

1st International Conference
INNOVATIONS IN CARBON CAPTURE AND WASTE MANAGEMENT *InnoCO₂Sorbent - FFH-CO₂*

Extraction of CO₂ from Low-Calorific Landfill Gas to Improve the Performance of the Power Generator

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Founded in 1949, located in Kyiv.

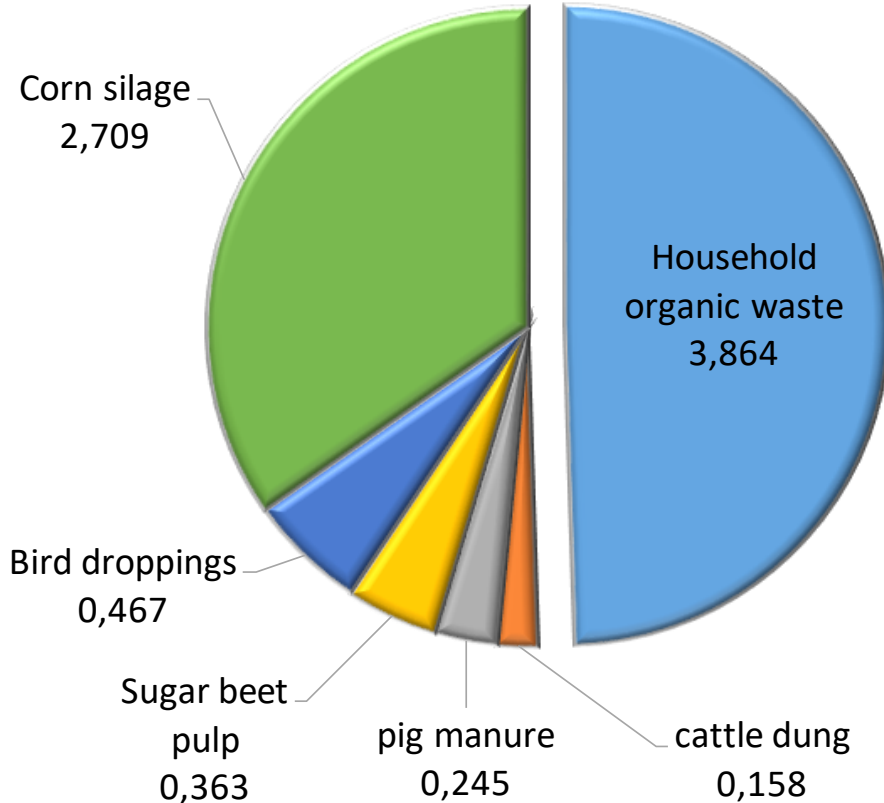
Main direction is research and development:

- Natural and oil gas processing, transportation and using;
- High effective gase burning;
- Engines conversion to natural gas, synthesis gas, biogas;
- Alternative Fuels using;
- Natural gas liquefaction;



Biogas production potential

Biogas sources in 2021 year, billions m³



Ukrainian potential of biogas:

Farmland waste: 2,45 MT of conventional fuel

Solid municipal waste: 0,46 MT

Sediments of aeration stations: 0,13 MT

Corn (energetic source): 1,11 MT

Total biogas potential is up to 8 billion m³.



