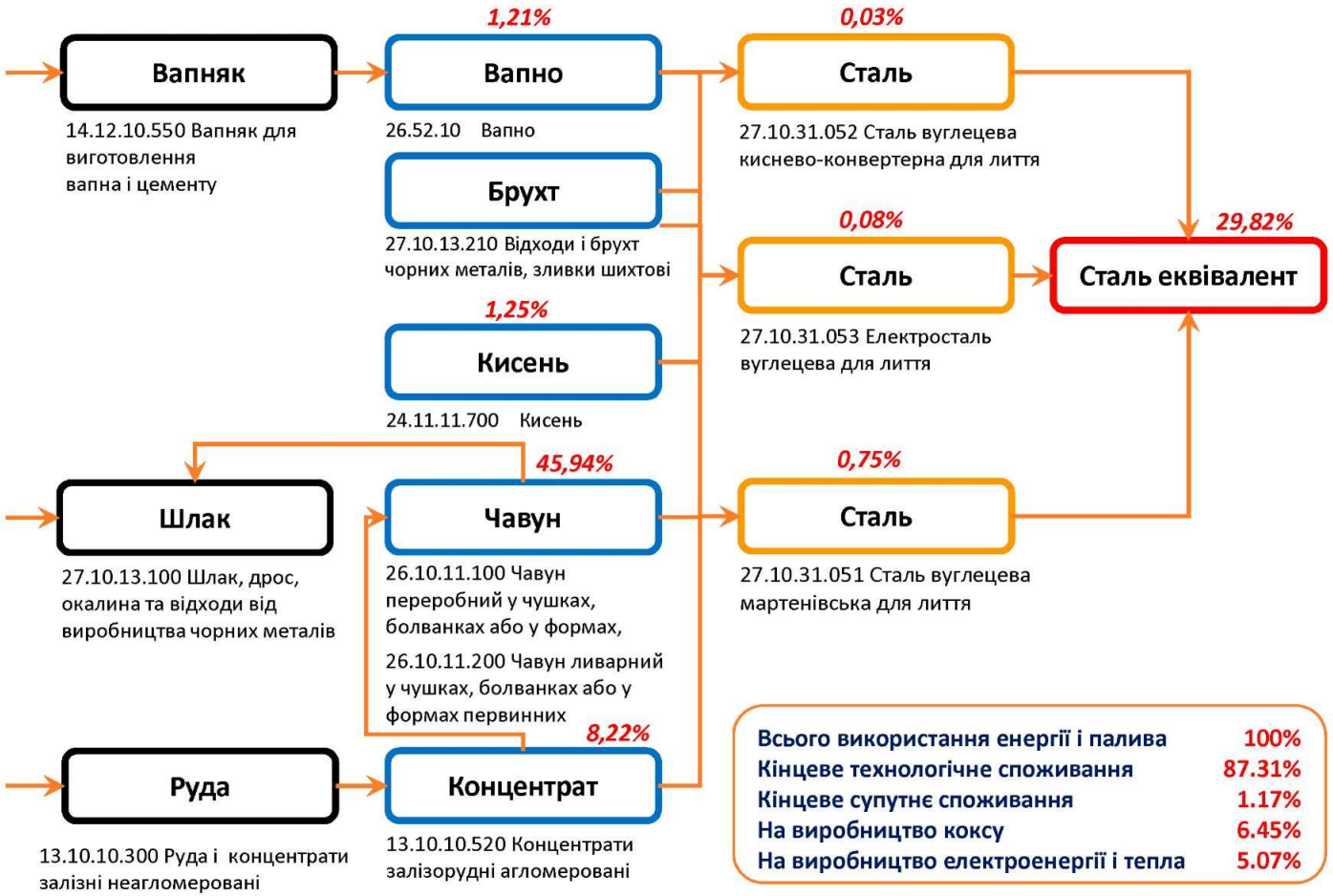
Теплоелектроцентралі *представлені 18-ма найбільшими в Україні ТЕЦ, що відповідають більше 85% встановленої потужності електроцентралей.*

Атомні електростанції *представлені окремо кожним блоком.*

Гідроенергетика *розділена на гідроелектростанції та гідроакумулюючі електростанції.*

