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MODELING NEEDS TO SUPPORT THE RECONSTRUCTION STRATEGY OF UKRAINE

Pacific Northwest National Laboratory

Institute for Economics and Forecasting

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1. INTRODUCTION

Ukraine has been facing difficult times. Russia started a full-scale invasion on February 24, 2022, and has caused huge human and infrastructure losses. As a result of the invasion, more than 8 million people left their homes (MINRE, 2022). The Russian army has targeted Ukrainian energy sources, destroying or damaging over 50% of thermal power generation capacity (coal and gas), 30% of solar generation, and 90% of wind generation (NCR, 2022d). The Russians are also threatening Ukrainian energy security, as they currently control the Zaporizhzhia nuclear power plant – Europe's largest. In addition, Russia has destroyed 121,000 buildings, including 5,300 multistory buildings - more buildings than Ukraine built during the past five years. The occupiers destroyed or damaged 343 district heat boiler stations (destroyed 12 / damaged 331) and 8 CHPs (destroyed 4/ damaged 4) (Ukrainian Energy, 2022).

There is no doubt that Ukraine will be able to protect its sovereignty and restore its territorial integrity; however, this will be a long process. The Government of Ukraine needs to simultaneously focus on many issues, from waging war to the restoration of electricity, water, and heat supply in the territories close to the front line. In addition to these time-sensitive issues, the government also needs to plan a long-term multi-sector strategy for the reconstruction of Ukraine's economy.

Ukraine initiated a broad-based political process for recovery at the International Ukraine Recovery Conference (URC 2022) in Lugano, Switzerland. Prior to URC 2022, Ukraine applied for EU membership on February 28 and was granted the status of candidate country by the European Council on June 23, 2022 (European Council, 2022). More than 40 nations are fully committed to supporting Ukraine throughout its path from early to long-term recovery. In addition, these countries link a successful recovery to Ukraine's European future (URC, 2022a).

The reconstruction process will be long. The government also recognizes that it is not enough to build energy infrastructure back – it should be built back better. The government is committed to building a more sustainable and cleaner energy sector (Minenergy, 2022).

Energy modeling can provide important insights into paths to decarbonize Ukraine's economy while rebuilding it after the war. Pacific Northwest National Laboratory (PNNL) and the Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine (IEF) work on modeling decarbonization scenarios in the energy sector of Ukraine. The teams focus on the heat sector, which includes district heat, autonomous and individual heating, and energy consumption by final energy consumption sectors, including buildings. Since the teams use world-class integrated assessment models, other sectors will be analyzed as well.

The purpose of the document is to describe the needs of key Ukrainian ministries in modeling the reconstruction process. The scope of this document is limited to modeling energy consumption by the power and heat sectors, final energy consumption by buildings, and GHG emissions from these two sectors.

The rest of this policy memo is organized as follows. After this introduction, Chapter 2 discusses key provisions of the reconstruction strategy with a focus on energy, buildings, heat supply, environment, and European integration aspirations. Section 3 provides an overview of recent developments and key decisions of the Government of Ukraine in the area of energy efficiency and decarbonization. Finally, Section 4 provides key suggestions on how PNNL and IEF can help the Government of Ukraine in developing strategic documents.

2. THE RECONSTRUCTION STRATEGY (THE LUGANO SCENARIO)

2.1. National Council for the Recovery of Ukraine

The President of Ukraine created the National Council for the Recovery of Ukraine from the Consequences of the War in April 2022 (President of Ukraine, 2022). The Council created 24 working groups to develop a plan for the post-war recovery and development of Ukraine, a list of priority reforms and strategic initiatives, and other measures (CMU, 2022). These working groups worked on a wide variety of issues, including energy security, construction, urban planning, modernization of cities and regions, social protection, and environmental safety.

The Minister of Energy and the Minister of Communities and Territories Development presented the draft plan at The Ukraine Recovery Conference in Lugano, Switzerland on July 4-5, 2022 (URC, 2022b). The working groups continued developing the plans after the conference and presented updated drafts at the beginning of August 2022.