Biogas from landfills

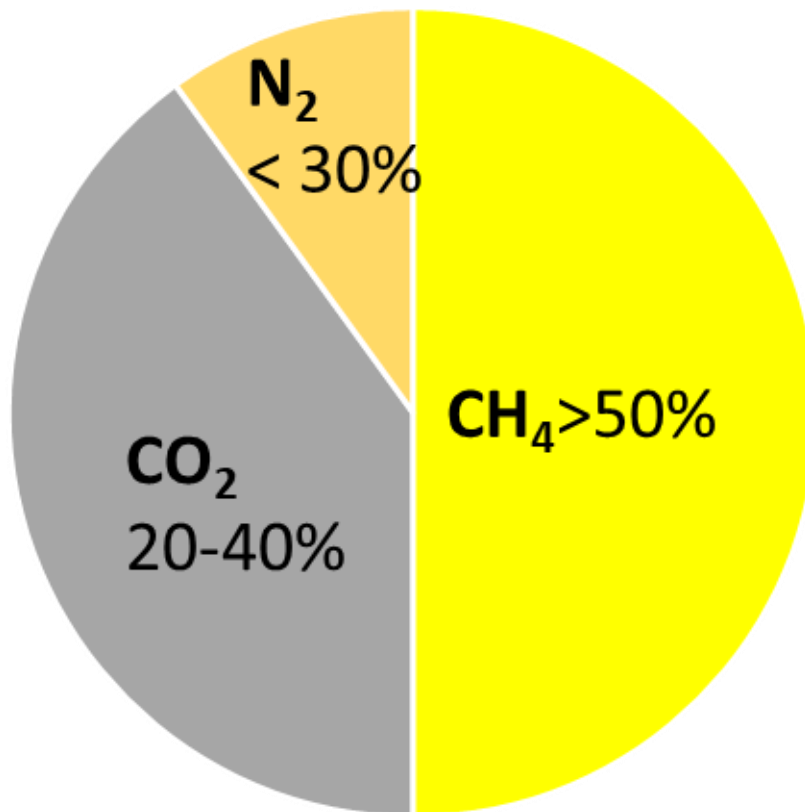
- In Ukraine - 6 000 of organized landfills with total area 90 km²
- 12 billions tones of waste added every year, this is equivalent up to 800 thousands tones of methane and 1800 thousands tones of carbon dioxide per year
- Near 90 landfills has enough capacity and structure of waste for commercial efficiency electricity production
- Only 26 landfills have biogas extraction systems with electric energy producing in amount 112.3 GW·hours per year and today it is 100 MW installed power



We have full path from research...

17 landfills was inspected in Ukraine

In most the cases methane concentrations was more than 50 %



... to first in Ukraine electricity generation from biogas...

- We had developed first in Ukraine biogas extraction systems from landfill with electricity producing to national networks with installed power 1 MW in 2012 year
- In 2015 year installed power had increased to 2 MW



