ЕКОНОМІЧНІ НАУКИ

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IDENTIFYING MEASURES FOR INCREASING RENEWABLE ENERGY GENERATION FROM AGROINDUSTRIAL RESIDUES AND WASTES IN UKRAINE IN ACCORDANCE WITH THE BEST PRACTICES IN LATVIA

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Subject of research. *The measures facilitating biogas and biofuels production from agro-industrial wastes and residues.* ***Purpose.*** *To conduct state-of-the-art review of policy measures and actions in Latvia stipulating growth production of biofuels and biogas from agro-industrial residues and wastes. Based on Latvian experience and policy actions, authors will identify key institutional, legal, policy measures and conditions for benefitting from biofuel/biogas production from agro-industrial residues and wastes in Ukraine.* ***Methods.*** *For the research, a systematic approach to factual materials was used, conceptual research through observing and analyzing legal acts and other policy documents, available data etc., and abstract-logical approach to generalize research results and formulate conclusions. The materials used for the studies included publications, research and policy papers, reports of public institutions and NGOs etc.* ***Results.*** *Ukraine is facing energy, economic and social challenges due to the dependence on import of energy resources aggravated due to unprovoked invasion of russian federation. At the same time, Ukraine possessing profound agricultural and food potential has an abundant supply of residues and by-products, combined with agro-industrial wastes. These resources have already found vast applications in Latvia and other EU countries for energy purposes, including production of renewable energy. Key measures for promoting and facilitating biogas and biofuel production in Ukraine should be based on Latvian experience regarding sound and sustainable development of biogas and biofuel industry.* ***Scope of research results.*** *The results are supposed to be used for identifying critical policy needs and policy levers to foster deployment of biofuel technologies as a part of a sustainable value chain in agriculture production and processing in Ukraine.*

Key words*: biofuels, biogas, biomethane, policy, measures, residues, wastes*

ВИЗНАЧЕННЯ ЗАХОДІВ З НАРОЩУВАННЯ ВИРОБНИЦТВА ВІДНОВЛЮВАЛЬНОЇ ЕНЕРГІЇ З АГРОПРОМИСЛОВИХ ЗАЛИШКІВ ТА ВІДХОДІВ В УКРАЇНІ З УРАХУВАННЯМ ДОСВІДУ ЛАТВІЇ

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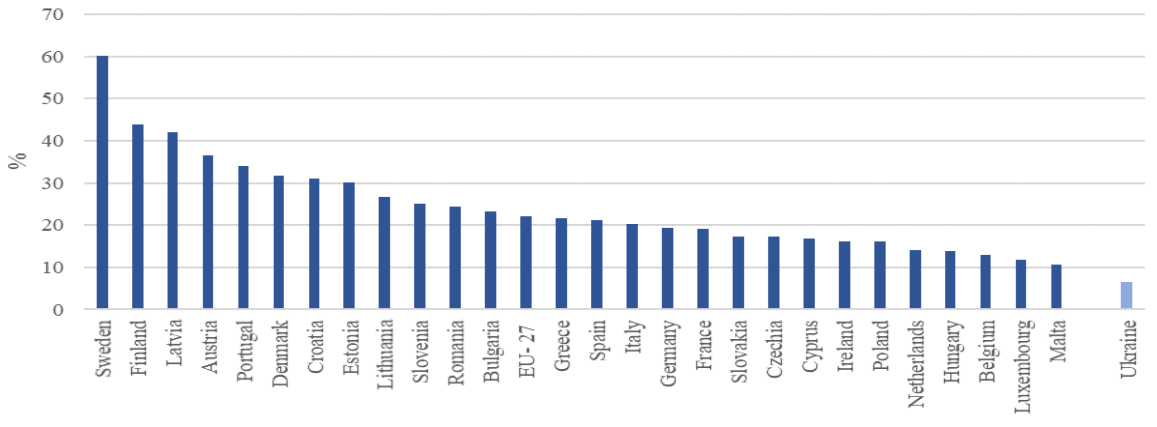
Предмет дослідження. *Заходи, що сприяють виробництву біогазу та біопалива з агропромислових відходів і залишків.* ***Мета.*** *Провести сучасний огляд політичних заходів і дій у Латвії, що передбачають нарощування виробництва біопалива та біогазу з залишків і відходів*

