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Exchange of experiences on how to increase the uptake of renewable energy. Case studies on Ukraine: strategy and plans for energy sector renovation with the use of renewable energy sources

Bioenergy production and potential for addressing the compound food and energy crisis in Ukraine

Note by the secretariat

Summary

The United Nations Economic Commission for Europe (ECE) has implemented extrabudgetary project “Addressing the compounded food and energy crisis in Ukraine through innovative technologies and adaptive agricultural practices”. The project is part of a Joint Sustainable Development Goals Fund (SDG Fund), Development Emergency Modality – Response to the Global Crisis on Food, Energy, Finance.

The project provides analysis on the current food and energy aspects of the crisis in the country to support an informed decision on a suitable biofuel strategy for Ukraine. It additionally identifies appropriate technologies and adaptations within the agriculture sector which can be employed to alleviate negative impacts on food production and food security. The project seeks to stimulate innovations in production and along supply chains, namely in alternative fuel use and production practices.

ECE is in charge of analyzing the normative and institutional framework in support of increasing the renewable energy uptake with special attention to bioenergy and of organizing a multistakeholder dialogue on how to use the untapped renewable energy potential, choice of a technological focus for the demonstration project and recommendations on needed normative and institutional changes.

There are global trends for the increase of the prices on fossil fuels. This issue is particularly tough for Ukraine, as the country depends on oil supplies from abroad. The fuel shortage endangers the operation of vehicles, machines, and equipment involved in the energy production. The achievement of the targets that are described in the study requires numerous legislative improvements in Ukraine and investments attraction to neutralize the harmful effects of the war and related damages to the economy.

The analysis of the current policy environment in the context of future bioenergy sector development was conducted and a set of policy recommendations for the utilization



of bioenergy products potential in Ukraine. There were also elaborated preliminary financial indicators of potential bioenergy projects that are feasible for implementation in Ukraine.

Currently, Ukraine needs to adopt a number of already developed legislative acts regarding the development of biogas, liquid and solid biofuel markets. This is extremely important for the development of bioenergy sector in Ukraine, increasing the use of local renewable fuel and substituting fossil fuels. Moreover, such steps will become a basis for the post-war reconstruction of the country's economy and energy sector of Ukraine.

I. Introduction

1. This study is linked to the following ECE activities:
 - “Addressing the compounded food and energy crisis in Ukraine through innovative technologies and adaptive agricultural practices” within the SDG Fund project and implemented by FAO, UNEP, and ECE. The activity is developed in response to the request of the Ministry of Agrarian Policy and Food (MAPF) for support to address fuel shortages in the agriculture sector
 - “ECE early development response: reconstruction of Ukraine – restoring connectivity and rebuilding infrastructure.” The activity supports efforts of the national and local governments for planning of and preparations related to redesigning and rebuilding energy system in Ukraine that suffered significant damage in the war to support achieving the SDGs and are based on the “building back better” principle.

II. Overview

2. This work is contributing to a comprehensive analysis on the current energy aspects of the crisis in the country to support a better knowledge of the situation and, therefore, to lead an informed decision on a suitable biofuel strategy for Ukraine. The objective of the study is to assess the role of bioenergy for ensuring energy resilience in Ukraine, including analysis of normative and legislative frameworks to increase the renewable energy uptake. Project aims to equip the Government of Ukraine with a comprehensive analysis of the biofuel production potential to solve the compound food/energy crisis in Ukraine.
3. Within the current global energy crisis, the development of renewable energy (RE) represents one of the main ways of solving problems related to instability of the supply of fossil energy resources. For Ukraine, bioenergy is one of the strategic directions for the development of the sector of renewable energy sources, taking into account the country's high dependence on imported energy sources, primarily natural gas, and the great potential of biomass available for energy production. Unfortunately, the rate of development of bioenergy in Ukraine is still significantly behind the European ones.
4. Ukraine has a significant potential of biomass available for energy production - in total more than 20 Mtoe per year. The main components of the energy potential of biomass are waste and by-products of agriculture and energy crops (altogether about 80 per cent), which is collectively defined by the term agro-biomass. At the same time, the largest shares of the potential of agricultural residues fall on the straw of cereal grain crops and by-products/waste from the production of grain corn.
5. The contribution of wood biomass to the energy potential is relatively small (about 12 per cent of the total volume). The remaining components of the energy potential of biomass in Ukraine (about 10 per cent) are liquid biofuels (biodiesel, bioethanol) and biogas obtained from various types of raw materials (waste and by-products of the agricultural industry, industrial and municipal wastewater, solid household waste).
6. The situation with the consumption of biomass for the production of energy and biofuels in Ukraine is actually the opposite in accordance to the existing potential. Currently, wood biomass is most actively used (more than 90 per cent of the economic potential), and the use of waste and by-products of agricultural origin remains at a low level. On average, the energy potential of Ukraine's biomass is used approximately for 11 per cent.