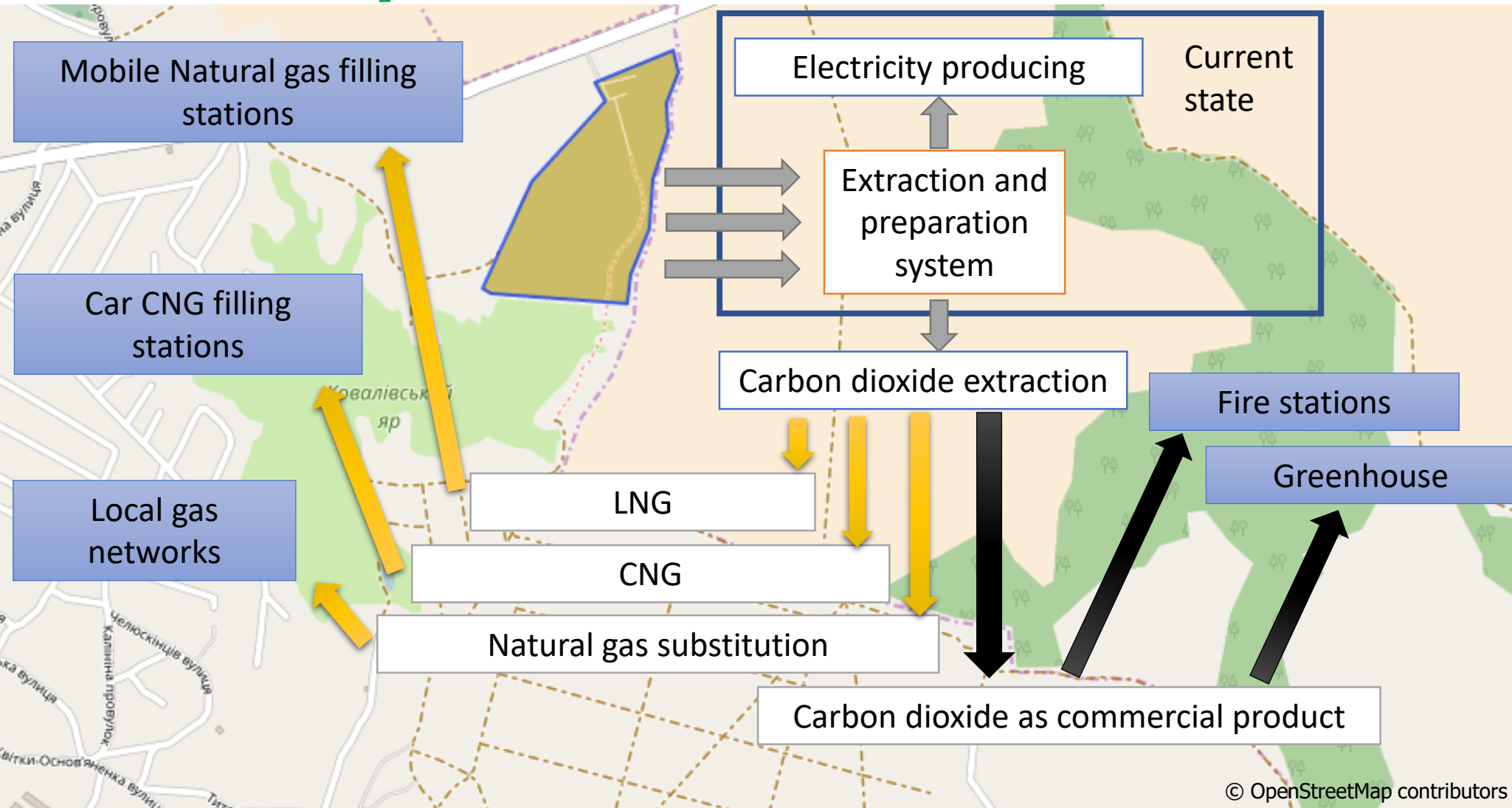
... and multiple implementation

- Today we have 6 implemented stations with total installed power 6.5 MW;