агропромислового виробництва. На основі латвійського досвіду та політичних дій автори визначать ключові інституційні, правові, політичні заходи та умови для одержання користі від виробництва біопалива/біогазу з агропромислових залишків і відходів в Україні. ***Методи.*** *Для дослідження було використано системний підхід до фактичних матеріалів, концептуальне дослідження шляхом спостереження та аналізу нормативно-правових актів та інших програмних документів, наявних даних тощо, а також абстрактно-логічний підхід для узагальнення результатів дослідження та формулювання висновків. Матеріали, використані для досліджень, охоплюють публікації, дослідження та аналітичні документи, звіти державних установ та неурядових організацій тощо.* ***Результати.*** *Україна стикається з енергетичними, економічними та соціальними викликами через залежність від імпорту енергоресурсів, що значно посилюється через неспровоковане вторгнення Російської Федерації. Водночас Україна, володіючи потужним сільськогосподарським і продовольчим потенціалом, накопичує значні обсяги залишків, побічних продуктів та відходів агропромислового виробництва. Ці ресурси вже знайшли широке застосування в Латвії та інших країнах ЄС для енергетичних цілей, включаючи виробництво відновлюваної енергії. Ключові заходи для сприяння виробництву біогазу та біопалива в Україні повинні враховувати латвійський досвід щодо надійного та сталого розвитку промисловості виробництва біогазу та біопалива.* ***Сфера застосування результатів.*** *Результати виконаних досліджень використовуватимуться для імплементації необхідних політичних рішень для сприяння розгортанню технологій біогазу та біопалива як частини стійкого ланцюга створення доданої вартості в сільськогосподарському виробництві та переробці сільськогосподарської продукції в Україні.*

Ключові слова: *біопаливо, біогаз, біометан, політика, заходи, залишки, відходи*

Introduction. Faced with the economic energy and logistics challenges, as well as national and energy security threats due to the russian unprovoked invasion to Ukraine, many countries are looking for energy efficiency and green energy solutions to improve their economic sustainability while minimizing further greenhouse gas emissions. Consequently, more countries are implementing measures to foster deployment of bioenergy facilities and to increase production and consumption of renewable energy, among which Latvia has gained relevant experience that could be applied in Ukraine.

Climate change mitigation and decarbonization, energy security and efficiency have become core state policy focus for Latvia in line with EU Green Deal national obligations for reduction of greenhouse gas emissions and UN Sustainable Development Gaols. At EU level, the share of renewable energy in energy consumption increased steadily from 9.6% in 2004 to 22.1% in 2020, thus exceeding the EU target of 20% renewables by 2020. Sweden had by far the highest share of renewables (60.1% of energy consumption) in 2020, followed by Finland (43.8%) and Latvia (42.1%) (Figure 1) [1].



Source: (Eurostat, 2022, Ukrstat, 2022)

Fig. 1. Share of energy from renewable sources in EU member states and Ukraine, 2020, %

