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Prospects for biomethane in the transport sector of Ukraine

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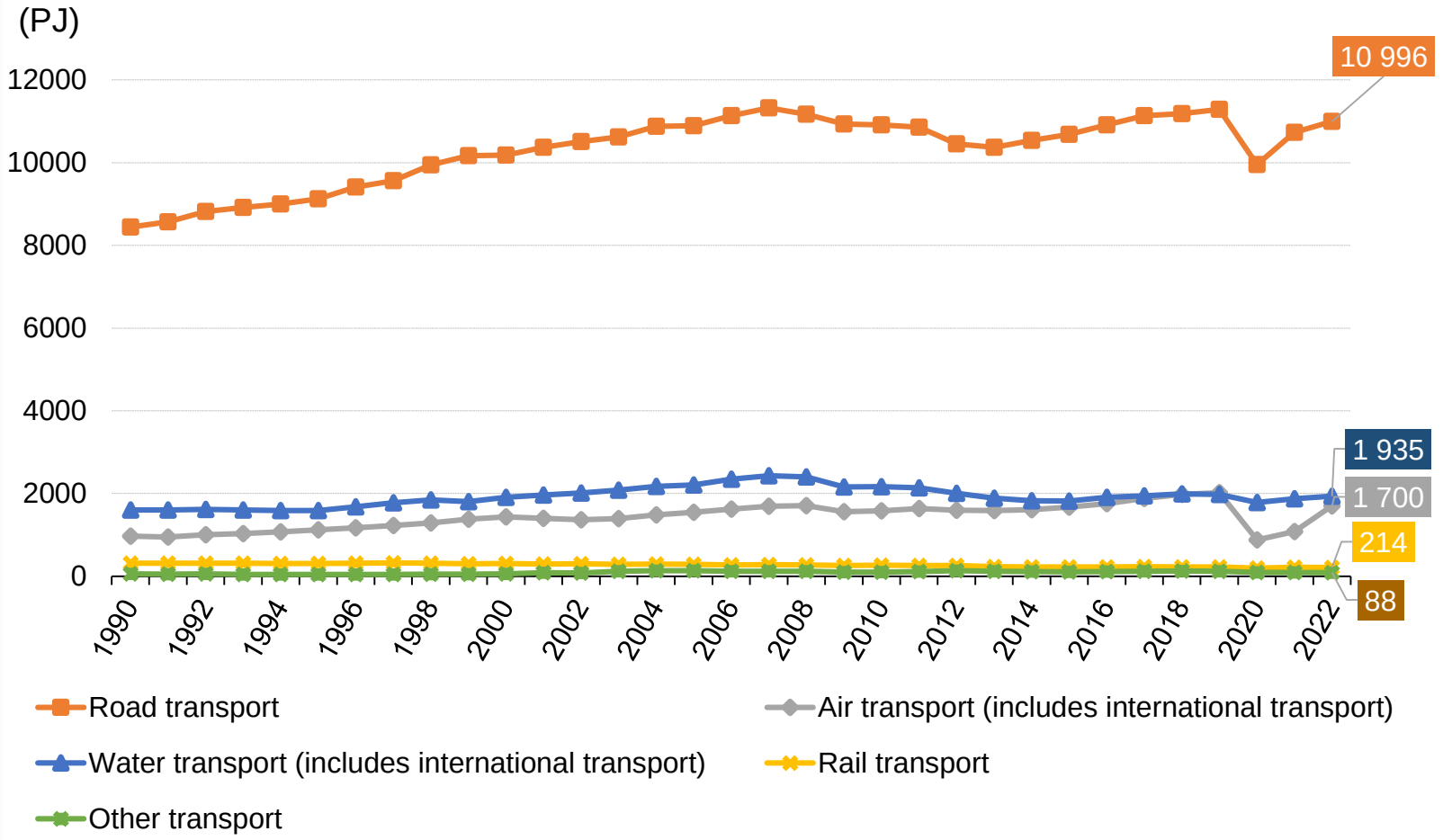
Evolution of final energy consumption in transport by mode in the EU

Between 2013 and 2023, almost all economic activities in the EU reduced their greenhouse gas (GHG) emissions. The only exception was transportation and storage, where emissions increased by around 14%. **Transport is responsible for about a quarter of the EU's total GHG emissions**.



Source: Eurostat (online data code: nrg_bal_c)

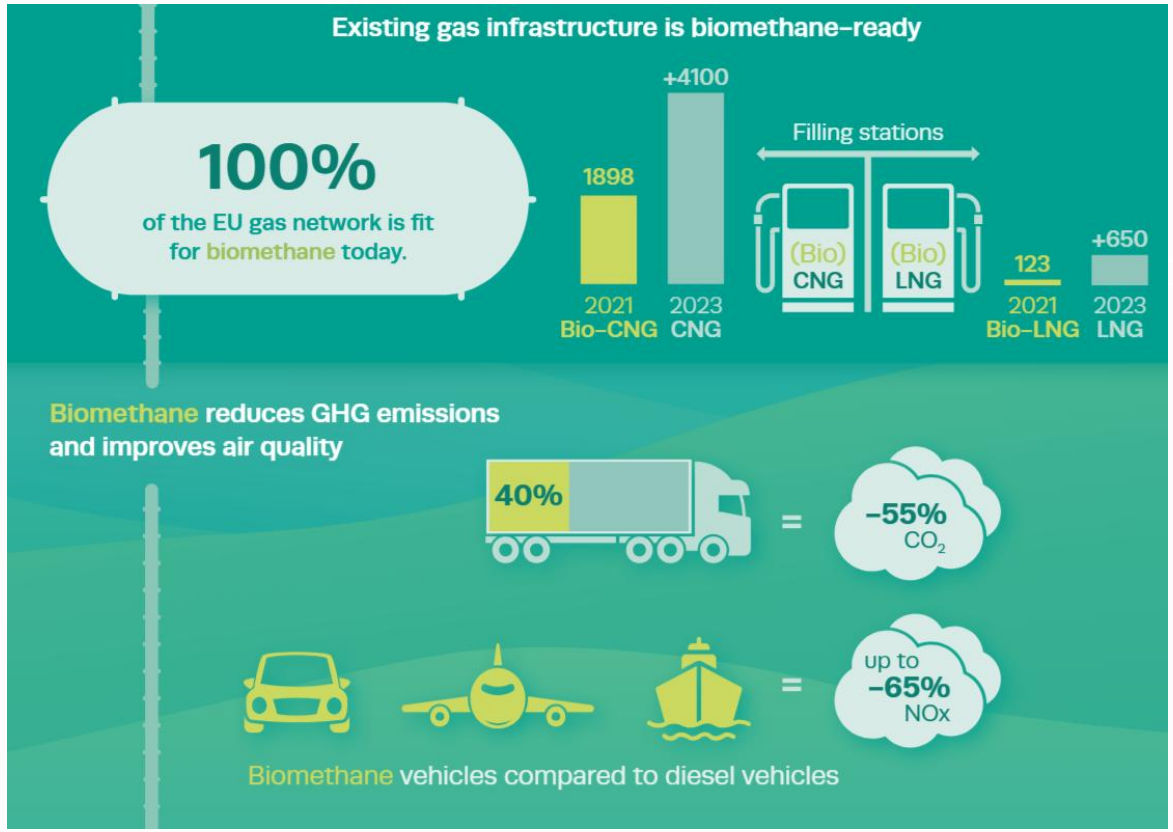
In 2022, **transport** activities accounted for **31% of final energy consumption in the EU**.