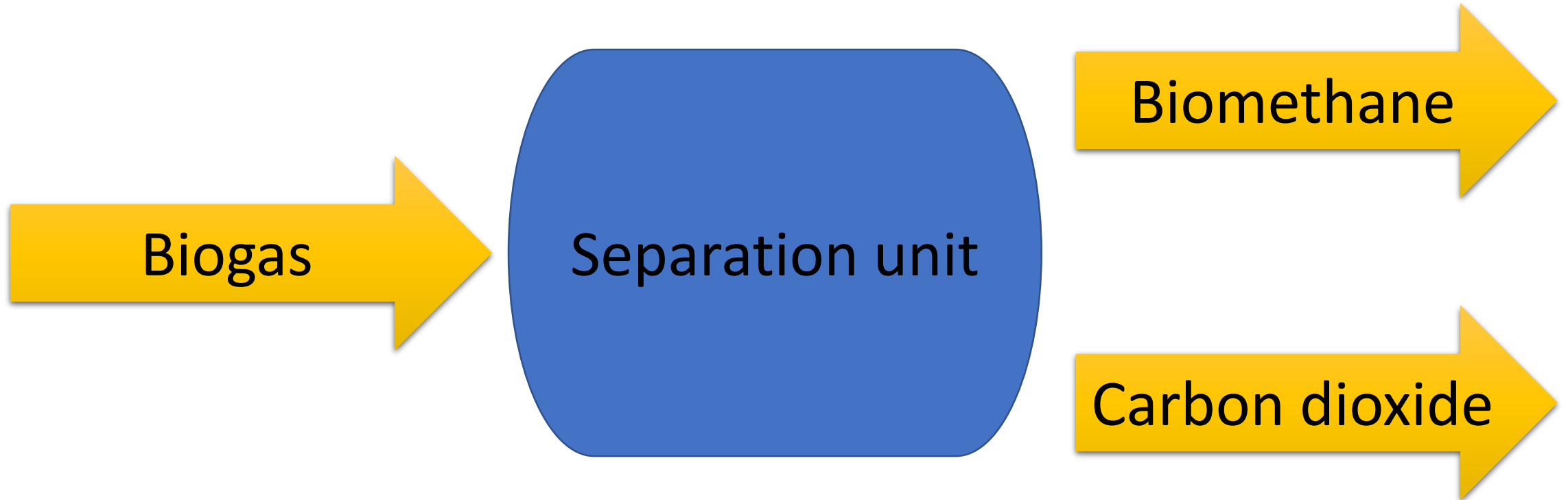


Biogas is not only fuel and heat source

- Today in Ukraine all extracted biogas is used for electricity producing
- Biogas can be as source for biomethane and carbon dioxide commercial products



Separation solution



Separation solutions:

- Membrane separation
- Short cycle adsorption method
- Physical absorption
- Chemisorption extraction

Traditional methods:

- Water separation;
- Amines separation;