In 2020 Latvia has adopted the National energy and climate plan for 2021-2030 which constitutes a framework document for long-term planning laying down main action lines for the change of the approach of the economy and society to ensure the fulfilment of EU and international commitments. The following action lines have been defined to achieve the objectives of the plan: 1. Improving the energy performance of buildings; 2. Improving energy efficiency and promoting the use of RES (Renewable Energy Sources) technologies in the heating and cooling and industry; 3. Promoting the use of negative emission technologies in electricity generation; 4. Promoting economically justified self-generation and self-consumption of energy; 5. Improving energy efficiency, promoting the use of alternative fuels and RES technologies in transport; 6. Energy security, reducing energy dependency, full integration of energy markets and modernisation of infrastructure; 7. Improving the efficiency of waste and wastewater management and reducing GHG (Greenhouse Gases) emissions; 8. Efficient use of resources and reduction of GHG emissions in agriculture; 9. Sustainable use of resources and reduction of GHG emissions and increasing carbon sequestration in the sectors of land use, land-use change and forestry; 10. Promoting the reduced use of fluorinated greenhouse gases (F-gases); 11. 'Greening' of the tax system and improvement of friendliness to energy efficiency and RES technologies; 12. Public information, education and awareness raising [2]. Latvia's target for the share of renewable energy in the final energy consumption to reach 50% till 2030. Latvia has already reached the third highest share of 42.1% of renewable energy in energy production in the EU, which (share of RES) exceeded 50% in 2020 in electricity (53.4%), heating and cooling (57.1%) [3]. Most of renewable electricity is produced within the large hydroelectric power plants (HPP) and a share of 9-12% annually are produced in the co-generation biomass and biogas power plants [4]. The current situation after the unprovoked invasion of the russian federation in Ukraine and the following changes in supply of the fossil energy form russia have highlighted the need to support a further development of decentralised energy production facilities in Latvia by using local renewable energy sources, especially biogas and biomass and to develop ways to use biogas and integrate it into the farming and production structure in a sustainable way.

Ukraine may gain substantial benefits from Latvian experience in promoting biofuels and biogas. Despite almost twice reducing the natural gas consumption during the last decade, Ukraine is still highly dependent on gas imports (around 40% of domestic consumption), thus deteriorating national economic and energy security. In 2017 the government endorsed the National Energy Strategy to 2035, which set a target of 25% share of renewable energy in the total final energy consumption till 2035 [5]. Fulfilment of this goal and ensuring affordable energy supply is a question of favourable investment climate and attractive mechanisms for financing renewable energy sectors, sustainability of raw supply and production capacities in bioenergy sector.

Results and discussion. In accordance with statistical data and energy balance of Ukraine, the share of energy supply from renewable sources was 6.6% in 2020 [6]. Production of solid fuel biomass reached 147860 TJ, biogases – 3852 TJ while liquid biofuel was not produced in 2020 [7]. The liquid biofuels sector of Ukraine is in stagnation due to lack of state policy decisions and incentive mechanisms, and resulting from disstimulating taxation. The potential for obtaining first generation liquid motor biofuels in Ukraine is estimated at 310 ktoe/year of biodiesel and 590 ktoe/year of bioethanol [8]. During the last years Ukraine succeeded with investments in wind and solar energy (their total share in the national electricity supply varies from 10 to 17% during the year). At the same time availability of biomass was not yet widely transformed into biogas production - the share of biogas in electricity production was only 0.5% at the end of 2021. On the other hand, Ukraine is facing an abundance of agro-industrial residues and wastes (post-alcohol distillery stillage, straw, corn silage, sugar beet pulp), valorisation of which is becoming a priority for producers aiming to increase the sustainability of the value chains, reduce waste and environmental obligations. In Ukraine around 50 biogas enterprises are

functioning with capacity of 97 MW. In agroindustrial sector the capacity of deployed biogas plants reaches 67 MW on the end of 2020 – only 23% from envisaged by the National action plan`s goal for renewable energy till 2020.

Overall biomethane production potential in Ukraine is more than 9 billion m^3 CH_4 a year. Half of this potential is related to crop residues and one third to maize silage production. Animal husbandry wastes can contribute by 9.2%. Food&Beverage industry can contribute by 6.7%. Organic fraction of municipal solid waste and wastewater sludge could contribute by additional 6.1% [9].

Scientific research and empirical evidences prove that biogas and biofuels from agro-industrial residues can positively contribute to the energy sector, create additional output, investments, employment, logistic and environmental benefits, thus should be considered by policymakers and stakeholders as a key target for further policy decisions.