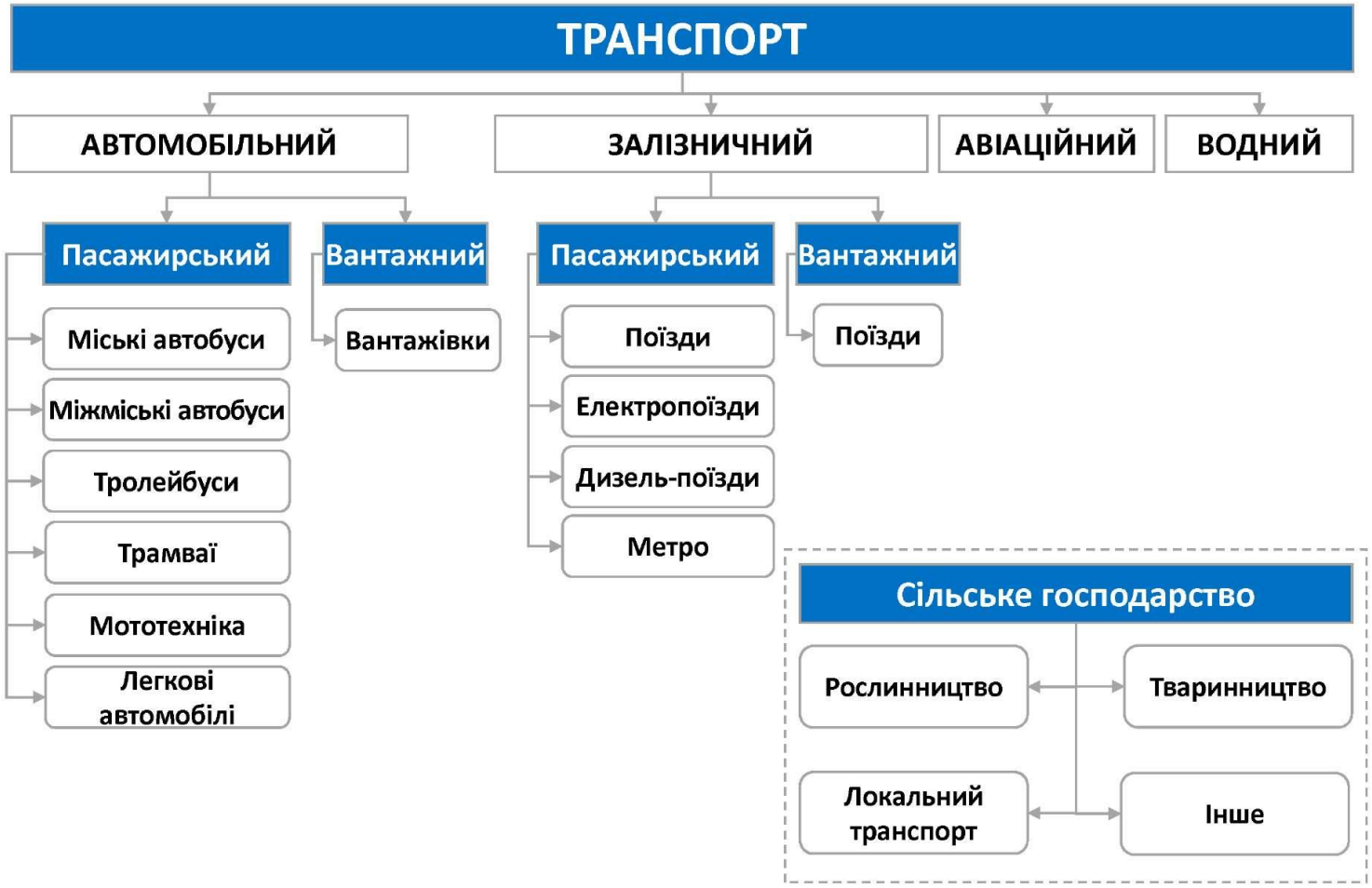
Автовиробництво *електроенергії та тепла задається відповідними групами технологій для кожного сектора і окремо для енергоємних галузей промисловості.*

Моделювання споживання енергії в металургії
Modeling of energy consumption in metallurgy



Населення, комерційний та бюджетний сектори
Population, commercial and public sectors

Транспорт та сільське господарство
Transport and agriculture



Останні публікації
Last publication

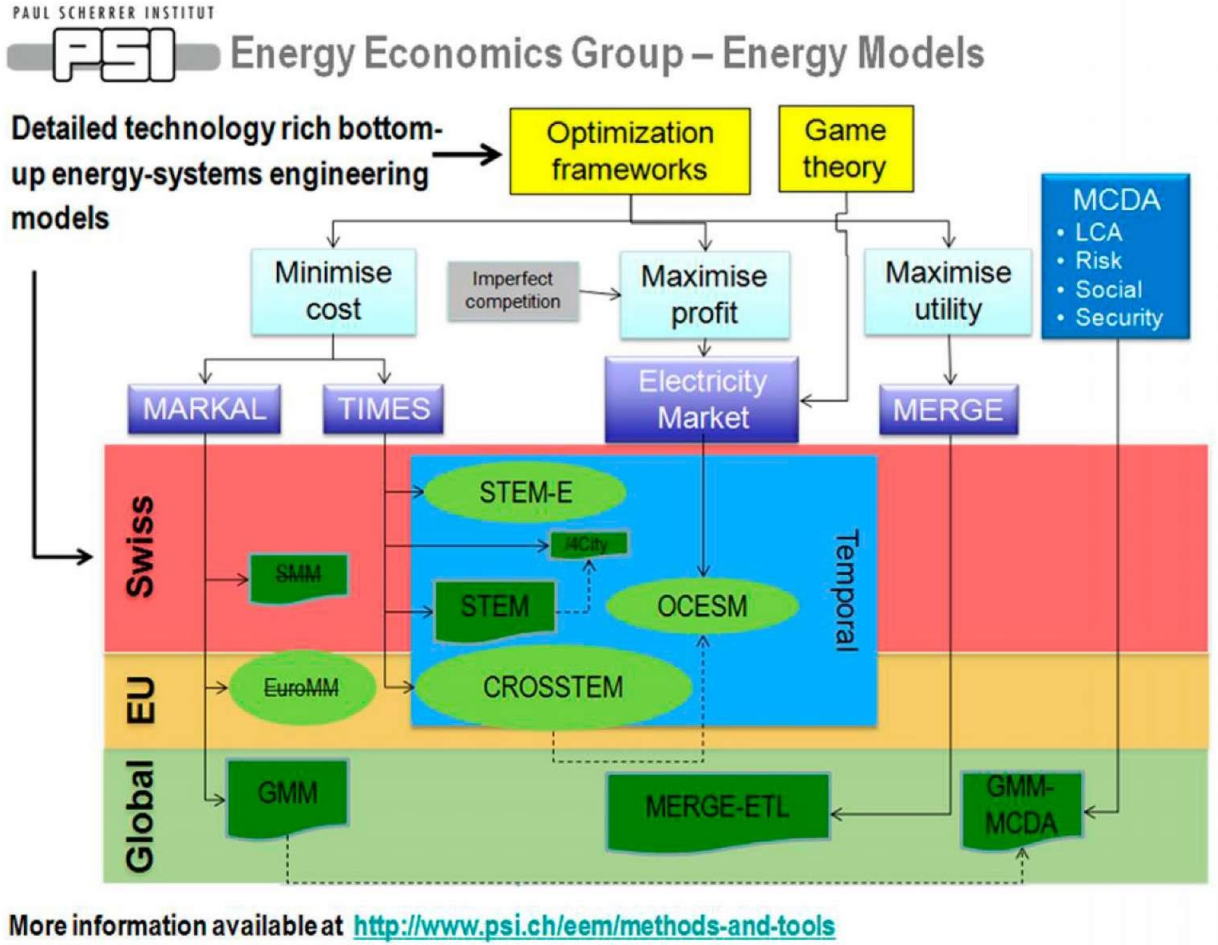
Джерела даних моделі та пов'язані з цим проблеми
Data sources of the model and related problems