Road transport accounted for 73.6 % of all energy consumed in transport in the EU, far ahead of air transport (11.4 %), water transport (13.0 %) and rail transport (1.4 %).

Motor gasoline (25.2%) and **gas/diesel oil** (65.4%) added together **made up 90.6 % of the energy consumption in road transport in the EU**, far ahead of renewables and biofuels (6.4%), LPG (2.0%), natural gas (0.7%), and electricity (0.3%).

Biomethane as a motor fuel (1)

In road transport, **15 bcm (approx. 154 TWh) would be sufficient to power approximately 20% of the EU's 2050 heavy-duty fleet with biomethane**, according to NGVA Europe; **14 bcm would cover 20% of the anticipated bio-LNG demand in the shipping sector in 2050**, as reported by SEA-LNG.



Energy content of biomethane
Methane net calorific value: 50 MJ/kg

Gaseous biomethane - standard conditions (15°C, 1.01325 bar)
1 m³ of biomethane with 97% vol CH_4
Methane density: 0.68 kg/m³
Energy content of biomethane: **32.96 MJ**

Gaseous biomethane (Bio-CNG) - compressed (15°C, 250 bar)
1 m³ of biomethane with 97% vol CH_4
Methane density: 186.88 kg/m³
Energy content of biomethane: **9.063 GJ**

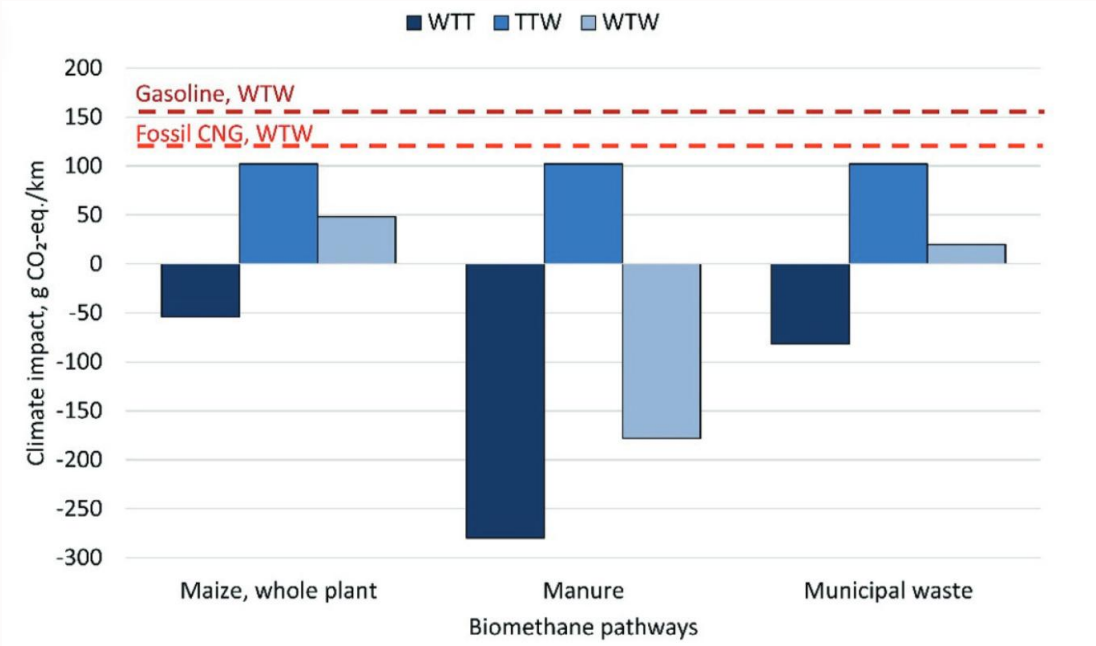
Liquid biomethane (Bio-LNG) (-162°C, 1.01325 bar)
1 m³ of biomethane with 99.995% vol CH_4 (50 ppm CO_2)
Methane density: 424.14 kg/m³
Energy content of biomethane: **21.206 GJ**

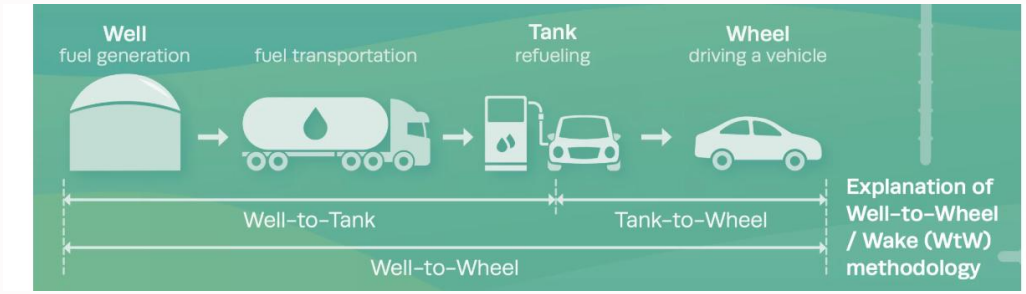
Equivalent calculation
1 m³ gaseous biomethane → 0.0036 m³ Bio-CNG
1 m³ gaseous biomethane → 0.0016 m³ Bio-LNG
1 m³ of diesel (36 GJ/m³) = 4 m³ Bio-CNG or 1.7 m³ Bio-LNG
1 m³ of petrol (32 GJ/m³) = 3.53 m³ Bio-CNG or 1.51 m³ Bio-LNG

Sources: https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2022/02/IEA_transport_T37_END_HIGH.pdf; https://www.europeanbiogas.eu/wp-content/uploads/2023/06/EBA_Campaign_FS3_Digital.pdf

Biomethane as a motor fuel (2)