III. Policy landscape

7. Policy frameworks for clean energy and carbon neutrality of Ukraine is determined by the:
 - **The Law of Ukraine “On Alternative Energy Sources”** defines the legal, economic, environmental and organizational framework for the use of alternative energy sources and the promotion of their use in the fuel and energy complex. It provides for the

establishment of a “green” tariff to stimulate the production of electricity from alternative energy sources (except blast furnace and coke gases, and with the use of hydropower – produced only by micro-, mini- and small hydropower plants)

- **The Law of Ukraine “On Alternative Fuels”** introduces the framework for financial mechanisms to stimulate biofuels and other alternative fuels in order to save energy resources and reduce dependence on imports. It aims at reducing environmental impact by using various kinds of waste as raw material for the production of alternative fuels
- **The Law of Ukraine “On Electricity Market”** specifies the legal, economic and organizational framework for the functioning of the electricity market, regulate relationships related to the production, transmission, distribution, purchase and sale, supply of electricity to ensure reliable and safe supply of electricity to consumers, taking into account the interests of consumers, the development of market relations, minimizing the cost of electricity supply and minimizing the negative impact on the environment
- **The Law of Ukraine “On Heat Supply”** defines the main legal, economic, and organizational bases of activities at heat supply facilities and regulates relations related to the production, transportation, supply, and use of heat energy to ensure the energy security of Ukraine, improve the energy efficiency of heat supply system operation, create and improve the thermal energy market and protect the rights of consumers and employees in the field of heat supply
- **The Law of Ukraine “On Energy Efficiency”** establishes the legal, economic and organizational framework of activities in the field of energy efficiency, ensuring the implementation of energy efficiency measures that will be carried out during the production, transportation, transmission, distribution, supply and consumption of energy
- **“Concept of State Policy Implementation in Heat Supply”** aims to develop and determine the methods facilitating effective implementation of the state policy focused to ensure reliable provision of heat supply services, Ukraine's energy independence and security; reduce adverse effects on environment, improve financial and economic situation of enterprises, to introduce transparent efficient system of payments between consumer and service suppliers, and to establish conditions and incentives geared to attract investment in heat supply sector
- **The policy document of Ukraine “National Economic Strategy until 2030”** defines strategic steps for the development of industry, agriculture, mining, infrastructure, transport, energy, information and communication technologies, creative industries and services. The Strategy also takes into account important cross-cutting areas such as digitalization, the green course, entrepreneurship development and balanced regional development
- **The policy document of Ukraine “National Energy Strategy until 2035”** encapsulates a whole range of far-reaching reforms in the energy sector. The essential task of the energy strategy is to reduce energy consumption of Ukraine's economy by half until 2030 and to boost the Ukrainian production of both traditional and alternative energy sources. The document stipulates for the new structure of energy needs, thus nuclear power will provide 50% of the country's electricity by 2035, renewable sources - 25%, hydropower - 13% and the rest will be covered by thermal electric power stations.

8. The relevant policies of Ukraine are shaped and implemented in accordance with international obligations, in particular the Association Agreement with the EU, the new European Green Course, the Treaty establishing the Energy Community and the Paris Agreement.

IV. Renewable energy industry overview

9. In recent years, trends in the development of renewable energy are going upward (the peak of investment in the construction of renewable energy facilities was in 2019). According to available information, in 2019, the capacity of power facilities that use renewable energy sources for electricity production reached 4,722 GW. During 2020, renewable energy facilities with a capacity of 1.95 GW were additionally put into operation, and in 2021 – another 1.45 GW. However, because of quarantine restrictions due to the spread of COVID-19 pandemic and for a number of economic reasons, not all facilities scheduled for commissioning during the year were put into operation. As expected, renewable energy facilities with a total capacity of about 1.54 GW or more will be additionally put into operation in 2022.

10. As of 31 December 2021, the installed capacity of RE plants in the Integrated Power System of Ukraine, which are directly connected to the grid and deliver electricity, is:

- WPP – 1,529 MW
- SPPs– 6,365.3 MW (including 1,205.3 MW of household SPP)
- BioPP – 254.2 MW
- Micro-, mini- and small HPP – 192.9 MW.

11. Ukraine should expect a sustainable expansion of all renewable energy sources, which are to become an instrument for achieving the energy security of the state. The ESU-2035 forecasts that renewables will account for 12 per cent of total primary energy supply in the short and medium-term perspective (until 2025), and no less than 25 per cent by 2035 (including all hydropower capacities and thermal energy).

12. Moreover, growth of renewable energy among consumers shall not be subject to energy system restrictions and should facilitate a dynamic local development. The state policy needs to encourage the initiative of private market players. Efforts to decentralize renewable energy (e.g. photoelectrical systems and solar collectors on the roofs of residential buildings) with an estimated capacity of about 5 per cent of electricity consumption by the population need also to be promoted.

