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PERSPECTIVES OF USING BIOGAS FOR DECARBONIZATION OF UZBEK POWER SECTOR

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Abstract. *Biogas production offers a versatile form of renewable energy, with methane serving as a viable replacement for fossil fuels in heat and power generation, as well as vehicular fuel. In the production of biogas, a variety of process types are employed, categorized as wet and dry fermentation systems. Biogas is predominantly employed in engine-based combined heat and power plants, while micro gas turbines and fuel cells offer alternative methods, although these technologies demand further development to reduce costs and enhance reliability. There is growing interest in gas upgrading and utilization as a renewable vehicle fuel or injection into natural gas grids, showcasing the potential for more efficient usage. This paper outlines the progress and future potential of biogas development and its application in electricity generation, heating, and transportation within Uzbekistan.*

Key words: *biogas, biomethane, renewable energy sources, decarbonization, electricity, heat production*

INTRODUCTION. The Republic of Uzbekistan has recently embarked on a significant endeavor to transition toward increased utilization of renewable energy sources, aiming to enhance energy efficiency and bolster economic competitiveness. The country's National Determined Contribution targets a 35% reduction in the economy's carbon intensity by 2030, relative to 2010 levels [1]. Uzbekistan currently contributes approximately 1.5% of global natural gas production, a critical component of the nation's economy, accounting for over 50% of final consumption in vital industrial sectors including chemicals, petrochemicals, non-metallic minerals, transportation equipment, food and tobacco, as well as textile and leather[2]. Natural gas is responsible for 80% of the nation's energy-related greenhouse gas emissions and approximately 2.5% of global fugitive emissions, which possess a notable global warming potential.

In this context, the Uzbek government's initiatives towards modernizing the energy system envision an innovative transformation of the gas infrastructure, while also tapping into the substantial potential of renewable energy (hydrogen, biomethane). This move is anticipated to potentially facilitate future energy exchange in the form of electricity or hydrogen with international partners.

Uzbekistan boasts a rich history with natural gas, which serves as a vital national resource and a cornerstone of the entire economic and industrial framework. It's important to note that natural gas significantly contributes to the country's greenhouse gas emissions. Consequently, focused attention and action towards decarbonizing the economy should prioritize innovative approaches within this critical energy sector.

Since the entire production industry is based on the use of natural gas, one of the possible replacements for natural gas in Uzbekistan is biogas or biomethane.

On 25th November 2015, the Government of Uzbekistan issued a resolution titled "On measures to stimulate the construction of biogas facilities at livestock and poultry farms in the country.” This move, announced by the Ministry of Economy’s press service, is designed to foster the integration of ecologically and energy-efficient technologies within Uzbekistan’s agroindustrial complex. The resolution provides a range of tax and customs incentives for entities utilizing biogas facilities.

The resolution further outlines the application procedure for initiators of biogas facility projects, wherein the process of land allocation and construction permits will adhere to streamlined, one-stop-shop protocols.

This directive advocates the development of guidelines for the construction, installation, and operation of specialized equipment, as well as the creation of a model biogas plant project. Additionally, it includes plans for the establishment of a territorial targeted program aimed at constructing biogas plants in livestock and poultry farms. The decree also addresses the potential inclusion of enterprises specializing in the production of biogas facilities, spare parts, and related components as part of the localization program.

The resolution underscores that enterprises utilizing electricity generated from renewable sources are permitted to supply excess electricity to the national electricity grid in accordance with established regulations.

ROLE OF RENEWABLE ENERGY SOURCES. The adoption of renewable energy sources has demonstrated substantial growth on a global scale, contributing to an estimated 19.2% of the world's final energy consumption in 2014 [16]. Notably, within the European Union, the utilization of renewable energy has seen a significant rise, escalating from 8.5% in 2005 to nearly 17% in 2015 in terms of gross final energy consumption. The global primary energy provision from biomass surged to approximately 60 exajoules in 2015, equating to a 10% share of the world's total primary energy consumption and a 14% share in final energy utilization.