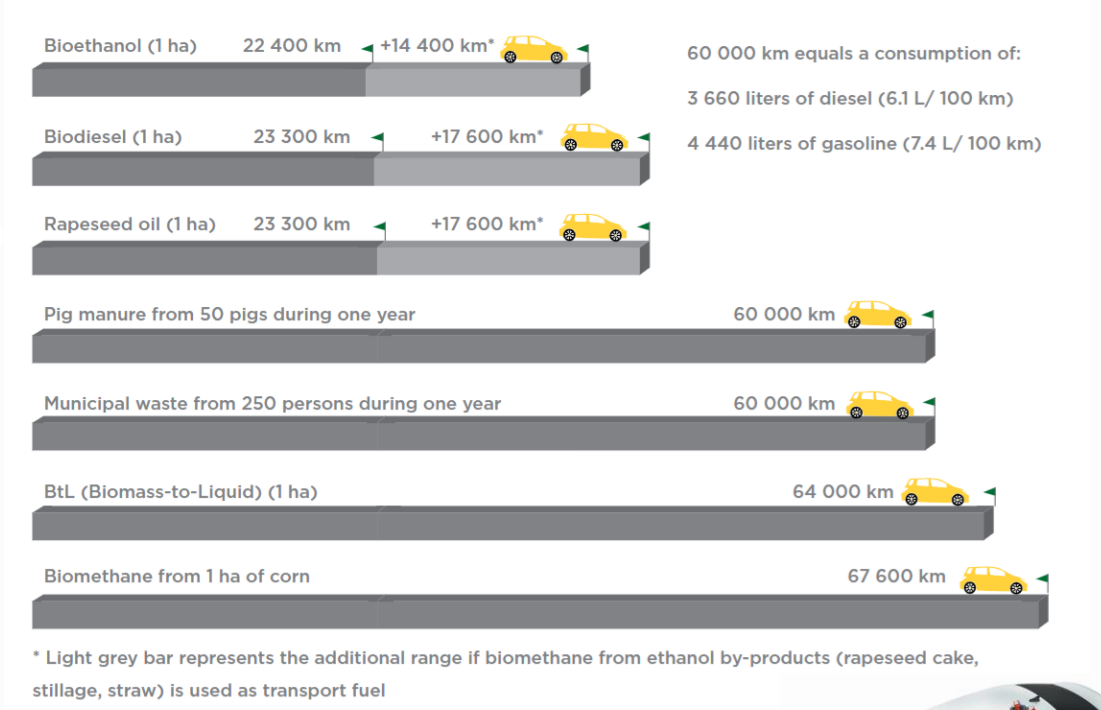
WTW climate impact of different biomethane pathways compared to fossil compressed natural gas and gasoline for passenger cars





Biomethane as motor fuel use can reduce GHG emissions not only by substituting fossil fuels, but also by avoiding methane emissions, for example from manure storage and waste disposal.

Ranges of passenger calls with different biofuels



Sources: https://task37.ieabioenergy.com/wp-content/uploads/sites/32/2022/02/IEA_transport_T37_END_HIGH.pdf; https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Mar/IRENA_Biogas_for_Road_Vehicles_2017.pdf

GHG emissions in Ukraine category 1.A "Fuel Combustion Activities"

(Mt of $CO_{2\text{-eq.}}$)

Category	1990	1995	2000	2005	2010	2012	2016	2017	2018	2019	2020	2021
1.A Fuel Combustion Activities total, including:	597.85	335.35	222.13	239.41	223.70	232.60	178.81	174.75	180.59	171.24	157.57	159.40
1.A.1 Energy Industries	272.68	194.73	115.78	120.79	121.41	131.21	98.86	90.45	98.75	92.22	86.40	85.24
1.A.2 Manufacturing Industries and Construction	111.26	24.99	31.23	36.79	22.60	22.92	18.40	18.05	18.42	18.61	19.82	21.01
1.A.3 Transport	111.79	49.22	34.55	39.19	40.20	39.36	32.89	34.94	34.96	37.73	31.81	33.67
1.A.4 Other sectors	102.01	66.35	40.50	42.55	39.46	38.99	28.12	30.78	27.99	22.32	19.08	19.08
1.A.5 Other	0.11	0.06	0.06	0.08	0.03	0.12	0.53	0.53	0.48	0.36	0.45	0.38

Source: Ukraine. 2023 National Inventory Report (NIR)

1.A.3.a Civil Aviation 0.19

1.A.3.b Road Transport 24.98

1.A.3.c Railways 0.42

1.A.3.d Waterway Transport 0.08

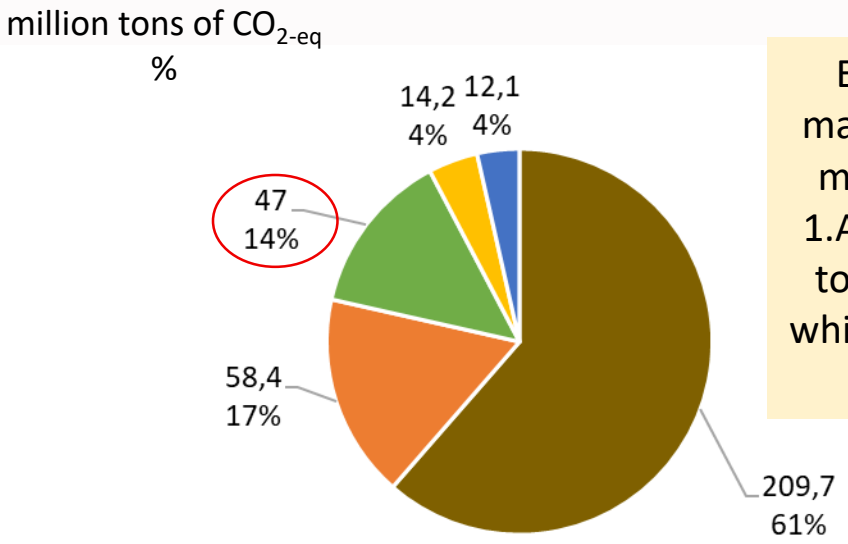
1.A.3.e Other types of transport 7.99

21%

or 10% of the total (with LULUCF)