To gain the maximum economic and social potential and impacts of the sustainable deployment of biogas and biofuels production from agro-industrial residues and wastes Ukraine should implement an assessment of relations between the renewable sector, rural economies, national energy sector, and macroeconomic situation; and investigate usage of existing logistic and industrial assets for development of sustainable value chains and integration of biogas and biofuel production in the existing value chains in a way that contributes to the principles of circular economy.

Among the key barriers to the development of the biogas and biomethane sectors in Ukraine, the NGO "Bioenergy Association of Ukraine" (UABio) have among others have identified the lack of biomethane legislation, lack of state support, uncompetitiveness of biomethane fuel price for transportation in comparison with the price of natural gas, lack of supplier guarantees, complicated project development procedure (issues with connection to the power grid), problems with connection to district heating, low conversion efficiency into electricity, heat loss [10]. Heat loss should be paid particular attention to estimate and to eliminate it in the production process as well as in the distribution chain.

Ukraine currently is forming the required legislation. In October, 2021 Verhovna Rada adopted the Law "On the Amendments to Laws of Ukraine Regarding Development of Biomethane Production", while Cabinet of Ministers of Ukraine adopted an implementing act in July, 2022 [11], which establish key rules, definitions and regulations regarding biomethane origin, certification and integration into the power grid.

While having the progress in adoption legislation, Ukraine is facing challenges with feedstock, which is deteriorating due to unprovoked russian invasion to Ukraine. The most critical feedstock supply conditions might be in animal husbandry. During last decade (2010-2021) number of cattle has reduced almost twice, number of pigs – for 25%, thus substantially decreasing the availability of biomass from manure for production of biogas. During the last years individual producers (rural households, family farms and other small-scale producers) have shown larger decline in animal husbandry comparing with larger farms. Ukrainian regions under active war since February 24, 2022 accounted for almost 40% of country's number of cattle, which may decrease substantially. These tendencies will deteriorate the overall capacity and feasibility of biogas production in rural areas. Thus future model of state agricultural policy would become a trigger either for developing and implementation of solutions for biogas production combined with waste management, or for further decreasing production capacities. Studies from Latin America show that for individual milk farms (up to 10 cows per farm) biogas required for covering their energy service demand is higher than their biogas production potential, making these farms depend on conventional energy services. For small farms (15-50 cows), the potential for biogas production is able to cover demand, while in medium and large farms, the potential production of biogas is much higher than the biogas required to meet all their energy demands. Estimation of levelized cost of biogas for small farms (up to 10 cows) varies from 3.73 to 4.64 USD cents/kWh, while for rest bigger farms – from 1.72 to 3.09 USD

cents/kWh. [12]. Comparing with Ukrainian tariffs it is higher than electricity costs for natural persons (around 3.4-3.9 USD cents/kWh), while lower than those for corporate entities (9-14 USD cents/kWh).

Ukraine lacks evidence-based evaluation/monitoring system to produce up-to-date technico-economic evaluations for biogas and biofuels capacity and energy demand by different types/sizes of agroindustrial entities and for defining possibilities of achieving energy self-sufficiency. This dimension should be outlined within national measures and steps. Proper evidence-based approach contributes highly for policy decisions through modelling of bioethanol, biodiesel, biogas systems deployment and valorisation of agro-industrial residues and wastes. Additionally it would create basis for defining economic prerequisites to make renewables a success story, including assessing economically feasible investments and low cost technologies.

Infrastructure to deploy facilities is becoming another crucial challenge and should become a priority for policy decision-making. For many rural communities availability of land areas, suitable for installation of equipment, especially for joint usage by individuals or small agri-producers, is scarce or limited. This is combined with other infrastructure challenges, like transportation/collection issues.

Financial challenges play a role of a trigger for deployment of biogas and biofuels equipment as well. Ukrainian case has many conditions relevant for other countries. High investment costs together with widespread poverty are critical economic barriers in developing countries. A key feature of biogas technologies is that almost all expenses are upfront, while, operating expenses are very low. This fact creates problems to potential users with a low capital base. Besides, family-sized biogas plants are still costly for poor households, who are also excluded from the benefit of subsidies [13].