- ✓ База даних моделі TIMES-Ukraine включає звітні дані:
  - *статистичні спостереження Державної служби статистики України;*
  - *дані Міненерговугілля; Мінекономіки, Мінприроди, МВС, Мінрегіону, ДАЕЕ, енергетичних генеруючих та постачальних компаній та інших.*
- ✓ Для визначення перспективних енергетичних технологій та їх техніко-економічних характеристик використовуються дані МЕА (зокрема, в ETP, E-TechDS), DIW Berlin, IAEA, OECD, DEA та інші.
- ✓ Використовуючи дані спеціалізованих асоціацій та компаній (Біоенергетична асоціація України, Українська вітроенергетична асоціація, Українська асоціація відновлюваних джерел енергії), «Енергоатом», «Укренерго», ДТЕК, «Нафтогаз України» та ін.
- ✓ Структура попитів в секторах кінцевого споживання кореспондується з відповідними структурами в моделях європейських країн.
- ✓ Довгострокові макроекономічні показники розвитку базуються на даних ІЕП НАНУ, міжнародних фінансових, рейтингових агентств та інших організацій (МВФ, Світовий банк, Standard & Poor's тощо), а також даних Мінекономрозвитку.
- ✓ Прогноз цін на основні енергоресурси базується на даних Світового банку.
- ✓ Прогнози демографічної динаміки в Україні базуються на даних Інституту демографії та соціальних досліджень НАНУ та Департаменту економічних і соціальних питань ООН.
- ✓ Коефіцієнти викидів парникових газів базуються на даних Національного кадастру антропогенних викидів із джерел і абсорбції поглиначами парникових газів в Україні.

Переваги і недоліки моделей TIMES
Advantages and disadvantages of a TIMES models

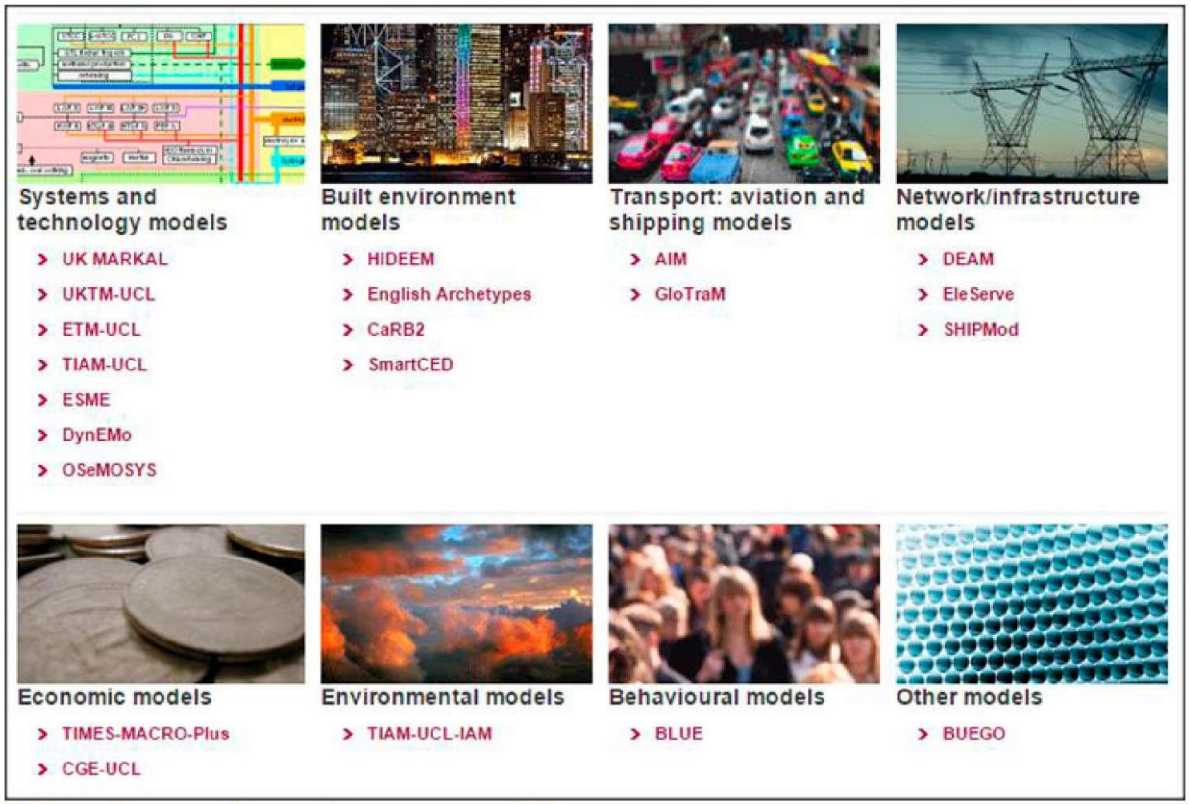
Переваги	Недоліки
1. Рекомендовані міжнародними організаціями та секретаріатом Рамкової Конвенції ООН зі зміни клімату. 2. Постійна підтримка та розширення можливостей моделі. 3. Велика кількість користувачів і наявність значної кількості площадок для обміну досвідом. 4. Детально описує усю енергетичну систему: від видобутку/постачання енергоресурсів до їх кінцевого споживання, разом із промисловими процесами. 5. Поєднує в собі різні системні підходи: технічний та економічний. 6. Можливість мульти-регіонального моделювання та прогнозування. 7. Враховує усі викиди парникових газів в секторах Енергетика та промислові процеси, відповідно до Кадастру викидів ПГ.	1. Потребує спеціальної фахової підготовки або залучення відповідних фахівців. 2. Потребує великої кількості статистичних та адміністративних даних. 3. Не достатні можливості моделювання ринку енергоресурсів. 4. Не достатні можливості аналізу адекватності та надійності роботи електроенергетичного сектору. 5. Значна вартість ліцензій: 1) GAMS/Solver: $640 (для наукових установ); $12,800 (для комерційних установ); 2) модельні оболонки: $1200 (для наукових установ); $12,000 (для комерційних установ).