13. The electricity and heat generation sectors are expected to increase the use of biomass and biogas, which results from a relative production stability and local generation development. Based on non-fuel technologies, hydropower will continue to play an important role in stable functioning of Ukraine's United Energy System (UES) since it provides the energy system with highly flexible capacities for regulating daily load schedules covering peaks and filling night gaps. Moreover, it performs an important function of emergency capacity reserve.

14. Major activities aimed at implementing strategic goals in the renewable energy sector include pursuing consistent and predictable policy as regards facilitation of SPP and PSPP construction; arranging international communication campaigns to attract international strategic and financial investors to Ukraine's renewable energy market; constructing and putting into operation of 5 GW RE capacity (excluding high-power HPP); increasing the use of biomass in electric and thermal generation by:

- Promoting the use of biomass as a fuel by companies generating biomass as a residual product
- Informing about possible use of biomass as a fuel in individual heating
- Promoting competitive biomass markets.

15. Feed-in tariff (FIT) was introduced in 2008 and by 2019 the amount of RE was rising steadily. However, on 25 April 2019 the new law No. 8449-dwas adopted in Ukraine, which partly cancels FIT and introduces green auctions. As a result, in order to secure FIT in the first half of 2019 alone, renewable energy facilities with a capacity of more than 1.5 GW were connected to Ukrainian electrical grid. In 2019, which has been a record-breaking year so far, numbers were almost 50 per cent more.

16. Ukraine also has commitments under different agreements with international organizations such as Energy Community (EnC) and International Renewable Energy Agency (IRENA), which also gives some benefits and leads Ukraine to the right regulatory decisions. IRENA predicts that Ukraine has the potential to increase its share of renewables by up to 20–25 per cent by 2030. The highest potential is in expanding the country's utilization of biomass because of the abundance of fertile black soil there, further to extensive agricultural and forestry waste too.

17. The country has set a goal of sourcing 25 per cent of its total energy mix from renewables by 2035. At the beginning of 2020, the share of energy generated from renewables by wind, solar, biomass, biogas, and small hydro, including large hydropower projects over 10MW reached – 11 per cent and by the end of the year - 12.4 per cent.

18. In order to achieve a more ambitious share of RE in Ukrainian power generation in 2030, investments in new capacities and flexible generators to balance fluctuations will be needed. The introduction of a fixed FIT for RE generation acted as the initial driver for investment into this sector, with around EUR 8 bln invested until 2020. However, the eligibility of new plants for FIT support ended in 2019 and FIT levels were retroactively restructured in 2020. From 2020, support for new plants is determined via competitive auctions.

19. In August 2017, the government adopted the new Energy Strategy of Ukraine (ESU) till 2035. It replaced the Energy Strategy till 2030, which was already outdated at the time of its adoption in July 2013. ESU implementation is divided into three stages:

- The first stage (2018-2020) aims to create the liberalized, competitive energy markets and minimize state interference in their performance
- The focus of the second stage (2021-2025) is on developing energy infrastructure, integrating it with the European system and attracting necessary energy sector investments
- Finally, the third stage (2026-2035) is concerned with sustainable development: meeting the greenhouse gas (GHG) emissions reduction commitments; rapidly developing renewables; ensuring energy security by further boosting gas production, including unconventional gas and offshore drilling, after achieving gas self-sufficiency in the second stage.

20. The National Renewable Energy Development Action Plan (NREDAP) was adopted in 2014 in accordance with Ukraine's Energy Community commitments. According to the SAEE the NRDEAP's ambitious goals required investment from USD 3.5 bln to USD 4.3 bln in order to raise the installed capacity (excluding large hydro) by more than five times, from 1 024 MW to 5 700 MW.

21. In order to enforce the renewable energy development in Ukraine, the Ministry of Energy mutually with SAEE has developed a draft National Renewable Energy Action Plan till 2030, which defines 27 per cent of energy consumption from renewable sources in 2030.

22. Currently, Ukraine has the following mechanisms for supporting renewable energy:

- FIT support scheme or auction price for 20 years for energy production from RE (Law on Alternative Energy Sources)
- Generating facilities that produce electricity from biomass and/or biogas will be entitled to a feed-in tariff if they were put into operation before the 1-st of January 2023
- The tariff for production of heat energy from RE at the level of 90 per cent cost of heat from natural gas (Law on Heat Supply).

V. Status and potential of bioenergy sector

23. Over the past years, Ukraine has been often spotlighted as one of the significant areas for expanding and consolidating renewable energy production for the European energy market, particularly bioenergy. This owes to the massive yet largely untapped sustainable biomass potential, extending on more than 600.000 sq. km, of which about 70 per cent are very fertile agricultural lands and 17 per cent of forests.