Another essential challenge for Ukraine, which requires country level measures, is the government policy and support incentives designed for biogas and biofuels producers. In Latvia four support mechanisms are used for production of electricity and heat from renewables – obligatory state purchase of electricity, guarantee of a set price, release from paying the electricity tax for the energy, produced from the renewable resources and public (EU structural fund) funding for investments, and one support mechanism for production of biofuel [14]. Although there have been a share of revisions in the support incentives throughout the years, it can be observed that the incentives through investment support and feed-in tariffs have had a substantial influence for the development of the biogas production sector. Among them relevant for Ukraine could be guaranteed price under the mandatory electricity purchase obligation (or the so-called feed-in tariffs), tax relieves for electricity from renewables, public co-funding for investment, and public tenders for the construction of new power plants.

Unfortunately for many years those issues have not found relevant adjustments within Ukrainian legislation. The shortcomings of ecological legislation which does not create necessary incentives for biofuels [15]. are still persistent and accompanied by disstimulating taxation.

As pointed out by the European Biogas Association experts, adequate support schemes are crucial for the development of renewable energy. Latvia started to support electricity generation from biogas in 2009, which had a clear impact on biogas production 3 years later in 2012. Since then, the production continued to grow steadily to reach 87.8 ktoe in 2015, which is considerable comparing to the total amount of the energy consumption in Latvia [16].

One more essential challenge that should be meet by Ukrainian policy makers and producers is public-private coordination and communication between stakeholders and science for potential uptake of bio-based energy sources. Comprehensive analysis of current and past trends, economic assessments and comparisons of the economic feasibility of various technological and financial options should be undertaken to understand the key challenges, impacts and incentives for increasing the production of renewable energy through statistical

analysis and case studies. Establishing a national bioethanol and biogas/ biomethane sub-targets with adequate strategy or action plan is necessary prerequisite to unlock production potential in Ukraine.

Conclusion. Production and consumption of biogas and biofuels in Latvia is stimulated through a complex policy provisions and support system based on a feed-in tariff, tax benefits and production/consumption obligations. The existing state support mechanisms for renewable energy production/consumption are being assessed and revised during the last years and now are envisaged by National Energy and Climate Plan 2021–2030 under the Energy Union Governance Framework.

Resulting from proper government actions Latvia has gained essential progress in RES, including biogas sector. Compared with other Central and Eastern European countries, biogas consumption per capita in Latvia in 2020 (1768 TJ) is significantly higher than, e.g., in Poland, where it amounts to 346 TJ, in Slovakia (990 TJ) or in Hungary (388 TJ).

Ukraine being an energy deficit economy and suffering highly from war actions should pay more attention for promoting RES sector, including bioethanol and biogas sub-sectors. Considering Latvian experience, key measures for boosting production/consumption of biogas/biofuels should include, among others:

- institutional improvements and capacity strengthening of engaged public bodies. Creation a framework allowing synergy work between stakeholders, including public authorities, producers, scientists, consumers to promote and increase financeability and attractiveness of biogas and biofuels production systems and to incentivize public-private actions;
- promoting de-centralised self-generation and self-consumption of bioenergy, including an emphasis of co-generation of electricity and heat and effective utilisation of heat;
- formation of up-to-date and relevant data and evidence accumulation system for stakeholders and policymakers;
- improve heating policy regulations, certification schemes and building regulations with the purpose to foster renewable energy consumption. Adjust biogas and/or biofuels project development procedures;
- implement adequate support schemes for the development of biogas and biofuels, including (but not limited to) a combination of feed-in tariffs, tax relieves, public co-funding for investment, public tenders etc;
- improve the efficiency of waste and wastewater management. Implement actions required for sustainability of feedstock and infrastructure development. Integrate such actions into state and regional agricultural policies, rural policies, economy recovery plans;
- assess future potential ecological, economic and social impact and market perspectives for biogas and biofuels production from agro-industrial residues and wastes in Ukraine. Elaborate baselines of national targets for renewable energy, as well as of agro-industrial residues and wastes production projections.

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