Приклад комплексу енерго-економічних моделей в Швейцарії
Framework of economics and energy models in Switzerland



Приклад комплексу енерго-економічних моделей в Англії
Framework of economics and energy models in England

Energy modelling at UCL Energy Institute



https://www.ucl.ac.uk/energy-models

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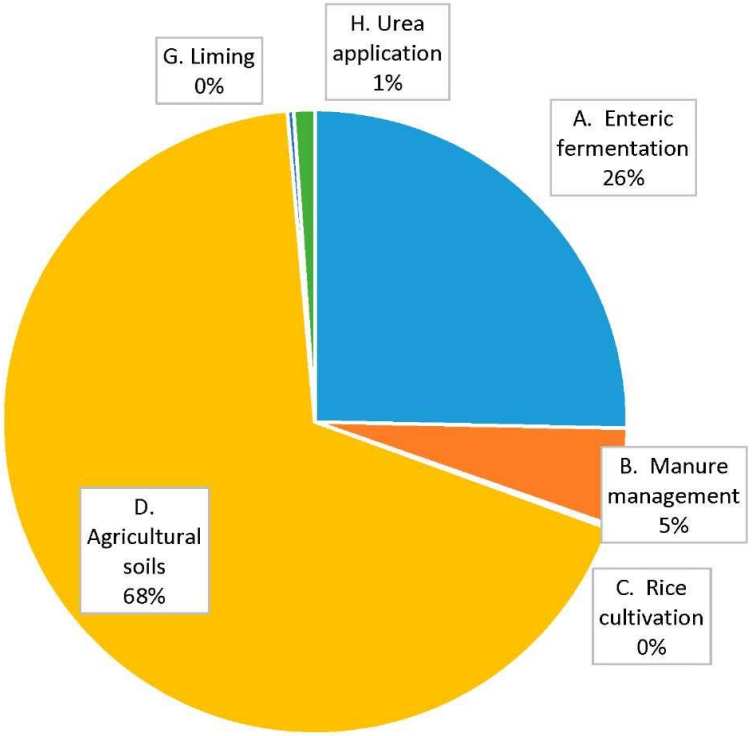
Швеція
Sverige

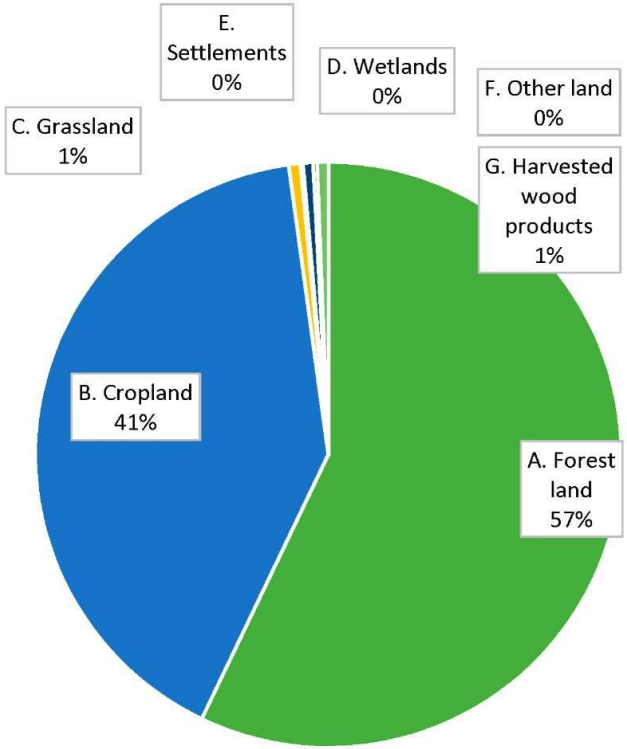
Моделювання динаміки викидів і поглинань в секторах Сільське господарство та ЗЗЗЛГ

Modelling of GHG Emissions and Removals in Agriculture and LULUCF Sectors

Структура джерел та поглиначів в секторах С/г та ЗЗЗЛГ
Share of sources/sinks in Agriculture and LULUCF



Сільське господарство



ЗЗЗЛГ

Підходи до моделювання в секторах С/г та ЗЗЗЛГ
Approaches for modelling in Agriculture and LULUCF sectors

Bottom-up підхід: врахування окремих видів діяльностей у секторах та їх взаємодію

Для яких цілей використовується підхід?
For what purposes is the approach used?

1. Поточний підхід, що використовується в національній інвентаризації за РКЗК ООН.
2. Моделювання викидів і поглинань у лісовому секторі за Кіотським Протоколом.
3. Комплексність впливу процесів на тваринництво та рослинництво.
4. Підхід «знизу вгору» дозволяє врахувати поточні та потенційно можливі заходи національних політик.
5. Підхід дозволяє враховувати альтернативні види використання ресурсів в інших секторах (біомаса для енергетики).