24. Most of the detailed biomass assessments date back some years now (or build on the past statistical data), yet there is some convergence in estimating that agricultural and forestry residues for energy production could deliver about 10-15 per cent of total primary energy supply (TPES) in the future energy mix. Bioenergy is currently approximately 4 per cent of TPES, where the overall target for renewables is 17 per cent in 2030. However, most of current usage refers to heating at the household level and biogas production in verticalized agri-businesses, while biofuels contribution to the transport sector is still very marginal. Most ambitious scenarios would imply significant efforts in the modernization of the primary sector, accompanied by appropriate investment. Among factors that could foster positive developments are the need to secure more energy self-sufficiency vis-a-vis the perduring tensions with Russia, formerly the primary provider of energy products.

25. The long-lasting conflict in the Eastern regions and confrontation with the Russian Federation are cyclically destabilizing society and the economy since almost a decade, impacting the energy market. Economic crises, demographic changes, long-term effects of the transition to market economy, decline of obsolete industries combined with limited investment capacity brought to a 20 per cent drop in domestic energy production in the past two decades. According to IEA, while TPES fell by 30 per cent and the final consumption of electricity is back to the year 2000 values. Since the COVID-19 pandemic and related impacts on the economy, the feed-in tariff system is stalling, thus affecting the overall outlook for both ongoing and planned investments. On the other hand, the current scenario could represent a real opportunity for the bioenergy take-off, particularly in the heating and transport sectors. So that biomass could play an important role, even though the current contribution to the energy mix is limited.

26. The field of bioenergy in Ukraine has a great development potential. This is due to the peculiarities of the climate, the potential of the agricultural sector and the availability of necessary workforce. The greatest energy potential in Ukraine is provided by such types of biomass as agricultural residues (primary - formed in the field during harvesting, secondary - formed at enterprises during crop processing, animal manure) and energy crops (for obtaining solid biofuel and biogas). The dynamics of electricity production from biomass lag behind the generation based on other renewable energy sources - the installed electric power on biomass and biogas at the beginning of 2021 was 212 MW. In Ukraine, there are 53 installations with a total electrical capacity of 124 MW, which produce energy from biogas and operate at a feed-in tariff.

27. One of the ways to develop biogas technologies is the production of biogas from solid household waste, of which about 10 mln tons are produced annually in Ukraine. In Ukraine, there are almost 5,500 landfills and solid waste landfills. The largest number of them are in the Vinnytsia (741), Poltava (675) and Chernihiv (659) regions.

28. In addition, at the beginning of 2021, there are 22 TPPs and CHPs with a total electric capacity of 109 MW operating in Ukraine, which produce energy from biomass and operate at a feed-in tariff. During 2019-2020, there was a rapid increase in the capacity of such facilities, from 51 MW of electrical capacity at the end of 2018 to 109 MW at the end of 2020.

29. Taking into account the significant underachievement of the goals of the National Action Plan for the Development of Renewable Energy for the period until 2020 in terms of bioenergy development and the projected generation profile of this segment of renewable sources, the Action Plan envisages the intensive development of electricity generation using biomass and biogas.

30. At the same time, a potential direction for increasing the share of renewable energy sources in electricity is the use of bioenergy at existing facilities of traditional generation, through their conversion. In addition, a potential direction for the use of bioenergy is the use of biomethane in highly maneuverable generation that consumes natural gas.

VI. Prospects for bioenergy development

31. According to the draft National Renewable Energy Action Plan until 2030, the share of renewable energy in the transport sector should be 14 per cent in 2030. The expected consumption reaches 238 ktoe for bioethanol/ETBE and 87 ktoe for biodiesel in 2030. Over the past 20 years, several relevant programs have been developed and approved in the country, including the Ethanol Program (2000) and the Diesel Biofuel Development Program (2006), but their implementation has not been successful.

32. The prospect of increasing the volume of the second generation (2G) biofuel in the EU is enshrined in the EU directives on the mandatory consumption rate of 2G biofuels in fuel mixtures. The main protocol of RED II to the EU Directive on alternative fuels (June 14, 2018) stipulates that the overall increase in annual use of biofuels in fuel mixtures for road transport should occur only due to the increase in the use of 2G biofuels, the share of which should be half by 2030 from the fixed at the level of 7 per cent of the volume of use of biofuel of the first generation according to the schedule - 0,2 per cent in 2022; 1 per cent in 2025; 3.5 per cent in 2030.

33. By 2030, the amount of 2G biofuel to offset the need for 3.5 per cent of the EU's transport fuel needs should be 10.5 Mt. Eurostat predicts that the total consumption of transport fuel (automobile and railway) in 2030 will be 306,567 Mt.