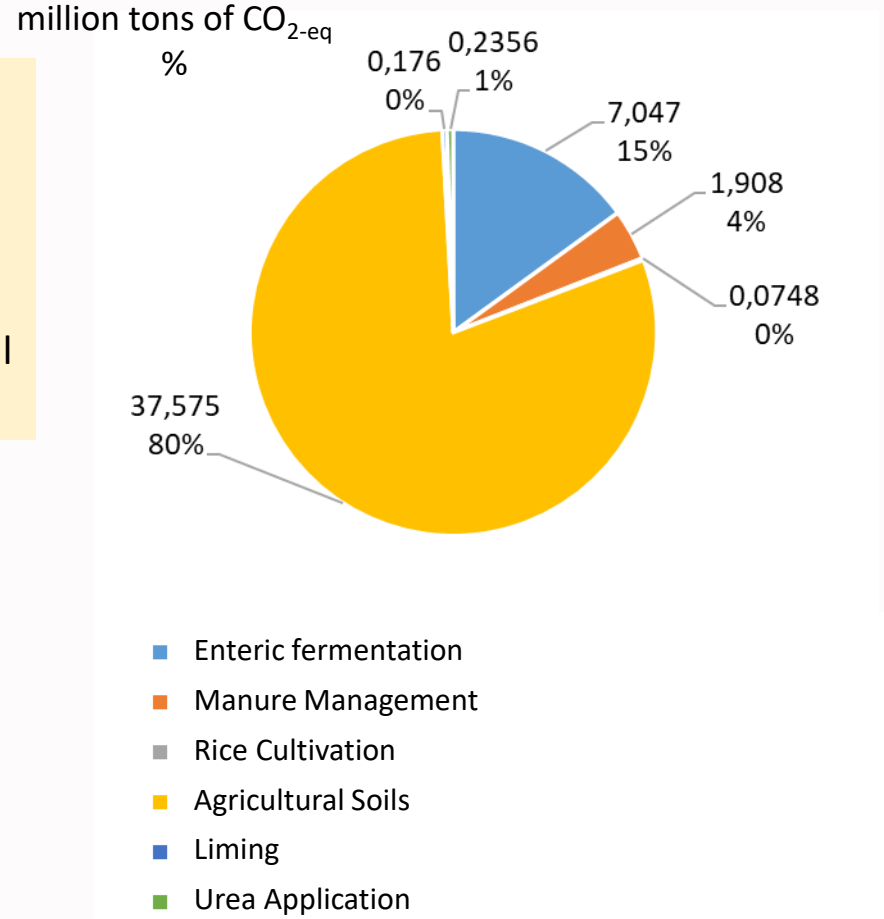
GHG emissions in Ukrainian agriculture in 2021

In total, in 2021, GHG emissions from LULUCF amounted to 341.5 million tons of $CO_{2\text{-eq}}$, of which 47 million tons of $CO_{2\text{-eq}}$ (14%) were from agriculture



Emissions from agricultural machinery fuel belong to other modes of transport (category 1.A.3.e) and in 2021 amounted to **6.36 million tons of $CO_{2\text{-eq}}$**, which adds 13.5% to agricultural emissions.

In total, 47 million tons of $CO_{2\text{-eq}}$ of GHG emissions were offset in agriculture in 2021



Source: Ukraine. 2023 National Inventory Report (NIR)

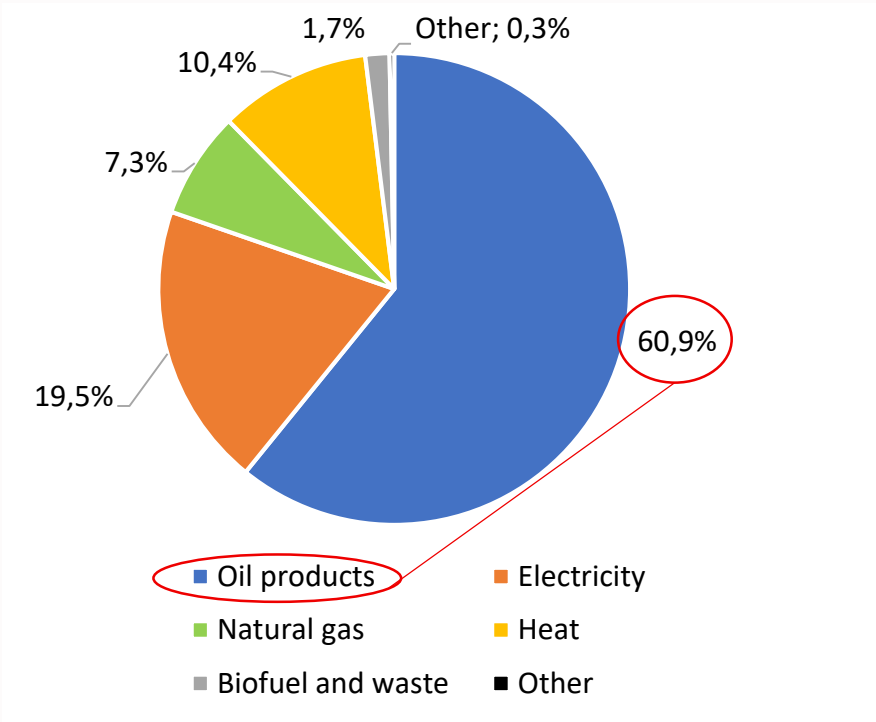
Final consumption of fuel and energy in agriculture of Ukraine

In 2020, final consumption of motor fuels in Ukraine amounted to **5,156 thousand tons of diesel fuel** and **1,691 thousand tons of gasoline**, with agriculture being one of the largest consumers (over 19% of the total volume of diesel fuel and 5% of gasoline).

Type of fuel/energy	Units	2016	2017	2018	2019	2020
Natural gas	TJ	6449	6115	5684	4443	5682
Not coking coal / anthracite	kt	13	13	12	11	8
Coal briquettes, peat	kt	1	1	1	2	2
LPG (propane, butane)	kt	19	21	15	17	14
Gas oils/diesel	**kt**	**1378**	**1108**	**1130**	**1216**	**983**
Fuel oil	kt	1	1	2	-	0
Other oil products	kt	3	1	2	-	-
Solid biomass fuel	TJ	825	1063	1538	1156	1158
Electricity	GWh	3513	3642	3868	3675	3777
Heat	TJ	10210	9114	9150	7854	7270