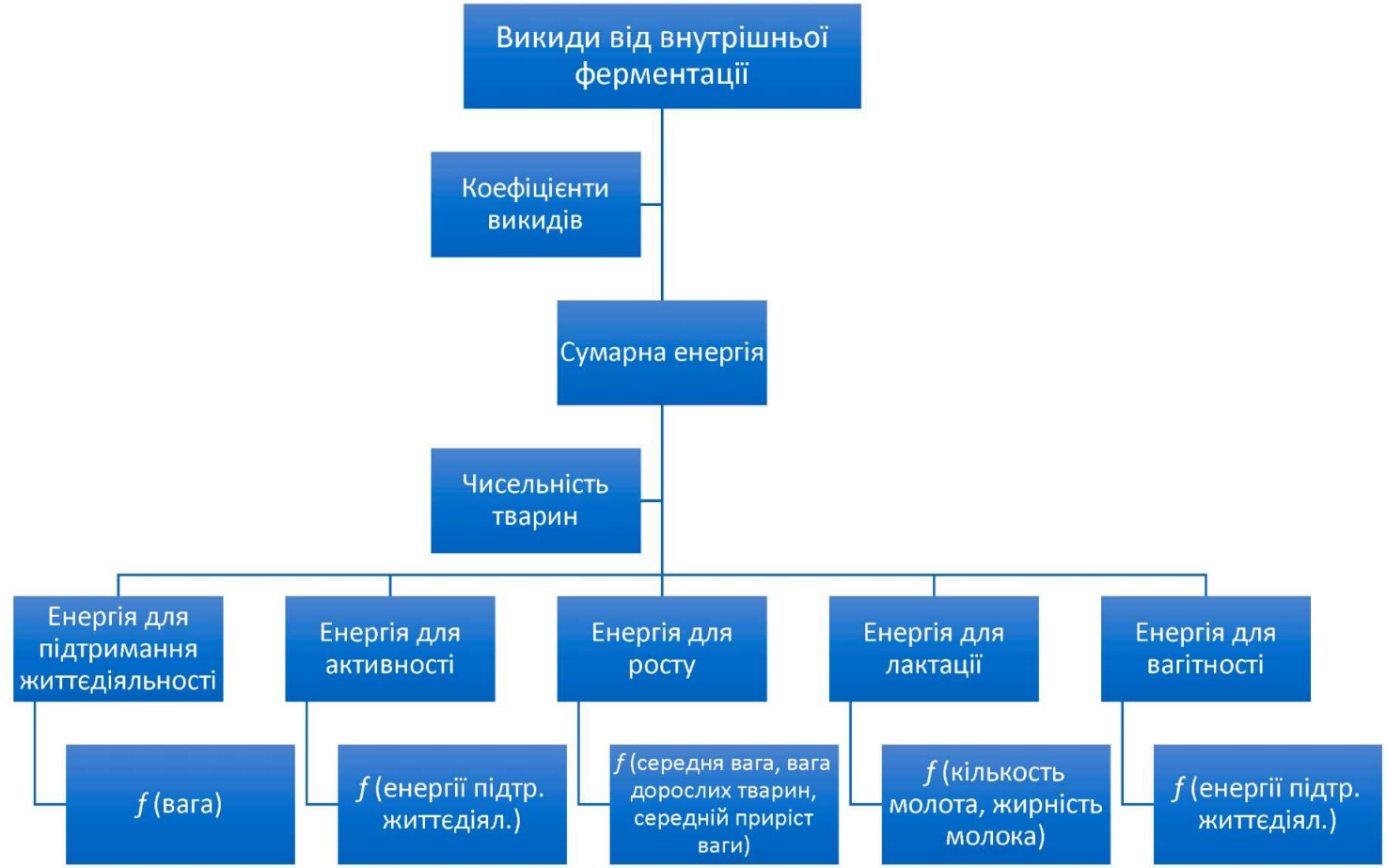
Тваринництво
Livestock

Оцінка викидів ПГ від тваринництва базується на сумарній енергії (СЕ), необхідній для тварин в процесі їх утримання та розмноження, та коефіцієнтів викидів (IPCC 2006).

Викиди від тваринництва:
1. Внутрішня ферментація
2. Поводження із гноєм.

Групи тварин:
- ВРХ (молодняк, доросла молочна ВРХ, інша ВРХ);
- Вівці;
- Свині;
- Інші тварини.