The reconstruction strategy defines key directions for rebuilding Ukraine after the war. The system is based on the following key assumptions (NCR, 2022d):

- Ukraine wins the war within the next 1-2 years, no significant parts of the energy sector are lost or severely damaged;
- Business environment and macro-financial stability that allow for significant investments and healthy returns are restored within 2-4 years, and "red tape" and other barriers to swift realization of investment projects are removed;
- There is major funding and investment flow into Ukraine, both public and private.

2.2. Power sector

Minister of Energy of Ukraine Galushchenko presented the Environmental Recovery and Development: Energy plan in Lugano (MEU, 2022). The plan envisions decarbonization of the power sector. By 2032, Ukraine plans to phase out coal (a reduction by 90% from the 2021 level), and expand nuclear and renewables to reach 93% of carbon free-fuel mix in the power sector. By 2050, Ukraine's power mix should have 96% of carbon-free fuels while electricity production should increase by a factor of 2.8 from the 2021 level.

The vision of the Ministry of Energy of Ukraine was expanded in the report of the Energy Security Group (NCR, 2022d). The working group reiterated the decarbonization goal and provided additional details about the decarbonization plan in the power sector. The Government of Ukraine plans to phase out coal-based generation after the war ends (abandon coal generation by 2035) and, once extra capacity is secured from nuclear and/or gas/biomethane ramps up, increase renewable energy capacity by 5-10 GW[1], and increase electrolyzer capacities for hydrogen production by 15 GW (MEU, 2022).

Although the energy plan discusses the development of combined heat and power (CHP) plants to generate electricity, it is silent on heat production by CHPs and heat-only boilers. In addition, the energy plan does not have any goals for emission reductions from heat production as it focuses on the power sector only. Similarly, the consumption of natural gas, coal, and biomass is considered only in the

[1] 1 million toe = 11.6 TWh = 1.1 bcm of natural gas

context of electricity generation. Given the security considerations and decisions by the National Security and Defense Council of Ukraine, certain urgent actions and decisions, which are implemented by the government and market participants for the preparation for the heating season 2022/23 are not reflected in the energy plan. The analysis of heat consumption should be added into consideration.

2.3. District heat and buildings

Minister of Communities and Territories Development Chernyshov presented the Ukrainian Approach to Regional Recovery and Development in Lugano on July 5, 2022 (Minregion, 2022b). Minregion's goal is to increase energy efficiency in buildings by 35% and reduce natural gas consumption for heating by 50% by 2030.

The residential sector, including district heat, is analyzed by the working group on construction, urban planning, and modernization of cities and regions (NCR, 2022a). Before the war, the building sector in Ukraine accounted for about 40% of total final energy consumption. The group highlighted that about 12,900 apartment buildings and 108,000 private buildings had been destroyed / damaged and 5.5 million people fled the country as of the beginning of June. The residential sector and district heat companies used no less than 50% of all gas consumed in Ukraine. At the same time, only a third of households were connected to district heat systems.

The plan outlined key goals in the development of heating and the building sector by 2032:

- 35% reduction in energy consumption and greenhouse gas emissions from buildings (from the 2021 level);
- 50% of heat in district heating systems is obtained from renewable energy sources, waste heat sources, and cogeneration units;
- The share of efficient district heating systems is up to 90%;
- The share of efficient individual heating systems is increased to 30%.

Although the plan has short-term goals, it does not have any long-term goals for the period between 2032 and 2050.

2.4. Environment

The presentation on environmental recovery in Lugano highlighted that Ukraine had set a climate target to reduce greenhouse gas emissions (GHG) by 65% in 2030 from the base year (1990). This goal was defined in Ukraine's updated Nationally Determined Contributions (NDC) to Paris Agreement nt. Ukraine submitted its updated NDC on July 31, 2021 to significantly strengthen the country's 2030 target and include the goal of reaching economy-wide climate neutrality no later than 2060 (GoU, 2021).

The authors of the report on environmental safety highlighted that in 2020, GHG emissions decreased to 33.7% from 1990 levels (NCR, 2022b). Still, the energy intensity of Ukraine's GDP in 2018 was three times higher than in Poland. The tasks to mitigate environmental risks, such as emissions, pollution, and waste, should be harmonized with the European integration aspiration of Ukraine and the provisions of the European Green Deal. Ukraine plans to launch the national emissions trading system between 2026 and 2032. Given that the recovery strategy focuses on the next ten years, there are no goals from 2032 to 2050.