Source: Energy Balances of Ukraine. State statistics service of Ukraine

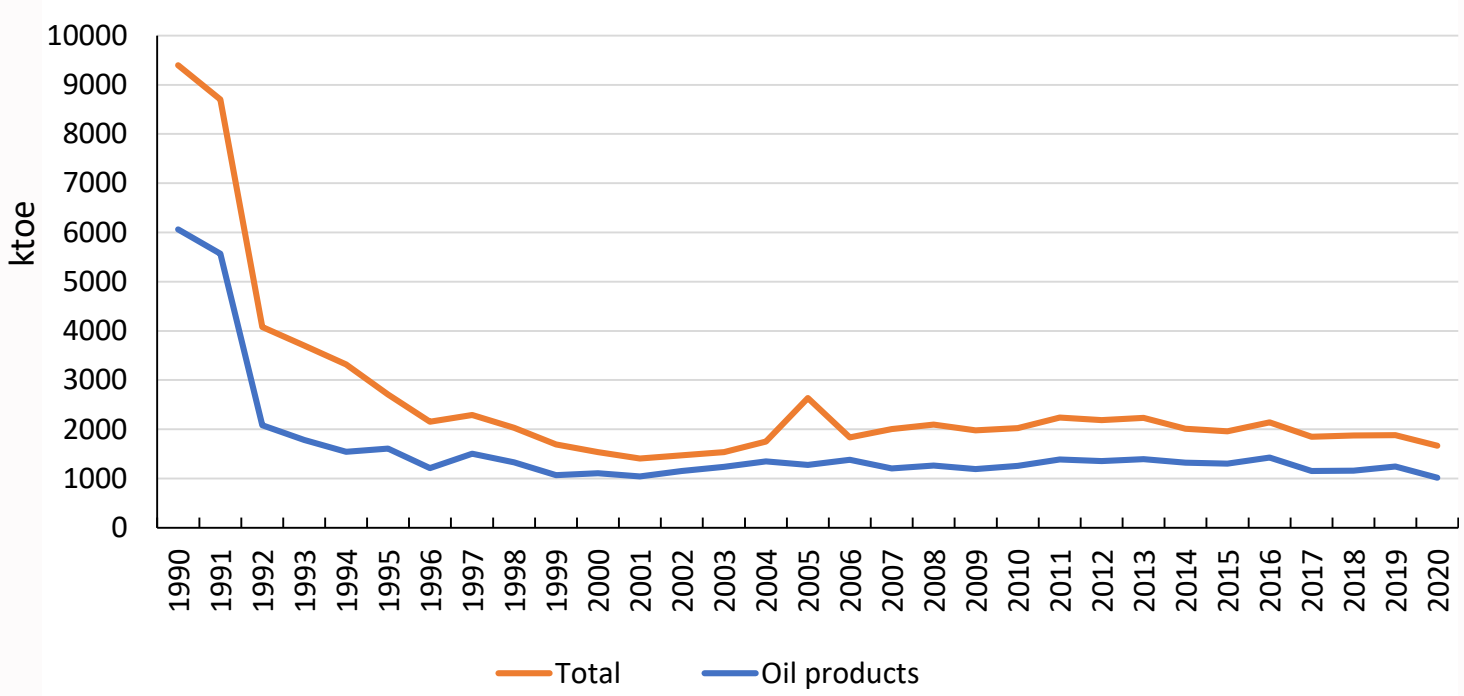
Structure of the final fuel and energy consumption in Ukraine's agriculture (2020), ktoe



According to the Energy Balance of Ukraine for 2020, the final annual consumption of fuel and energy in agriculture in Ukraine amounted to **1,669 ktoe, including the consumption of petroleum products - 1,016 ktoe** (≈61%)

Dynamics of the final fuel and energy consumption in Ukraine's agriculture

From 1990 to 2020, the consumption of petroleum products in Ukrainian agriculture decreased almost 6 times



Source: State statistics service of Ukraine

According to the calculations of the Institute of Agrarian Economics, **in 2023 the total consumption of diesel fuel in agriculture in Ukraine was 972 thousand tons.** This is 33% less than the pre-war 2021. The same **reduction** applies to **gasoline**. In 2022, fuel consumption was even lower - **900 thousand tons** and **60 thousand tons, respectively**.

Source: https://www.growhow.in.ua/ahrarnyy-sektor-ie-osnovnym-spozhyvachem-palnoho-v-ukrainskiy-ekonomitsi/

By energy content, 1 million tons of diesel fuel and 60 thousand t of gasoline is equivalent to about **1.3 bcm of methane**.

Expenditures for the purchase of motor fuels in the agriculture of Ukraine

Fuel type	Units	2016	2017	2018	2019	2020
Gasoline:						
Quantity purchased	kt	145	125,3	109,3	101	85,4
Average price	UAH/t	18602	22750	27124	25185	19981
Average price	$/t	726,6	855,3	997,2	976,2	740
Acquisition costs	***million $***	***105,4***	***107,2***	***109,0***	***98,6***	***63,2***
Diesel fuel:						
Quantity purchased	kt	1378	1345,4	1445	1454,7	1301,3
Average price	UAH/t	15038	18949	23863	21488	16466
Average price	$/t	587,4	712,4	877,3	832,9	609,9
Acquisition costs	***million $***	***809,4***	***958,5***	***1267,7***	***1211,6***	***793,7***

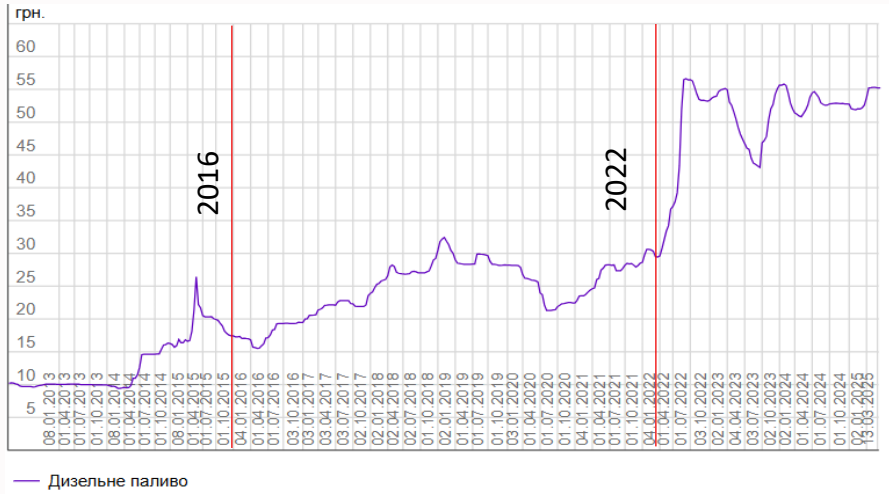
Source: Calculated according to data from the State statistics service of Ukraine

In May 2025, **diesel prices** are 1,500 $/t (**35 $/GJ**) and **gasoline** is 1,750 $/t (**41 $/GJ**).
At **a natural gas price** of 24,450 UAH/thousand m^3, its specific energy cost is **17 $/GJ**.
In May 2025, **CNG Ukravtogas price** is 33.9 UAH/m^3 (**24 $/GJ**).

Agricultural product prices

Source: https://www.apk-inform.com/uk/prices

Diesel fuel prices



Source: https://index.minfin.com.ua/ua/markets/fuel/dt/

Concept of biomethane production and use on the farm

Source: https://www.consorziobiogas.it/wp-content/uploads/2018/04/T6-METHANE-POWER.pdf