Внутрішня ферментація
Enteric Fermentation



Поводження із гноєм
Manure Management

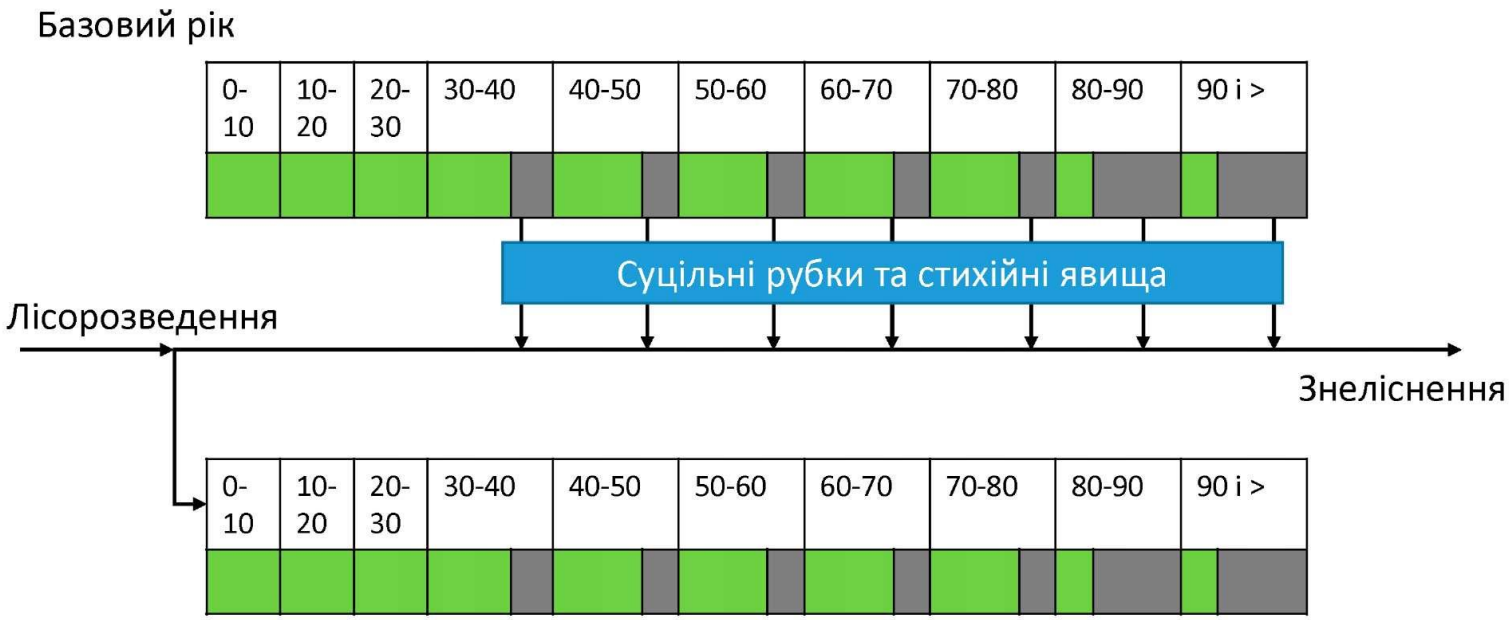
Рослинництво
Crop Production

Основа розрахунків – національний метод балансу азоту в ґрунті в процесі вирощування с/г культур, а також коефіцієнти викидів ПГ (IPCC 2006).

Лісові площі
Forest Land

Єдина діяльність, за якою ведеться звітність із прогнозів очікуваних поглинань/ викидів від лісів за Кіотським Протоколом (Forest Management Reference Level)

Лісові площі
Forest Land



Практичне використання підходів у світі
Practical use the approaches in the world

Усі країни Додатку I РКЗК ООН ведуть звітність за подібними підходами у сільському господарстві, якщо не мають національних методів (Ірландія, Польща та інші).

Підхід на основі методу «бізнес як звичайно» до прогнозування очікуваних викидів/поглинань від Лісових площ був прийнятий усіма країнами, що звітуються в другому періоді звітності за КП.

Джерела даних та пов'язані з цим проблеми
Data sources and related problems

Джерела вхідних даних:

- Державні статистичні дані (Держстат);
- Адміністративні дані (міністерства, агентства, відомства);
- Міжнародні джерела (ФАО);
- Експертні оцінки, використані в національній інвентаризації ПГ (NIR).

Джерела коефіцієнтів викидів:

- Керівні принципи національних інвентаризацій ПГ (IPCC 2006);
- Експертні оцінки, використані в національній інвентаризації ПГ (NIR).

Джерела даних для прогнозування:

- Національні стратегії розвитку (LEDS, галузеві політики);
- Результати прогнозування макроекономічних та галузевих темпів розвитку;
- Міжнародні оцінки (ФАО);
- Експертні оцінки та припущення на основі історичних даних.

Переваги і недоліки моделі
Advantages and disadvantages of the model

Переваги

- Можливість врахування різних темпів розвитку сільського та лісового господарства;
- Заплановані або потенційно можливі заходи національних політик можуть бути оцінені в контексті скорочення викидів ПГ безпосередньо;
- Наявність значного масиву даних в поточній національній інвентаризації;
- Можливість врахування альтернативних варіантів використання ресурсів (біомаса, гній);
- Комплексний розгляд секторів (тваринництва і рослинництва);
- Узгодженість із поточною інвентаризацією ПГ.

Недоліки

- Досить значна кількість показників та коефіцієнтів, необхідних для розрахунку, які не доступні в національному масштабі (фактичний раціон тварин, поживна цінність кормів, фактичні актуальні практики поводження із гноєм і ін.);
- Відсутність оцінки змін запасів вуглецю від мертвої органічної речовини, що негативно впливає на комплексність оцінки;
- Часткова доступність історичних даних про характеристики лісів (тільки ліси Державного агентства лісових ресурсів України);
- Значна невизначеність деяких явищ та їх частота і інтенсивність (особливо стихійних явищ);
- Неповна верифікація моделі балансу азоту в ґрунті.