Traditional biomass use, particularly for cooking and heating purposes, continues to make a substantial contribution, accounting for approximately 9% of the globe's final energy consumption. Conversely, the contemporary use of biomass is rapidly expanding, particularly across Asia. The global share of bioenergy in total primary energy consumption has exhibited stability since pre-2000, hovering around 10% [16].

Looking ahead, it seems that bioenergy will maintain its position as a primary renewable energy source in the European Union's energy mix, with a projected share exceeding 60% of renewable energy until 2020. In sum, the proportion of bioenergy in final energy consumption is predicted to elevate from 5.0% in 2005 and 9.6% in 2015 to nearly 12% in 2020 [8].

Uzbekistan also follows global trends in the involvement of renewable energy sources in power, heating, transport sectors. According to the United Nations Development Programme (UNDP), the number of biogas facilities in Uzbekistan surged from 16 in 2011 to 42 in 2015. Preliminary estimates suggest that Uzbekistan holds a substantial biogas potential, estimated at 8.9 billion cubic meters, which in terms of energy equivalence, corresponds to 6.5 billion cubic meters of natural gas, constituting more than 10% of the country's annual energy demand.

BIOGAS FOR ELECTRICITY AND HEAT PRODUCTION Nowadays all over the world is interested on the production of electricity and heat from biogas in cogenerative power plants.

In 2014, biomass use for heat production globally amounted to 45 exajoules (EJ), representing 75% of the total global biomass demand. Of this, around 70% (31.5 EJ) was generated from traditional biomass, mainly in Asia (19.1 EJ) and Africa (11.6 EJ). Biomass constituted over 90% of modern renewable heat generation in 2015. Within the European Union, heat production from biomass reached 3.5 EJ in 2015, accounting for approximately 90% of renewable heat production. Notably, modern biomass heat generation was prominent in Europe (3.1 EJ), developing Asian countries (2.7 EJ), and North America (2.6 EJ) [12, 6].

In the world, a significant portion of heat derived from biogas accounted for approximately 4% of global bioheat in 2015.[7] In high-income countries, biogas usage was primarily channeled into electricity-only and cogenerative (CHP) plants, with smaller amounts directed to heat-only plants. Conversely, in low-income countries, biogas was more commonly utilized for cooking and lighting purposes. In Europe, biogas was responsible for producing 127 terajoules (TJ) of heat and 61 terawatt-hours (TWh) of electricity in 2015, with approximately 50% of total biogas consumption (exceeding 330 PJ) allocated to heat production. [7] In the figure 2 it's possible to observe the trends of increasing of electricity capacity derived from biomass from 2010 to 2018[17]

BIOGAS IN TRANSPORT SECTOR The increasing of biofuel use in transport sector has met setbacks due to the ongoing debates surrounding sustainability issues, notably concerning greenhouse gas (GHG) emissions, Indirect Land Use Changes (ILUC), impacts on food security, and other related concerns. This ambiguity has led to discussions about potentially reducing support for biofuels, creating a notable degree of uncertainty in the market.

National Renewable Action Plans (NREAPs) outline various categories of biofuels intended for use in transportation. While NREAPs do not offer detailed information on the anticipated contribution of biogas in transport, a category identified as "other biofuels" encompasses biogas, vegetable oils, and other relevant sources. This class of biofuels was projected to supply a maximum of 13.9 petajoules (PJ), representing 1% of the expected biofuels to be utilized in transport by 2020 [8]. As observed, a small portion of biomethane obtained through biogas upgrading has already found application in transportation across multiple European countries. In 2015, the European Union emerged as the leading market for biomethane as a transportation fuel, with a collective usage of 160 million cubic meters [9].

IOGAS PRODUCTION POTENTIAL In terms of global biogas production, Europe, the People's Republic of China, and the United States collectively represent 90% of the output. (Figure 1) Presently, Europe stands as the foremost producer of biogas. In China, governmental policies have actively promoted the deployment of household-scale digesters in rural areas, aiming to enhance access to modern energy and clean cooking fuels. These digesters presently contribute to about 70% of the total installed biogas capacity in the country.