34. Ukraine has a great advantage over other biofuels exporting countries, having huge reserves of cellulose-containing raw materials in the form of wheat straw, corn stalks, etc. In 2019, Ukraine harvested 65 million tons of grain. There is 0.5 tons of straw per 1 ton of wheat, so Ukraine has 32 million tons of straw where 5.5 tons of wheat straw are needed for 1 ton of 2G biofuels. This number of raw materials is enough for 6 million tons of 2G biofuels. As of today, no enterprise in Ukraine has been certified for 2G biofuel production.

35. Regarding the biomethane market, during 2021 and 2022, the necessary legislative regulation for the development of biomethane production was implemented in Ukraine, and the first biomethane plants are currently being under construction. Their launch is planned by the end of 2022. The launch of the biomethane registry for issuing of GoO is planned for 2023.

36. However, today there is no legislative base in Ukraine regarding the development of use in the transport sector. In view of the above, it is suggested to develop an appropriate act that would take into account the best world experience in the development of an effective regulation.

37. In order to develop the market of liquid biofuels, the Parliament of Ukraine, together with the government and other stakeholders, have developed a draft law "On Amendments to Certain Legislative Acts of Ukraine Regarding Mandatory Use of Liquid Biofuels (Biocomponents) in the Transport Industry" (Reg. No. 3356-d dated 5 November, 2020).

38. On 30 June 2021, at a meeting of the Verkhovna Rada of Ukraine, the draft law was adopted in the first reading as a basis. The main goal of the draft Law is to create an effective legislative mechanism for the development of a competitive market for the production and use of bioethanol and other biocomponents in transport sector of Ukraine. Its adoption is an important step on the way to replace oil.

39. In addition, Ukraine annually imports up to 80,000 tons of bioethanol as part of gasoline, which it could produce and consume on its own territory.

40. The bill envisages to:

- Establish a mandatory share of liquid biofuel (quota) in the total annual volume of gasoline sales of at least 5 per cent by volume

- Introduce accounting and control of the content of biocomponents in gasoline
- Establish liability (fines) for non-compliance with quotas by business entities engaged in the production, import and sale of gasoline in the customs territory of Ukraine
- Introduce requirements for compliance with sustainability criteria for biofuels.

41. At the same time, the technical characteristics of fuel with biocomponents must necessarily meet the requirements of technical regulations, harmonized with European standards and other legal acts.

42. In general, the adoption of the draft law will allow to:

- Attract investments in the production of liquid biofuel
- Stimulate the construction of new capacities for the production of bioethanol
- Activate agricultural holdings and distilleries in the production of liquid biofuels
- Increase the utilization level of distilleries and the production potential of adjacent areas
- Contribute to the fulfillment of international obligations before Energy Community in achieving a share of 14 per cent in transport from renewable sources.

43. In addition, the draft law provides introduction of sustainability criteria for bioethanol used in transport. The mechanism of imposing fines for non-fulfillment of mandatory quotas for the addition of bioethanol, which is also proposed by draft law No. 3356-d, is used in more than 20 of the 27 EU member states, in particular in: Austria, Sweden, Portugal, Poland, Netherlands, Germany, Italy, Czech Republic, Finland and others.

44. In view of the above, the adoption of draft law No. 3356-d is extremely important for the development of the domestic energy market, reduction of import dependence, establishment of bioethanol export to EU countries and development of the use of Ukraine's agricultural potential in the energy sector. Therefore, the adoption of the draft law will allow to reduce emissions of harmful substances and the amount of CO₂ emissions in the transport sector. In accordance with the requirements of the Law of Ukraine "On Standardization", the state policy in the field of standardization is based on the principle of voluntary application of national standards and codes of established practice, unless otherwise provided by regulatory legal acts.

45. Also, according to the provisions of the current legislation of Ukraine, in particular Article 1 of the Law "On Technical Regulations and Conformity Assessment", a technical regulation is a legal act that defines the characteristics of products or related processes and production methods, including relevant administrative regulations, compliance of which is mandatory. That means the state standards for motor fuel in Ukraine are not mandatory, and the Technical Regulation on requirements for automobile gasoline, diesel, marine and boiler fuels, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 1 August, 2013 No. 92731, applies only to gasoline with bioethanol content up to 10 per cent and diesel fuel with biodiesel content up to 7 per cent. Therefore, in order to establish clear procedures for the use of alternative motor fuel and biocomponents in transport, ensure their quality, environmental friendliness and safety, it is necessary to develop and approve relevant technical regulations taking into account the requirements of European and international standards in this area.

46. Another effective step for the development of the liquid biofuels market could be the reduction of excise taxes on biodiesel and alternative fuels (with a content of biocomponents over 30 per cent), which currently amount to 103 EUR/ton and 162 EUR/ton, respectively. During the period of martial law, these excise tax rates are set at the same level as petroleum gasoline and diesel – 100 EUR/ton.