2.5. European integration

The report on European integration provides key tasks and direction to fully integrate Ukraine into the European Union (NCR, 2022c). The most important provision is that Ukraine aspires to be a full member of the European Union between 2026 and 2032. Ukraine should implement measures aimed at infrastructure rehabilitation, taking into account approaches for reducing emissions, improving energy efficiency, and ensuring energy transition within the framework of the European Green Deal.

Ukraine stopped short in the Recovery strategy from announcing the goal to reach net zero emissions by 2050. However, according to the European Green Deal, the EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions (Commission, 2021). As a result, Ukraine de-facto accepted the EU goals.

3. POST-LUGANO DEVELOPMENTS

3.1. Obligations under the Energy Community Partnership

Ukraine became the Contracting Party of the Energy Community in February 2011. The Energy Community is an international organization which brings together the European Union and its neighbors to create an integrated pan-European energy market.

Upon request by the European Commission and in agreement with the Ministry of Energy of Ukraine, the Energy Community Secretariat set up the legal framework for the Ukraine Energy Support Fund to counteract the impact of the Russian invasion. The Fund will enable governments and international financial institutions to provide emergency financial support to the Ukrainian energy sector (Energy Community, 2022a).

Ukraine co-chaired the Informal Ministerial Council meeting on July 13, 2022. During the meeting, Deputy Minister of Ukraine Yaroslav Demchenkov said: “Energy was a weapon of Russian foreign policy for decades, and included blackmail and political pressure on Europe. The current situation made this problem as acute as ever. This entails a reconsideration of the energy supply chains and their origin. As we work towards the goal of climate neutrality by 2050, today’s meeting marks a major step forward in our joint work to decarbonize the energy system and fight against climate change. The energy system of the future will require higher shares of renewable energy and higher ambition on energy efficiency. This will also help Europe to cut its dependence on Russian fossil fuels” (Energy Community, 2022b). Nine Contracting Parties expect to adopt the 2030 energy and climate targets and achieve climate neutrality by 2050 at the Energy Community Ministerial Council in December 2022.

3.2. The draft strategy of thermomodernization of buildings

The Ministry of Communities and Territories Development of Ukraine released a draft Long-Term Strategy for Thermal Modernization of Buildings Through 2050 in August 2022 (Minregion, 2022a). The strategy should provide directions to increase energy efficiency and decarbonize buildings. According to the draft strategy, in 2050, “residential and public buildings will have almost zero energy consumption. A small proportion of the energy required by buildings for heating, hot water supply and cooling will be covered by local renewable energy.” The strategy should provide a basis for developing the roadmap of measures to reduce greenhouse gas emissions by 80-95% by 2050 from the 1990 level.

Energy modeling that informs the development of the strategy was performed several years ago and did not account for the recent challenges, including the effect of the war. The strategy also has a number of inconsistencies between the descriptive part and the modeling part. For example, the draft strategy

highlights the need to reach almost zero energy consumption while the modeling part states that emissions from the building sector in 2050 should decrease by 69.5% from the 1990 level. At the same time, according to the national GHG inventory, emissions from the buildings sector in 2020 decreased by 68% from the 1990 level (UNFCCC, 2022). Thus, the decarbonization goal stated in the draft strategy for 2050, was already achieved in 2021 (without taking into account the effect of the war).

Further analysis of the draft Long-Term Strategy for Thermal Modernization of Buildings till 2050 clearly shows that there is a need to remodel energy consumption by buildings and calculate emissions from the buildings sector to inform the development of the next version of the strategy.

4. PROPOSED MODELINGS ACTIVITIES BY PNNL AND IEF

The analysis of the key strategic document produced by the Government of Ukraine during the past three months revealed some important areas where PNNL and IEF can help:

- The reconstruction strategy of the energy sector covers only the power sector. All other energy sectors are analyzed only from the electricity point of view. The strategy should include the district heat and the residential sector, which consume about half of natural gas in the country;
- The reconstruction plan on buildings and district heat system should have projections to 2050;
- The environment and climate plan should describe the decarbonization path outlined in the European integration documents.