Conversely, in the United States, the predominant approach to biogas production has been centered around landfill gas collection, which currently constitutes nearly 90% of the nation's biogas output. Moreover, an increasing emphasis is being placed on biogas generation from agricultural waste, given that the domestic livestock sector accounts for close to one-third of methane emissions in the United States (USDA, 2016). [11]

According to the UNDP data Uzbekistan has a technical potential of producing 8.9 billion cubic meters of biogas annually.[10] By taking into the account the low percentage of methane (50-75% of methane, 25-45% of Carbone dioxide [5]) it is possible to get about 6 billion cubic meter per year of pure methane. Biogas resources accounts about 10% of total volume natural gas production. In 2008, the production of natural gas reached its highest point, generating a total of 68,329.4 million cubic meters. However, in 2021, gas production has increased by 4,033.8 million cubic meters, while gas consumption has risen by 5,826 million cubic meters, in comparison to the levels recorded in 2020. [4]

According to the World Bank, livestock farming in Uzbekistan accounts for 13% of GDP and about 50% of the added value of agro-GDP. And this does not take into account the assessment of the effect of using manure as a valuable organic fertilizer. This means that the possibility of obtaining biogas from livestock is very high. For comparison, 1 ton of cattle dung allows to produce 30 cubic meters of gas, and chicken droppings - 60 cubic meters of gas.[14]

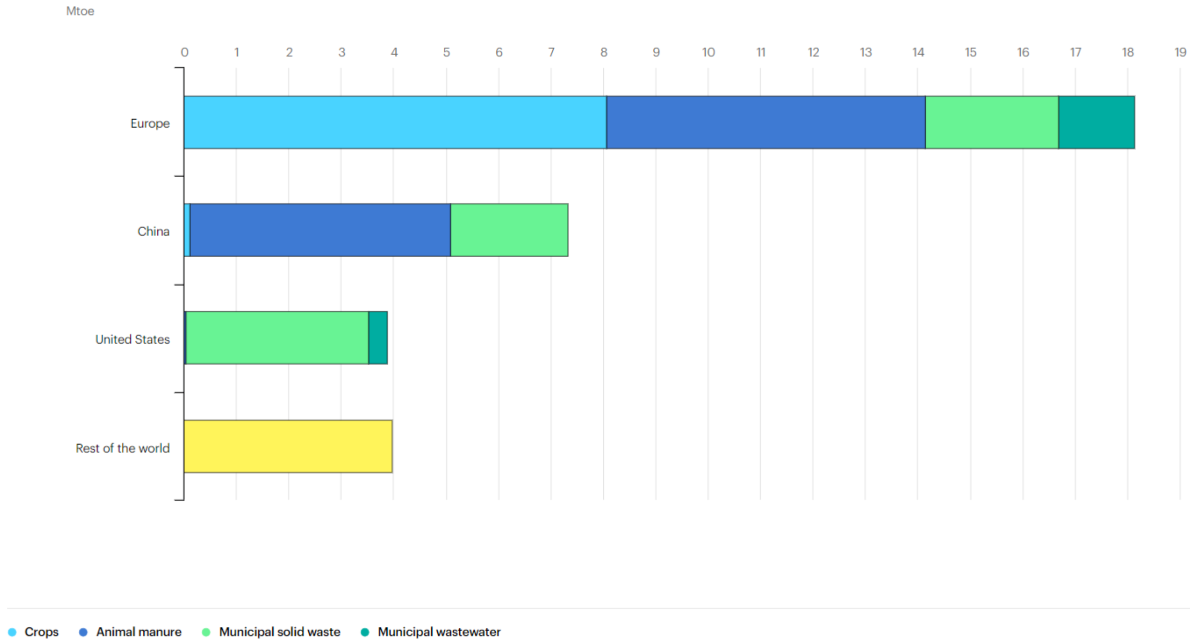

Figure 1. Biogas production by region and by feedstock type, 2018 [15]