47. The mechanism for the development of the solid biofuel market in Ukraine can be the use of a single electronic platform where all interested producers and consumers will trade biofuel. In order to solve this issue, the Members of Parliament of Ukraine developed a package of draft laws:

- The draft law "On Amendments to Some Legislative Acts of Ukraine Regarding the Development of Electronic Trade in Alternative Fuels" (reg. No. 8052 dated 19.09.2022)
- The draft law "On Amendments to the Code of Ukraine on Administrative Offenses Regarding Liability for Offenses in the Field of Electronic Trading of Alternative Fuels" (reg. No. 8053 dated 19.09.2022).

48. The bills propose to introduce a single electronic platform in Ukraine, where all interested producers and consumers will trade biofuels.

49. In order to fill the electronic trading system of biofuel with real transactions, it is proposed to provide for the obligation gradually, from 40 per cent of the total annual volume of production or consumption of solid biofuel to 100 per cent (the introduction is planned to be made within 4 years), to trade through the exchange for individual enterprises:

- Traders of biofuel - state and communal enterprises that produce solid biofuel
- Buyers of biofuel - economic entities that obtained FIT or an auction price for the production of electricity and economic entities that received an incentive tariff of 90 per cent (cost from the gas tariff) for the production of thermal energy from alternative sources.

50. The electronic platform plans to provide biofuel trade in accordance with the quality classes to be determined by the Ministry of Energy and internal documents of the electronic trade system based on European standards.

51. Administrative liability is provided for failure to comply with obligations regarding trading in the electronic biofuel trading system.

52. The adoption of the specified legislative changes will contribute to:

- Creation of a transparent biofuel market in Ukraine
- Significant reduction of biofuel prices
- Construction of new biofuel generating capacities
- Increasing the number of biofuel suppliers and buyers
- Expansion of activities for producers of solid biofuel of wood and agricultural origin
- Increasing the volumes of feedstock suitable for the production of solid biofuel
- Provision of generating capacities with biofuel.

53. The raw materials for the production of solid biofuel are mostly waste from forestry and the woodworking industry (sawdust, wood chips), grain straw, sunflower husk, etc. However, the supply of such raw materials is seasonal and not always stable. Therefore, the cultivation of perennial energy crops is another option for providing solid biofuel producers with raw materials. This is the way to the faster decarbonization of energy production, reduction of greenhouse gas emissions and achievement of energy independence.

54. In order to ensure the possibility of using the potential of unproductive lands for the cultivation of energy crops with the aim of their further use in the energy sector, the Members of Parliament of Ukraine developed a package of bills:

- The draft law "On Amendments to Some Legislative Acts of Ukraine Regarding Promotion of the Development of the Field of Growing Energy Crops" (reg. No. 5227 dated 12.03.2021)
- The draft law "On Amendments to Article 288 of the Tax Code of Ukraine regarding rent for land plots on which energy crops are grown" (reg. No. 5228 dated March 12, 2021).

55. The main provisions of the draft laws are:

- Establishment of the maximum amount of rent for land plots of state and communal property at the level of 5 percent of the normative monetary assessment

- Introduction of a minimum lease term for land plots provided for the cultivation of energy crops - 20 years
- Lease of unproductive and marginal land plots of state and communal property (without conducting land auctions)
- Providing a definition of the term "energy crops" and introducing state support for the cultivation of energy crops.

56. Cultivation of energy crops on marginal lands is the optimal solution, because it will allow to simultaneously earn a profit and gradually restore their fertility without additional budget costs. However, currently there is one more legislative barrier to the development of bioenergy sector in Ukraine. As mentioned above, according to the requirements of the current legislation, a tax of 30 UAH/ton is levied in Ukraine for carbon dioxide emissions that occur when biofuel is burned (at the same level as fossil fuel). However, this is contrary to international practice.

57. The coefficient of greenhouse gas emissions for biomass is zero in accordance with the provisions of Annex IV of Directive 2003/87/EC on the establishment of a trading system of quotas for greenhouse gas emissions within the EU and amending Council Directive 96/61/EC. Therefore, taxes on carbon dioxide emissions during the production of energy from biofuels are also not applied in all EU member states.

58. Therefore, according to SAEE, the Government of Ukraine is developing a package of bills to solve the above-mentioned issue, namely:

- The draft law "On amendments to the Tax Code of Ukraine regarding the establishment of a zero-tax rate for carbon dioxide emissions for installations that produce such emissions as a result of burning biofuel"
- The draft law "On Amendments to the Law of Ukraine "On Alternative Fuels" regarding the creation of a Register of installations that use biofuel as the only type of fuel".

59. The adoption of these draft laws will contribute to the:

- Exemption from taxation of biofuel installations in order to create conditions for further stimulation of energy production from biofuel
- Attraction of investments in the field of biofuel usage
- Increase in projects that directly substitute fossil fuels.