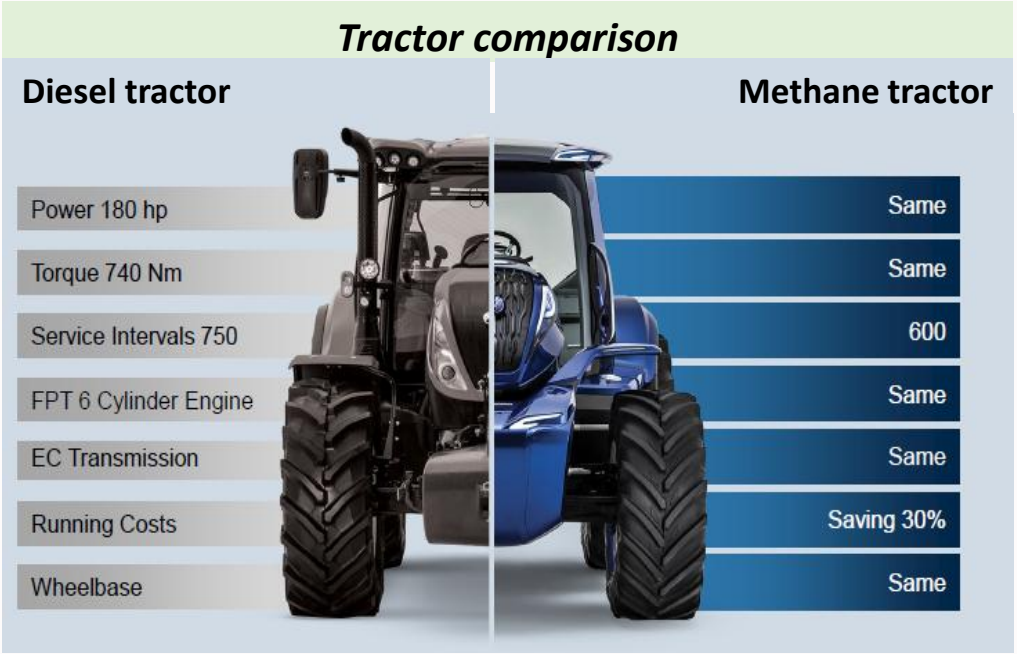
Waitrose is using biomethane produced from manure from its own 500-cow farm on the Leckford Estate in the UK to fuel its tractors.
The system was created by energy company Bennamann and will help Waitrose cut carbon emissions by 1,300 tonnes per year, part of its goal of achieving **net-zero greenhouse gas emissions by 2035**.

Source: https://leckfordestate.co.uk/the-leckford-estate-on-the-journey-to-net-zero

CNG tractor New Holland T6.180 Methane Power

The New Holland T6 Methane Power is the world's first 100% methane powered production tractor, and is key to completing the virtuous cycle of the Energy Independent Farm[SM] system. Farmers grow crops and use waste products to generate biomethane, which powers the tractor, which, in turn, helps to grow those very crops.

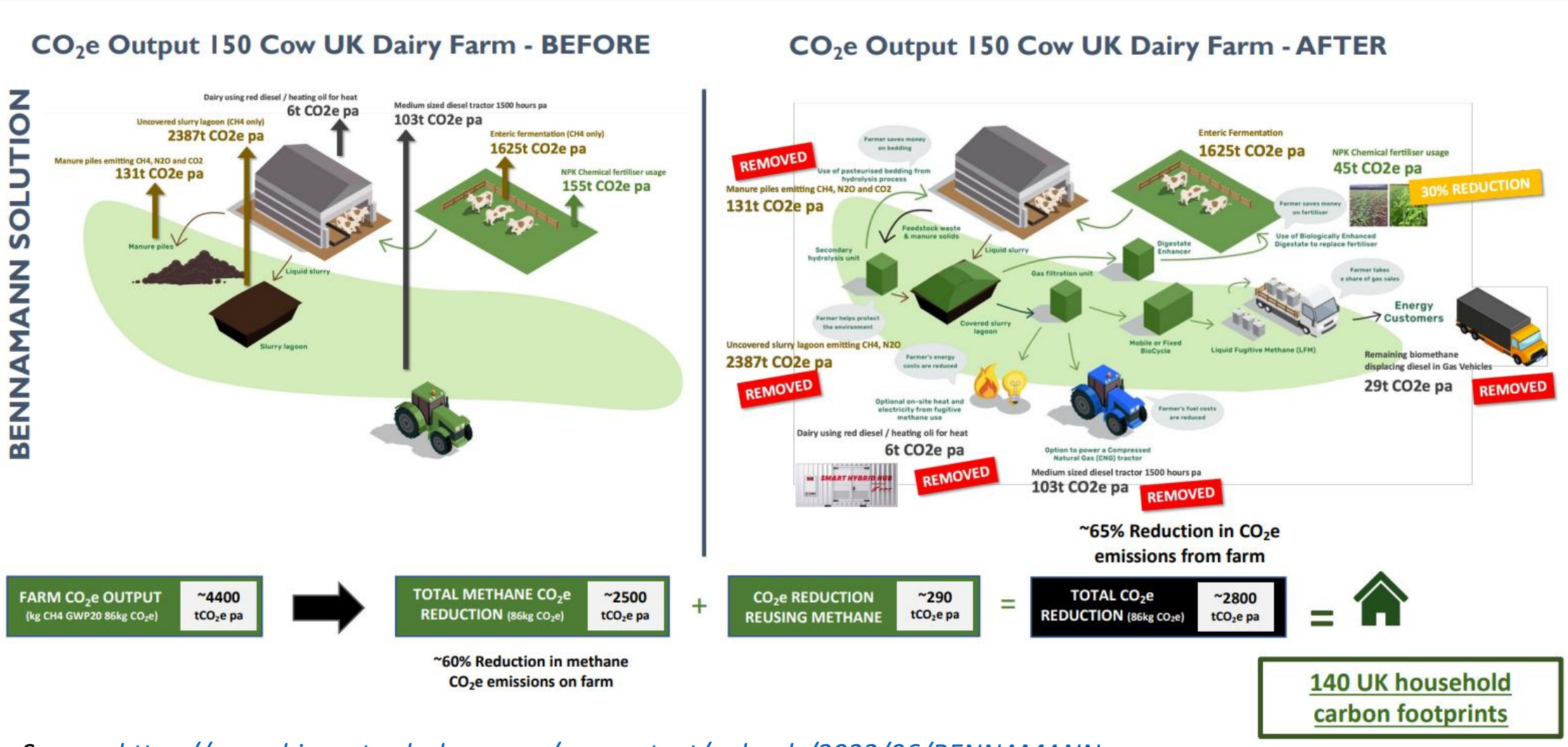
Tractor comparison



Model	T6.180
New Holland Engine, developed by FPT Industrial	6 Cylinder Nef, 6728 cm^3
Compliant with engine emissions regulations	Above Stage V
Max. EPM horsepower - ISO TR14396 - ECE R120	129 kW / 175 hp
Rated horsepower - ISO TR14396 - ECE R120	110 kW /150 hp
Rated engine speed	2200 rpm
Methane tank capacity (tractor/range extender)	185 l /270 l
Service interval	600 hours
Typical working weight	6290 kg / 6540 kg
Max. permissible weight	10500 kg / 10500 kg

Source: https://assets.cnhindustrial.com/nhag/eu/en-uk/assets/pdf/agricultural-tractors/t6-180-brochure-uk-en.pdf