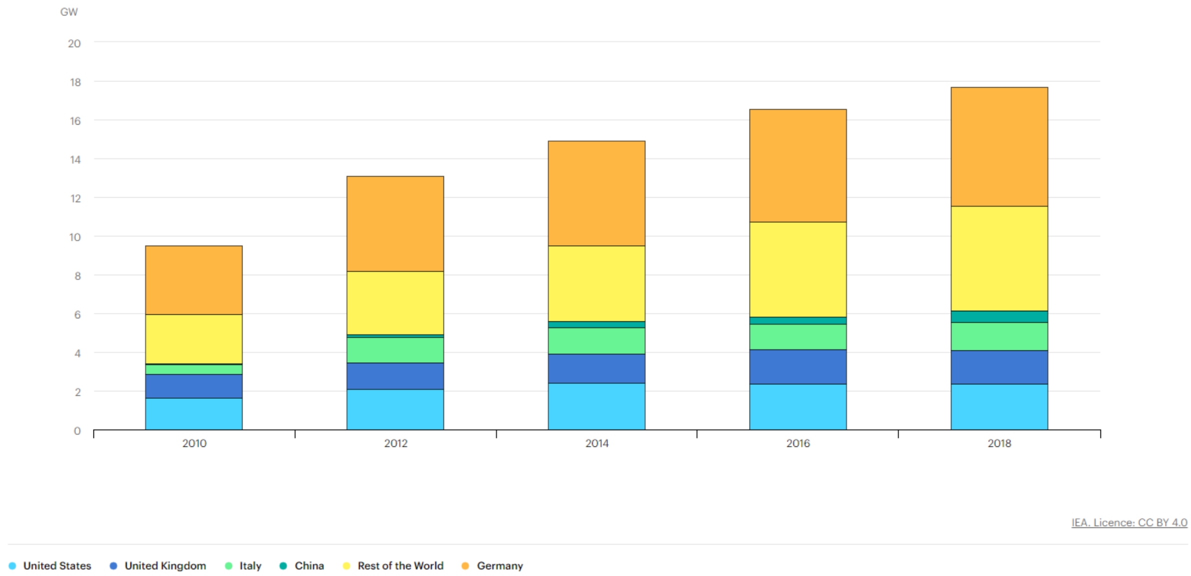

Figure 2. Biogas installed power generation capacity, 2010-2018 [15]

According to government statistics, at the end of 2019, there were 16.8 million head of cattle and 21.5 million head of small cattle in the country. About 83% of sheep and 95% of cattle were kept in households. [3] Every day about 50 cows produce 1 ton of dropping, so 30 cubic meters of biogas every day. Theoretically there is possibility to produce 10 million cubic meters of biogas every day. As of now, Uzbekistan boasts over 6,000 farms, collectively breeding over 650,000 head of cattle and 21 million birds annually, yielding approximately 6 million tonnes of organic waste.

If biogas will be used for heating purposes a single cubic meter of biogas holds approximately 4 kWh of heat energy. Converting this amount of biogas into electrical power yields about 2 kWh, leaving the remaining energy to be released as heat, which can then be recovered and utilized for other purposes. [13]

CONCLUSION For many countries, the use of biogas is unfeasible due to the rather low prices for natural gas and wood. But there is a trend in the world to increase the cost of natural gas, and biogas (biomethane) will serve as an excellent alternative to replace gas in heating sector, in the electricity production and transport sectors. Recent developments have shown that the development of biogas and biomethane technologies can be a sustainable contribution to the environment, especially when the main supporting biomass feedstocks, manure and waste, are available like in Uzbekistan, where the livestock farming is well developed and population is high. The next stage to consider will be the introduction of biomethane into the main gas network to stabilize and modernize the gas network, especially to the regions of Uzbekistan with sick gas shortage due to high population density.

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