VII. Challenges and existing barriers

60. Addressing market challenges and barriers in Ukraine will require coordinated efforts from the government, private sector, and other stakeholders to develop policies and incentives that will support the growth and development of the bioenergy sector. This could include measures to increase market transparency, improve infrastructure, streamline regulations, and provide financing and other forms of support to bioenergy projects.

61. The Ukrainian biofuel market requires the implementation of regulations to govern its activities. There is a monopoly in the heat supply market, and a competitive market of thermal energy needs to be introduced, along with bylaws to ensure law enforcement. Access to heating networks is complicated, and the regulatory framework needs to be updated to provide clear steps for connection. Insufficient biomass in the market leads to higher prices, which can be addressed by creating a single electronic platform for biofuel trading, where state-owned enterprises will be obliged to sell part of the raw materials, and those who use the "green" tariff and the stimulating heat tariff will be obliged to buy biomass through this platform.

62. Therefore, bioenergy projects have low investment attractiveness, and the "green" tariff needs to be extended and become higher for low-capacity installations. There are also no incentives for farmers to grow energy crops due to low profitability and the solution lays within right land lease for such projects, extend it and provide for a one-time subsidy per

hectare. Difficult access to logging residues needs to be addressed, and it is important to ensure that these residues are transported to nearby roads and not burned in the forest.

63. Biomethane production needs to be increased in Ukraine, which can be achieved through the use of modern technologies for agricultural residues and straw. Unfortunately, the production of bioethanol and biodiesel in Ukraine has not been widely developed. Today, the motor biofuels sector of Ukraine is in stagnation due to the lack of a consistent state policy and incentive mechanisms. The situation is exacerbated by the high excise tax on biodiesel (106 euros/1000 litres) and the tax bill on the full rate of excise duty, required for the bioethanol transportation.

64. Since the beginning of the war, Ukraine has abolished and then reduced excise taxes on traditional fuels, but this did not affect biofuels. In general, in Ukraine, the excise tax on ecological fuel was higher than on traditional fuel. At the end of 2022, excise duties were equalized however no extra preferences were given to biofuels.

65. Substantive pressure on biofuel investors is related to institutional superstructure of controllers who are required to check production at all technological stages. Each release of products and production is possible only with the consent of tax inspectors of the excise warehouse, which creates corruption and institutional risks. The movement mechanism using promissory notes for the full rate of excise tax on ethyl alcohol greatly complicates the purchase of the product by fuel companies.

66. An important element for the development of biofuels, in particular bioethanol, was the de-monopolization and privatization of the alcohol industry, which is currently continuing. Today, the Government of Ukraine is conducting intensive work on deregulation and implementation of incentives for projects implementation. Currently, fuel companies and agricultural holdings are conducting an intensive study of the possibilities for creating their own plants on complex processing of agricultural raw materials, one of the elements of which is bioethanol and biodiesel.

VIII. Conclusions and recommendations

67. The bioenergy sector has the potential to contribute significantly to the energy mix of Ukraine and help achieve national energy security goals. However, to fully unlock the potential of bioenergy, there is a need for policy and regulatory support. The project study provides recommendations for the development of four key bioenergy technologies in Ukraine: biomethane, bioethanol, biodiesel, and solid biomass.

68. In the case of biomethane, the implementation of the biomethane Register is recommended, along with the development of regulatory support schemes for biomethane usage in transport and agriculture. There is a need for regulatory adjustment of gas distribution system to receive the reverse flow of biomethane and the inclusion of biomethane consumption goals (5-10 per cent of natural gas consumption in transport by 2030) in the National Energy Strategy and National Renewable Energy Action Plan, as well as goals for the number of gas filling stations. Additionally, technical requirements for the use of biomethane as motor fuel should be developed. Furthermore, should be developed support mechanisms in order to enable export of biomethane.

69. For bioethanol, the adoption of a draft law on a mandatory share of bioethanol in gasoline and the development of the liquid biofuels market are recommended. The regulatory environment should be created for the increase of the mandatory share up to 10 per cent for existing engines and up to 50-85 per cent for flexible fuel vehicles in the future. Excise tax reduction or cancellation on gasoline with a content of at least 5 per cent by weight of bioethanol is also needed, along with the introducing incentives for importing flexible fuel vehicles that can use up to 85 per cent of bioethanol as fuel. In addition, there should be mitigated requirements for the full excise duty rate tax bill for bioethanol transportation.

70. For biodiesel, reduction or cancellation of the excise tax on biodiesel and its blends is recommended. Should be developed and adopted technical regulations for alternative diesel fuel with a biodiesel content of more than 7 per cent by volume, along with the introduction of a mandatory share of biodiesel in diesel fuel at the level of 5 per cent. It is also

recommended to introduce an export duty on rapeseed (10 per cent of the product customs value) similar to the existing duty on flax, sunflower and camelina seeds. There is a need of gradual transition to the production and consumption of hydrotreated vegetable oil (HVO), which is a complete analogue of diesel fuel and can be used up to 100 per cent in diesel engines. Also should be developed legislation for creating incentives for the collection of used cooking oils.