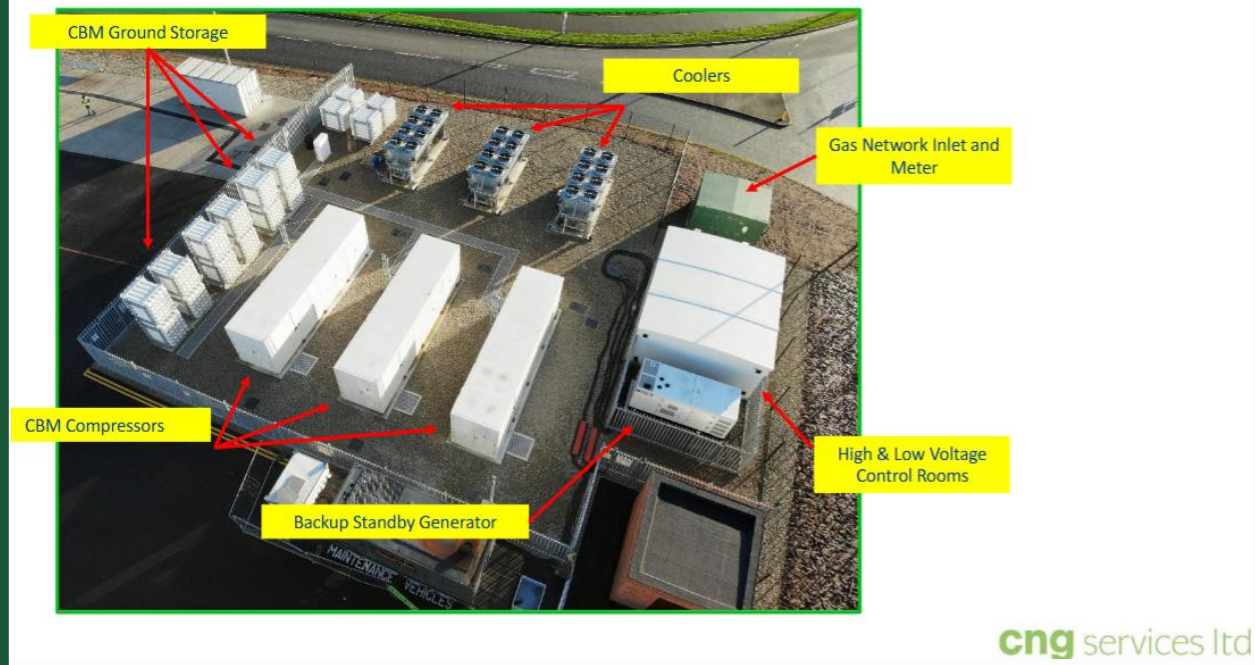
Negative carbon footprint of the farm



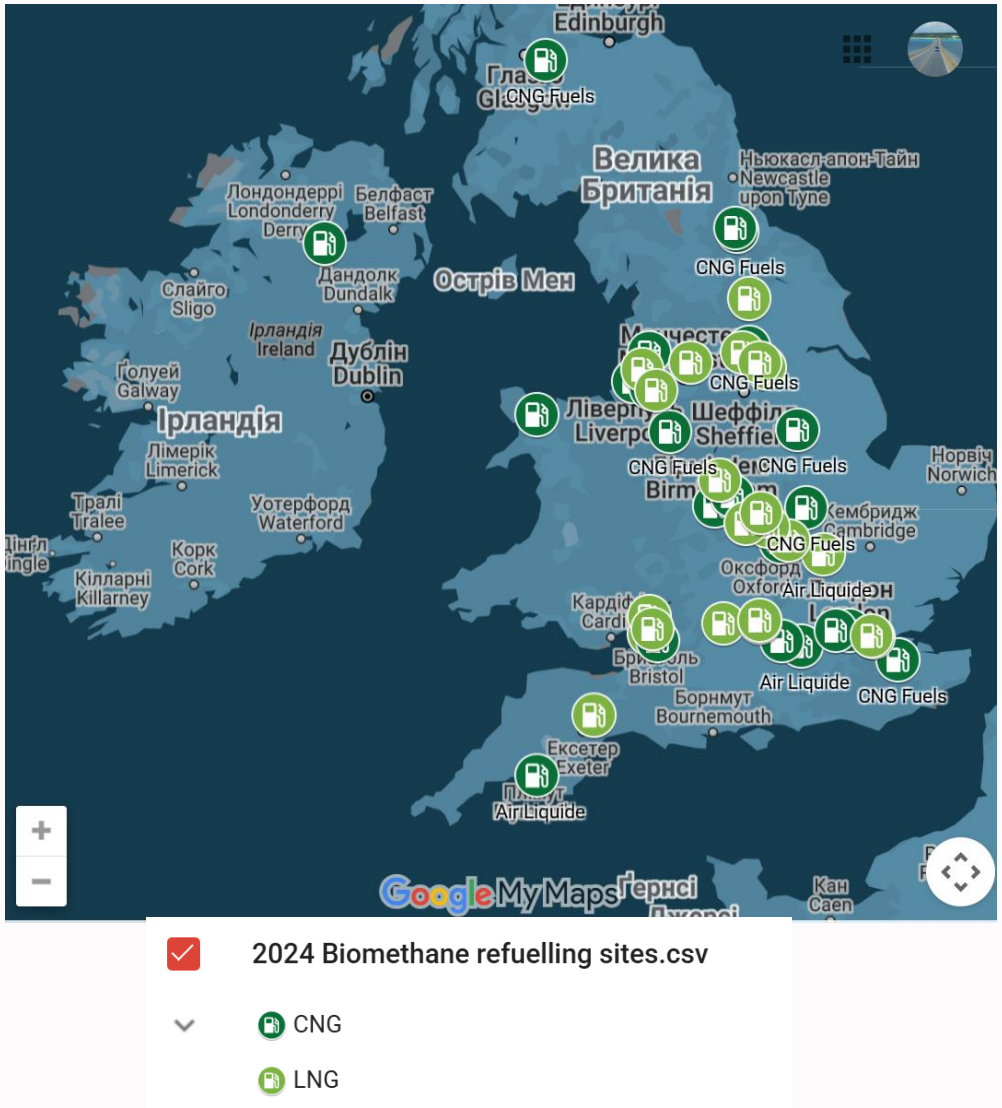
Source: https://www.biogastradeshow.com/wp-content/uploads/2022/06/BENNAMANN-GAS-UPGRADING-FOR-TRANSPORT-FINAL-14062022.pdf