Amines separation allows 2-2.5 times decrease amount of water used



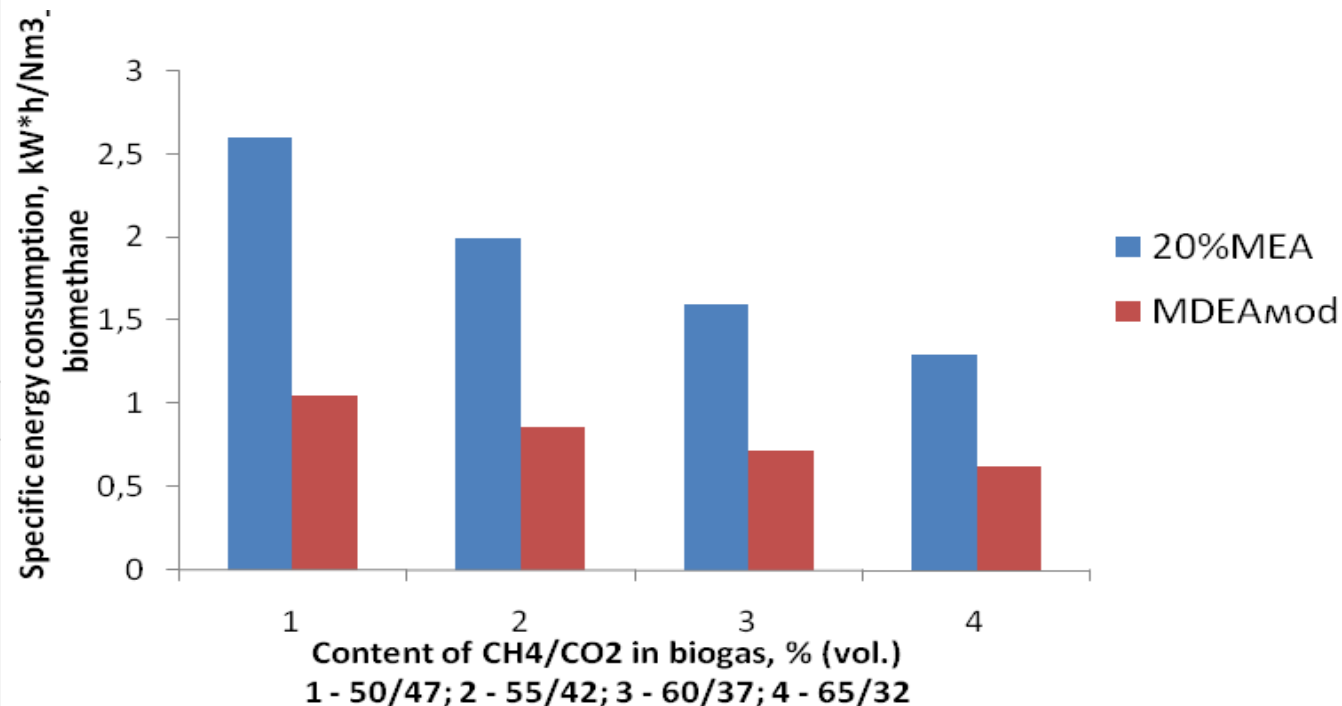
Search for best solutions

Indicators of biogas purification process by different amine sorbents

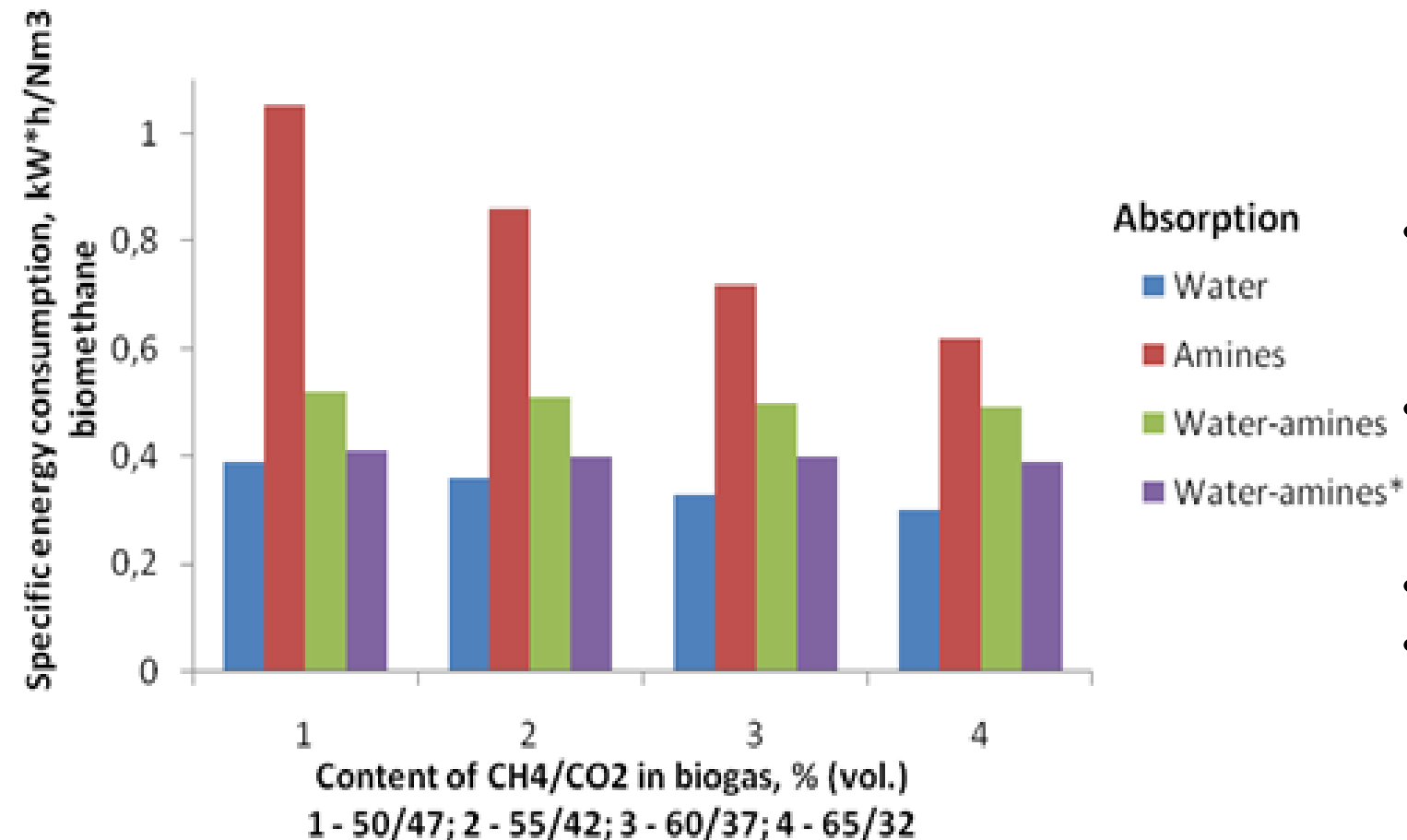
Indicators	Biogas Composition, % (vol): CH ₄ -50, CO ₂ -45, N ₂ -3, H ₂ O -2 G = 335 Nm ³ /h, P _{abs} = 0.26MPa, P _{des} = 0.16MPa					
	Sorbent composition, % (mass)					
	13MEA+ 87H ₂ O	15MEA+ 85H ₂ O	18MEA+ 82H ₂ O	6MEA+ 40MDEA+ 54H ₂ O	8MEA+ 40MDEA+ 52H ₂ O	10MEA+ 40MDEA+ 50H ₂ O
G _{sorbent} , kg/h	5475	4835	4210	7285	3730	3100
Q _{Reb} , kW	384	380	402	303	180	166
Q _{Dephl} , kW	264	269	290	197	89	88
Q _{Hc} , kW	163	158	159	141	125	114
N _P , kW	0.21	0.19	0.17	0.28	0.14	0.120
Y _{CO₂ biomet} , %	1.5	1.8	2.0	1.9	2.0	2.0