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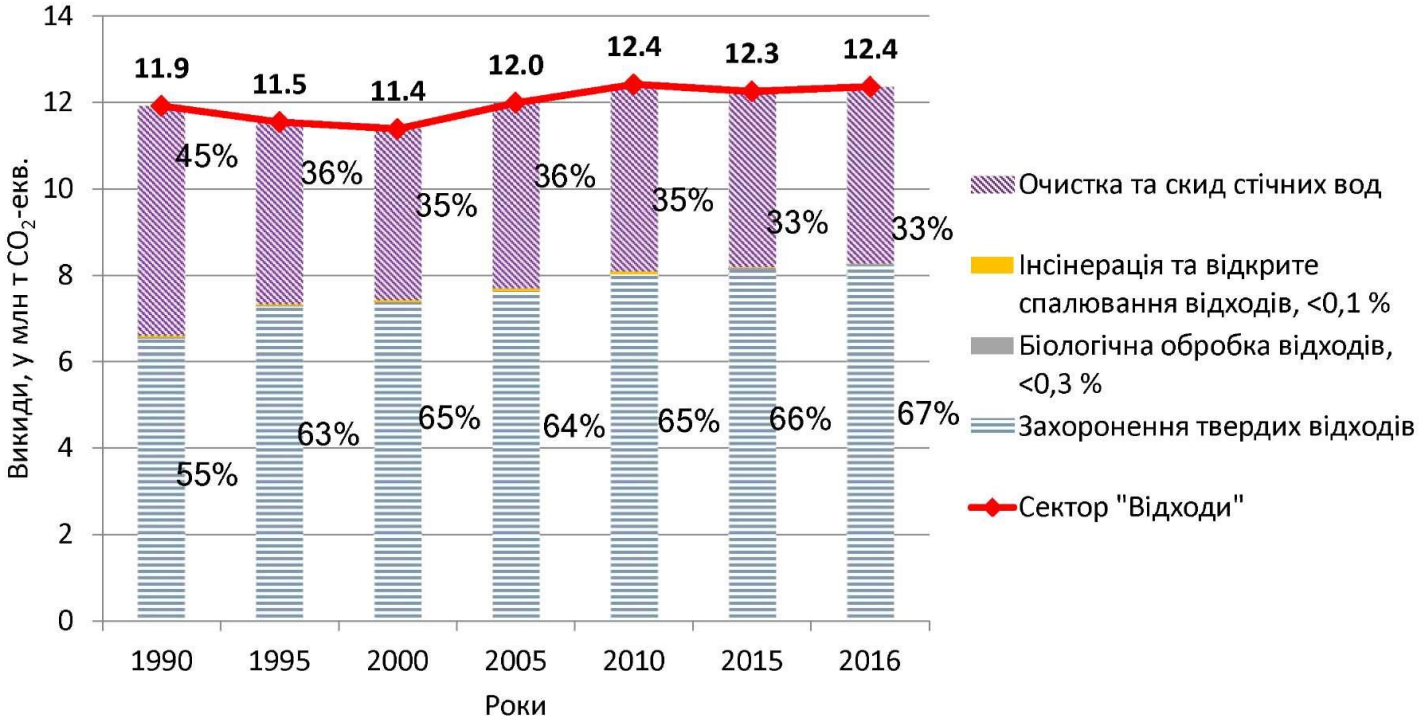
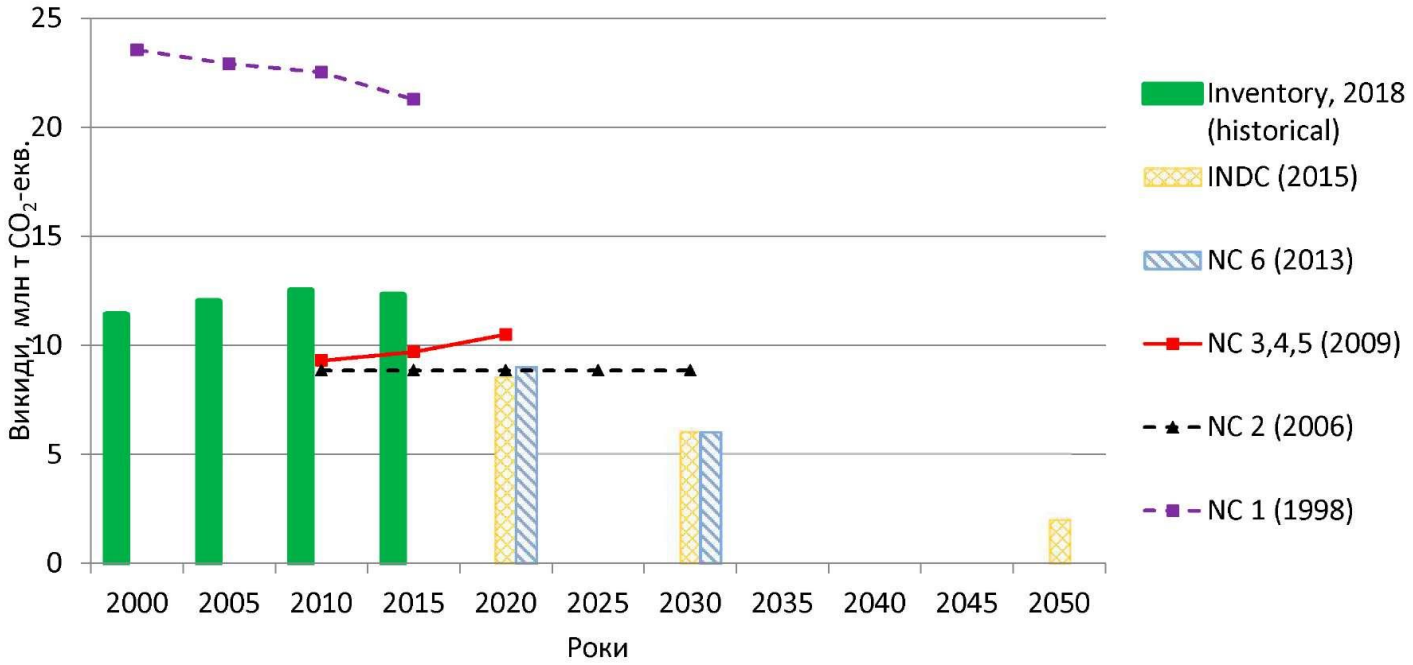
Пропонований методологічний підхід для другого НВВ України. Сектор «Відходи»

Proposal on Ukraine's second NDC methodological approaches. Waste sector

Історичні викиди парникових газів у секторі «Відходи»
Historical GHG Emissions in Waste Sector



Моделювання викидів в Україні: набутий досвід
Emissions Forecasts: Existing Experience



Сильні та слабкі сторони моделювання у секторі «Відходи»
Strong and Week Aspects of Projections in Waste Sector