Biomethane filling stations in the UK

Typical Grid Connected Bio-CNG Station



cng services ltd



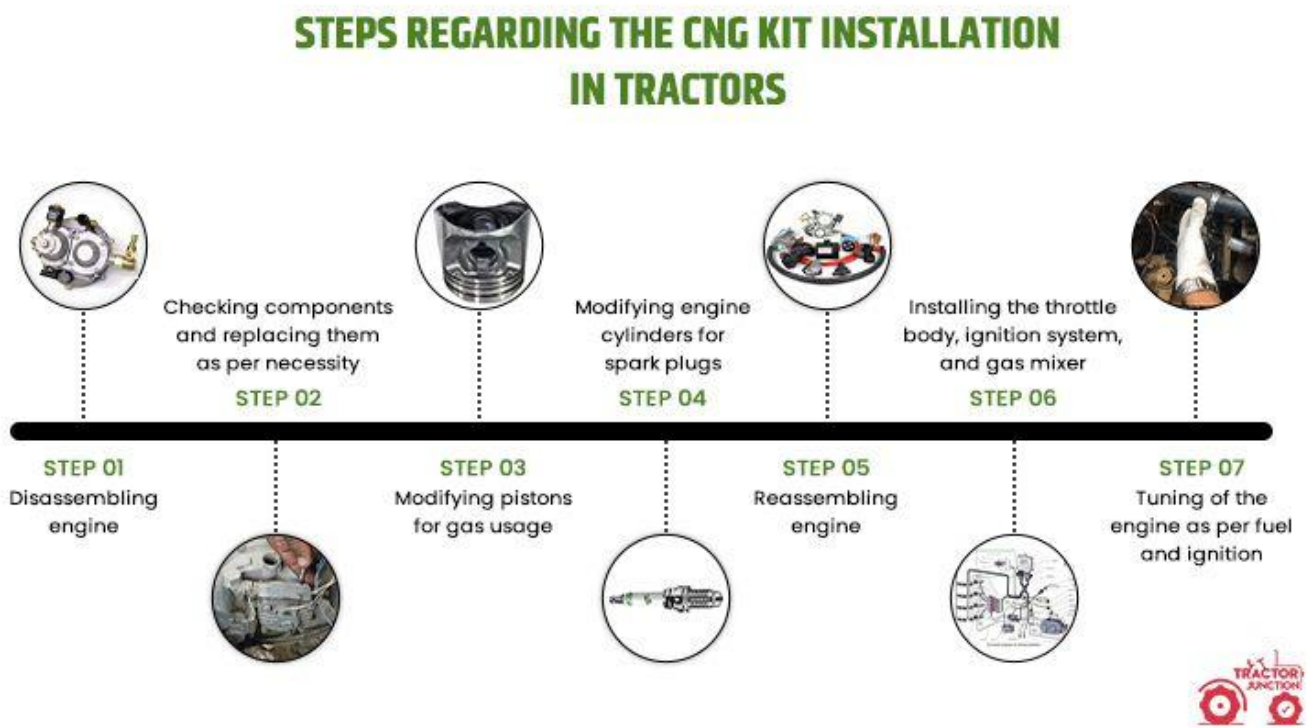
Sources: https://www.cngservices.co.uk/wp-content/uploads/Biomethane-Truck-Fuel-UK-Update-for-Task-37.pdf#page=5.00; https://rtfa.org.uk/2024/10/07/map-of-biomethane-filling-stations/

Gas conversion kits

Methods of converting diesel engines to gas fuel:

1. Conversion of a diesel engine into an internal combustion engine with spark ignition of the gas-air mixture (complete fuel replacement). This method is quite radical and involves significant changes to the design of the base engine. In this process, the diesel fuel equipment is dismantled from the engine, the compression ratio is reduced to 11-14, and an ignition system, gas supply system, and gas cylinders are installed.

2. Using a gas-diesel mode, in which the engine is supplied with two fuels - primary diesel (but in a smaller quantity than in the base engine), and additional - gas (replacement fuel). A gas supply system, necessary sensors, an injection reducer, and gas electromagnetic injectors are installed on the engine. For new tractors, the fuel consumption ratio is approximately 20% diesel fuel and 80% gas; for used ones - 30% and 70% respectively.



Sources:
https://www.khadi.kharkov.ua/fileadmin/P_vcheniy_secretar/%D0%90%D0%92%D0%A2%D0%9E%D0%9C_%D0%A2%D0%A0%D0%90%D0%9D%D0%A1%D0%9F/%D0%95%D0%A0%D0%A2%D0%97/Gazodizel_0.pdf; https://www.tractorjunction.com/blog/cng-kit-in-tractors/

Feasibility study for the introduction of tractors running on CNG and bio-CNG

Indicators	Units	CNG Ukravtogaz	NG to CNG	Bio-CNG
Annual tractor loading	hours/year	1500		
Diesel tractor				
Specific CNG consumption	l/hour	17.5		
AdBlue	l/hour	1.2		
Diesel fuel price	EUR/l without VAT	0.93		
AdBlue price	EUR/l without VAT	0.52		
Annual diesel fuel consumption	l/year	26250.0		
Annual fuel cost + AdBlue	**EUR**	**25268.7**		
Methane tractor				
Specific CNG consumption	kg/hour	13.5	13.5	13.7
Annual CNG consumption	kg	20250.0	20250.0	20532.3
Methane price	EUR/1000m^3 without VAT	598.5	431.7	750.0
CNG cost	EUR/kg without VAT	0.83	0.60	1.05
Additional costs for CNG	EUR/kg without VAT	-	0.10	
Annual cost of CNG	**EUR**	**16903.7**	**14267.8**	**23582.4**
Cost reduction for CNG compared to diesel	*EUR*	*8364.9*	*11000.8*	*1686.2*
Reduction amount in %	%	33.1%	43.5%	6.7%

Sources: New Holland T6.180 Dynamic Command. DLG test report
https://pruefberichte.dlg.org/filestorage/PowerMix_Datenblatt_NH_T6_180_Dynamic_Command_EN_V3.pdf

Estimation of biomethane consumption volumes in the agricultural sector of Ukraine

MIN

The minimum value of biomethane consumption for replacing motor fuels in agriculture is 1 ktoe in 2030, in accordance with *the National Renewable Energy Action Plan* (*NREAP*) for the period up to 2030, which determines the need for biomethane in the volume of about **1.2 million cubic meters of CH_4**.
This is enough to operate 42 tractors of the NH T6.180 type with an annual load of 1,500 engine hours.

MAX

The maximum value of biomethane consumption for replacing motor fuels in agriculture can be taken as 17.2% *(the national indicative target of NREAP for renewable energy sources in the gross final energy consumption in the transport sector by 2030)* of the annual consumption of diesel fuel of 1 million tons. In this case, the need for biomethane in 2030 will be about **224 million cubic meters of CH_4**.
This volume of biomethane will be enough to operate 7.8 thousand tractors of NH T6.180 analogues.

Therefore, by 2030, Ukraine requires varying biomethane volumes for different agricultural goals: 224 million cubic meters to replace 17.2% of diesel fuel, and 1.2 million cubic meters equivalent to 1 ktoe. Complete motor fuel replacement in agriculture, however, would require approximately 1.3 bcm. Given the significant variations in the presented results, **developing a comprehensive Strategy for Biomethane Production and Use in Ukraine is crucial to establishing clear and specific goals**. In addition, support for agricultural producers and transport operators is essential to enable the economic transition to biomethane-powered machinery, including in the form of **monetization of greenhouse gas emission reductions**. Furthermore, a demonstration project for the production and use of biomethane to fuel machinery would be beneficial for the industry's development.

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Thank you.
Any questions?

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