The fact that Ukraine is an EU candidate country with ambition to become a full member of the European Union within the next ten years has provided it with an obligation to prepare an energy and climate action plan through 2030. This necessitates the need to have a comprehensive modeling study that focuses on decarbonization pathways for the power and heat sectors, buildings, and other sectors in line with the EU obligations. The study should employ integrated assessment models to assess energy needs, energy and power mixes, technology mix, investment needs and emissions in key sectors. It is critically important to comprehensively analyze all energy flows in all the sectors to assess the energy needs and resulting GHG emissions. Finally, the analysis should be expanded beyond the reconstruction period (now through 2032) to 2050 to fully capture Ukraine's future obligations as a member of the European Union.

PNNL and IEF have unique expertise in modeling long-term development strategies using advanced modeling tools. For example, PNNL developed the Long-Term Strategy for Decarbonization of the United States of America (Horowitz et al., 2022; White House, 2021). PNNL developed the state-of art Global Change Analysis Model (GCAM). PNNL is working to develop GCAM-Ukraine, the model which will focus on Ukraine given the development of the world.

IEF worked on the National Energy Efficiency Action Plans until 2020 and 2030 (SAEE, 2022), the Low-Emission Development Strategy of Ukraine until 2050 (GOU, 2017), Nationally Determined Contributions of Ukraine to the Paris Agreement (GOU, 2015, 2021), and other strategic documents. IEF used the TIMES-Ukraine model in all these studies and is updating the model to reflect new realities.

PNNL and IEF can develop scenarios for the development of the building sector, which would fully take into account recent international and national goals, obligations, etc., for the post-war recovery and further development of the economy of Ukraine. The modeling scenarios will take into account the findings of the working groups of the National Recovery Council. PNNL and IEF will coordinate with key stakeholders in Ukraine to develop common assumptions across the ministries. The modeling will include different scenarios for GPD growth, population, building floorspace, assumptions for energy efficiency improvements, etc. Accordingly, potential beneficiaries of the study will receive broad and detailed research results of the following scenarios:

1. ***The Reference scenario*** (Business-as-usual Scenario, BAU) will assess the consequences of the absence of any targeted changes in the technological structure or regulatory environment of the energy sector of Ukraine. This scenario will only provide an assessment of the lowest costs of economic recovery through 2032 (and 2050).

2. ***Ukraine's Recovery Plan Scenario***. The scenario is mainly based on the key indicators of the Recovery Plan of Ukraine presented in Lugano, as well as other national plans, strategies, programs, etc., which directly or indirectly determine the transformation of the energy sector of Ukraine and related GHG emissions. The key indicators of recovery and development of Ukraine's economy include:

- macroeconomic indicators (GDP, volumes of industrial production and added value by sector, population, number of households, area of non-residential premises, number of passenger and cargo vehicles, volumes of agricultural production, etc.);

- energy indicators (potential and volumes of extraction (production) of energy resources, including renewable energy sources (RES), the structure of the supply of energy resources, including import/export of energy resources, goals for energy conservation and development of RES by sectors, international prices for energy resources, goals/volumes of production of synthetic fuels (hydrogen, biomethane, etc.), etc.;

- environmental and climate indicators (compliance of future energy, industry, transport, etc. with environmental goals and obligations to the Energy Community and the European Union, international climate obligations (Paris Agreement, UN Sustainable Development Goals, etc.)). This will also include an assessment of GHG emissions from the power, buildings, industry, transport, and other sectors.

3. ***Alternative Ukraine's Green Recovery Scenarios***. The teams will explore alternative pathways for recovery and "green" transition and, accordingly, decarbonization of Ukraine's economy. These pathways can be developed to analyze the sensitivity of certain climatic, economic, and energy indicators. In addition, given that the Recovery Plan of Ukraine, presented in Lugano, was developed by a large number of expert groups in an extremely short period of time, it may contain inconsistent indicators and, therefore, may not be optimal from the point of view of investment directions and needs.

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