71. For solid biomass, exemptions of installations that burn solid biofuel and biogas from CO₂ emissions tax is recommended, along with the elaboration of regulations in the Forest Code on the prohibition of the burning of felling residues in the forest, obligation of forestry enterprises to clear felling site and simplification of the access of third parties to felling residues. Development of regulatory incentives for the population to produce heat from solid biomass is also recommended, along with the introduction of a centralized electronic system for biomass trading (biomass exchange). There is needed also an improvement of legislation for supporting competitive heat energy markets and ensuring non-discriminatory access for independent producers to the heat networks. Moreover, introduction the definition of "energy crops" into legislation of Ukraine and the regulatory extension of the land lease agreement terms for the cultivation of energy crops up to 20 years (currently it is maximum 7 years) are also recommended, with the limitation of the maximum land lease payments for unproductive and degraded land on which energy crops are grown to 5 per cent of the normative monetary value. Should be introduced changes to legislation for simplifying the lease of unproductive land for the cultivation of energy crops without holding land auctions. Development and implementation of a mechanism of guarantees of origin for electricity produced from biomass. There is needed a launch of state support auctions to produce electricity from biomass and start of auctions for balancing capacities with electricity storage systems.

Annex

Identified Bioenergy Sector Barriers

<i>Technology</i>	<i>Identified Barriers</i>
Biomethane/ biogas	<ul style="list-style-type: none"> • The Register for issuing Guarantee of Origin has not yet been operational; mechanism for issuing a guarantee of origin for biomethane in transport has not been implemented. • Absence of state goals and obligations regarding the share of biomethane use in transport. • Absence of legislation supporting for biomethane producers to connect the gas distribution system (GDS). • Lack of legislation providing incentives for the use of biomethane in the transport and agricultural sectors. • Lack of regulations on technical requirements for the use of biomethane as motor fuel in transport. • Due to Martial law in Ukraine, there are natural gas export limitations.
Bioethanol	<ul style="list-style-type: none"> • There is no regulation for mandatory share of bioethanol in gasoline. • Lack of technical regulations for alternative fuel with a bioethanol content of more than 10 per cent by volume to add about 85 per cent vehicles. • High excise tax rate on gasoline with a content of at least 5 per cent by weight of bioethanol – 100 EUR per 1000 litres. • Requirement for the full excise duty rate tax bill for the transportation of bioethanol.
Biodiesel	<ul style="list-style-type: none"> • High rate of excise tax on biodiesel and its blends – 100 EUR per 1000 litres. • Lack of support for alternative fuel with a biodiesel content of more than 7 per cent by volume. • There is no requirement for a mandatory share of biodiesel in diesel fuel. • There is no export duty on rapeseed. This reduces incentives to process rapeseed inside of the country. • There are no regulations and stimulus for the collection of used cooking oil that can be used for the production of biodiesel.
Solid biomass	<ul style="list-style-type: none"> • The need for biomass and biogas boiler plants, CHP plants/TPPs to pay obligatory CO₂emissions tax. • Lack of regulations on the management of felling forest residues. • Lack of incentives for the production of heat from solid biomass for population due to subsidized natural gas tariffs. • Absence of a biomass exchange in Ukraine. • Monopoly of the district heating operators and lack of

<i>Technology</i>	<i>Identified Barriers</i>
	<p>incentives for independent producers to access heat networks.</p> <ul style="list-style-type: none"> • Absence of the “energy crops” definition in Ukrainian legislation. • Expensive and short-term land lease agreements for the cultivation of energy crops. • Imperfect land auctions procedure for land leases to cultivate energy crops. • Production of electricity from biomass is not supported by the mechanism of guarantees of origin. • Absence of auctions for the allocation of state support for bioenergy projects. • Lack of balancing capacities and electricity storage systems to balance the energy system with a high proportion of renewable energy sources.

Estimated potential of Ukraine's bioenergy sector

<i>Technology</i>	<i>Current volumes of production (2021)</i>	<i>Development potential 2035</i>	<i>Investment potential</i>
			<i>2035, B Euro</i> <i>2050, B Euro (long term scenario)</i>
Biomethane/biogas	150 mln m ³ CH ₄ (biogas)	2012 mln m ³ (biomethane)	4.0-5.4 33-44
	125 ktoe (biogas)	1719 ktoe (biomethane)	
Bioethanol	81.1 kt (2020)	555 kt	0.87
	51.1 ktoe (2020)	350 ktoe	3.9
Biodiesel	-	322 kt	0.62
		300 ktoe	2.3
Solid biomass	16.2 Mt	37.1 Mt	10.3
	4.2 Mtoe	10.1 Mtoe	16.4

Source: Estimates according to the basic modelling scenario, with the support of 100RE-UA and UABIO.