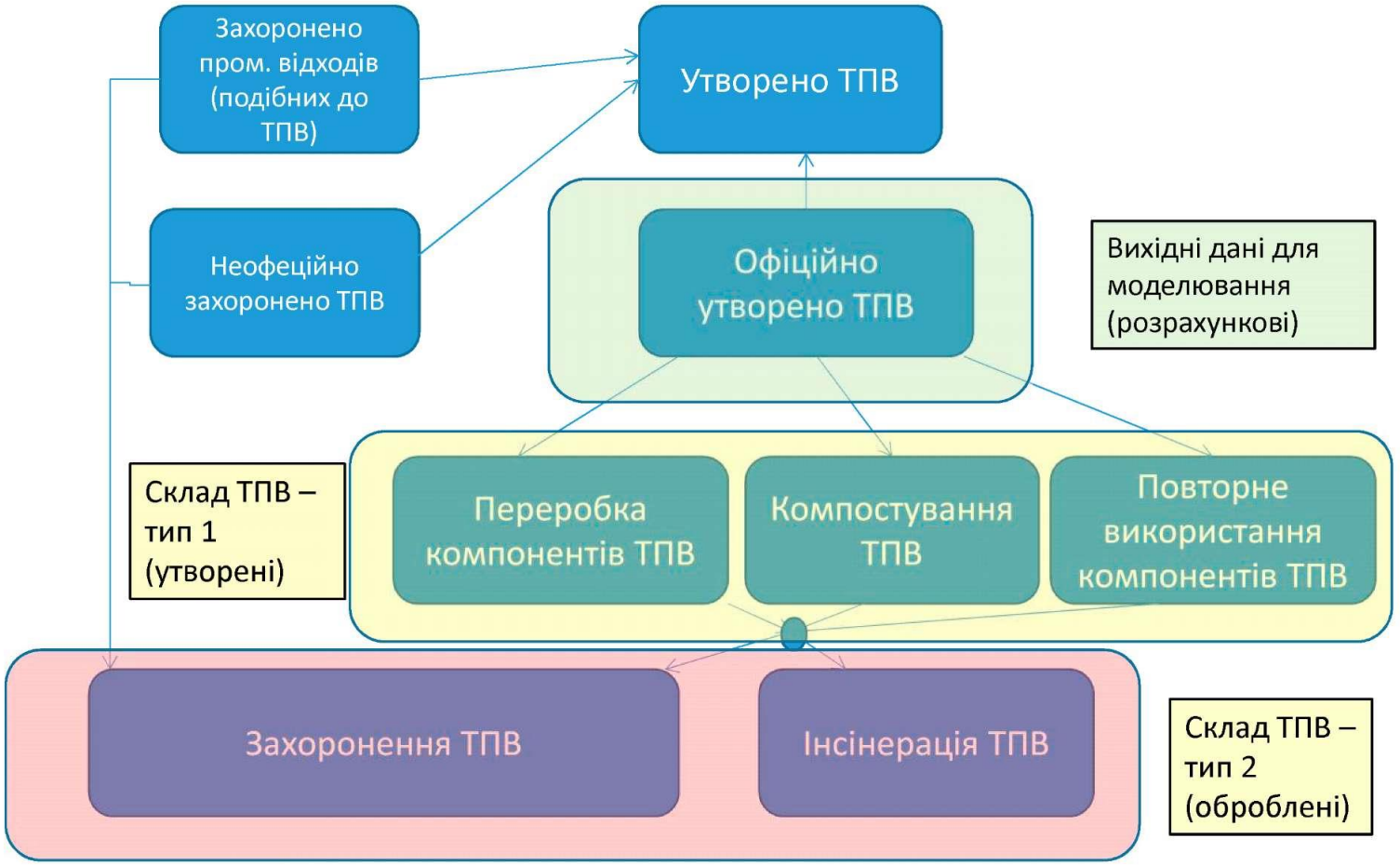
NDC 3,4,5 (2009)

Сильні сторони (враховано)	Концептуальні недоліки
1.Національні програми та плани	1. Прогнозування виконано з використанням застарілих методик обліку викидів парникових газів (IPCC 1996, IPCC 2000)
2. Демографічний прогноз	
3. Зростання благополуччя населення	2. Відсутні внутрішні зв'язки між показниками моделювання (баланс мас утворених відходів не використовувався)
4. Зміни складу захоронених ТПВ	
5. Розвиток промисловості за галузями	3. Не враховано можливе технологічне переоснащення: систем водоочищення, полігонів ТПВ тощо.
6. Зміни у структурі споживання харчової продукції	
	4. Проігноровано категорії «Біологічна обробка» та «Інсінерація»

Запропонована методологія: забезпечення масового балансу твердих побутових відходів та основні показники прогнозування

Proposed Methodology Approach: Compliance of Municipal Solid Waste Mass Balance and Key Indicators of Projections

Забезпечення масового балансу ТПВ
Compliance with MSW Mass Balance



Вхідні дані моделювання
Input data for modelling

Тверді відходи

№	Вихідні показники моделювання
1	Кількість населення
2	Питомі обсяги утворення ТПВ
3	Частка компостування ТПВ
4	Частка повторного використання ТПВ
5	Частка рециклінгу ТПВ
6	Частка термічної утилізації ТПВ
7	Частка захоронення ТПВ
8	Технічне переоснащення умов захоронення
9	Частка охоплення населення системою поводження з ТПВ
10	Впровадження технологій з рекуперації звалищного газу

Рідкі відходи (та їх похідні)

№	Вихідні показники моделювання
1	Кількість населення
2	Зміни у структурі споживання харчової продукції
3	Технічне переоснащення очисних споруд
4	Розширення централізованого водоочищення
5	Розвиток промисловості за галузями
6	Використання біогазу в метантенках

Колір свідчить про джерело даних
Прогнозні даних наукових установ
Національні плани, стратегії тощо
Міжсекторальні зв’язки
Середньоєвропейське значення, 2015 рік
Необхідно виконати експертне судження/заключення

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Send questions, suggestions and comments to:
ndc2ua@gmail.com

або звертайтеся до представників Проекту:
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