Different concentrations of amine in water were simulated and optimal solutions for different input streams conditions were determined.

Optimal concentration of amines decrease stripper heat consumption up to 2.5 times than traditional amine solutions.



Carbon dioxide extraction with water or amines

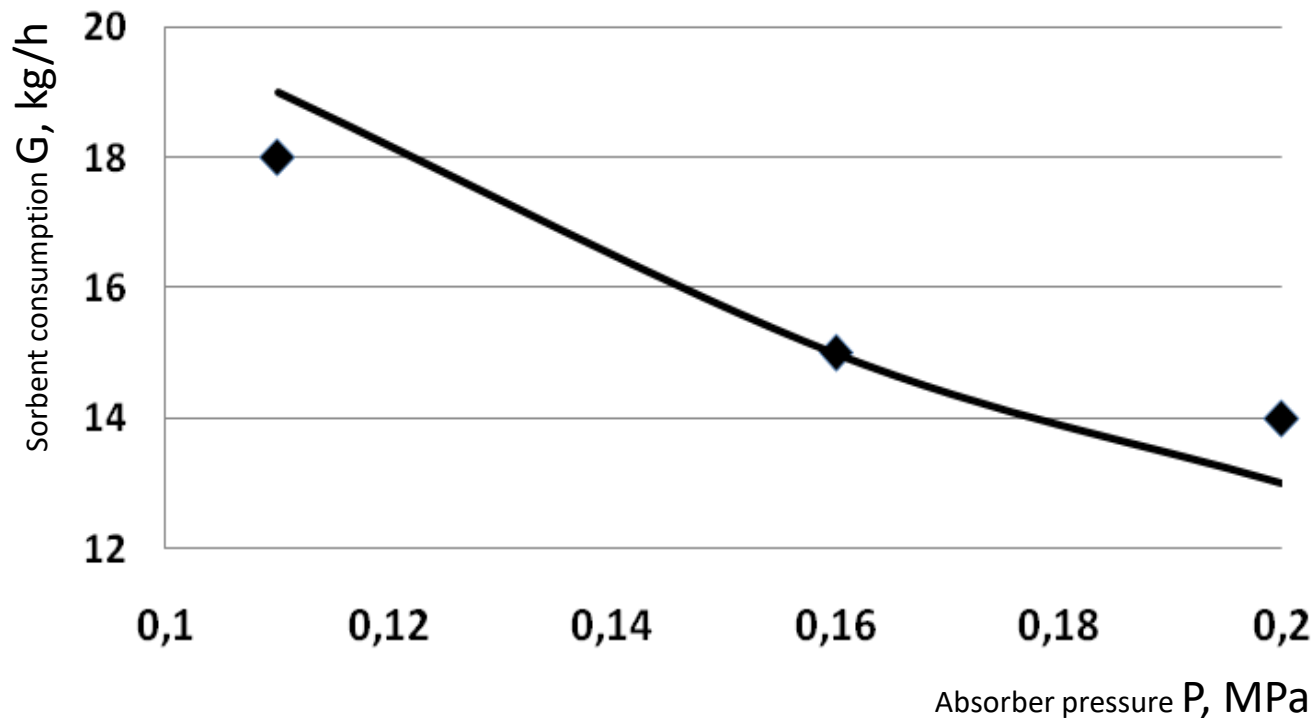


- The energy consumption of the water process is 2 times lower than that of amine absorption. In this case, the loss of methane during water absorption as due to its solubility is up to 8%
- Combined water-amine absorption has a average specific cost 25% higher than water absorption
- For water-amine absorption using the energy potential of the degassing gas (CH₄>30% vol.) in the amine stripper, the energy consumption is comparable to water absorption.



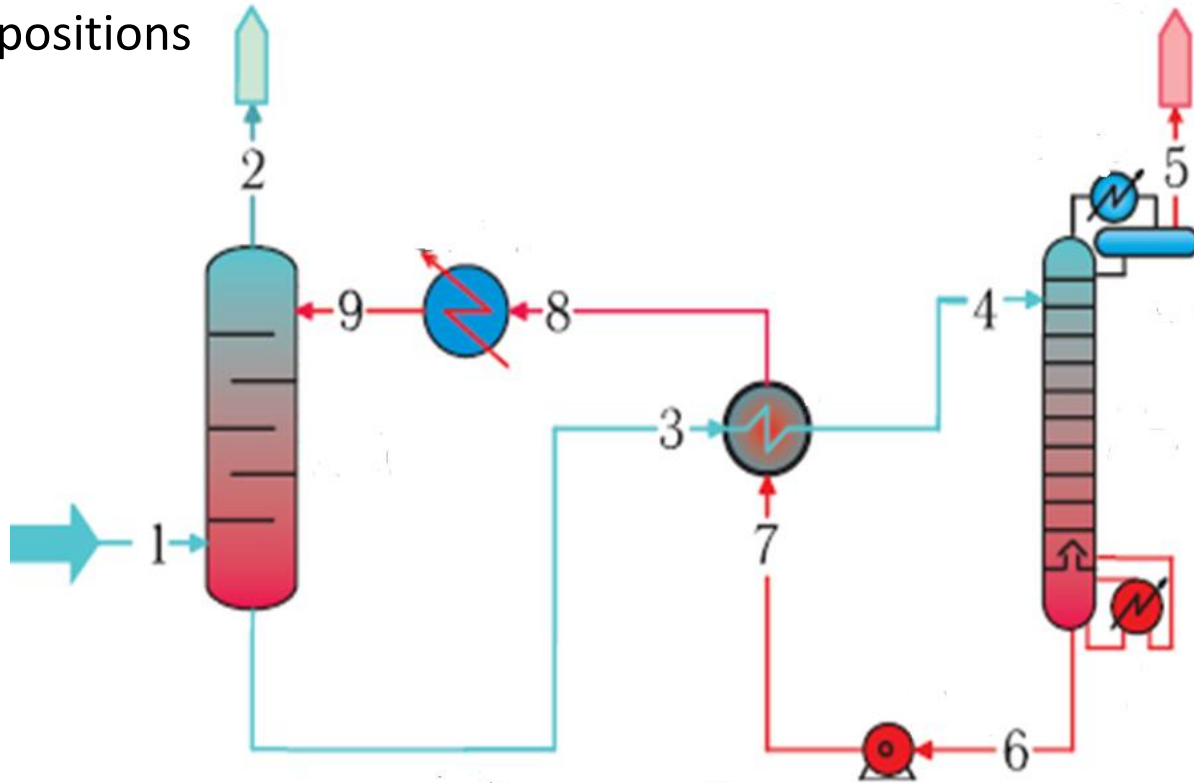
Laboratory research

Experimental equipment was built for practical research of separation process with water amines solution and tested with different absorber intake pressure and sorbent flow speed.



Energy consumption

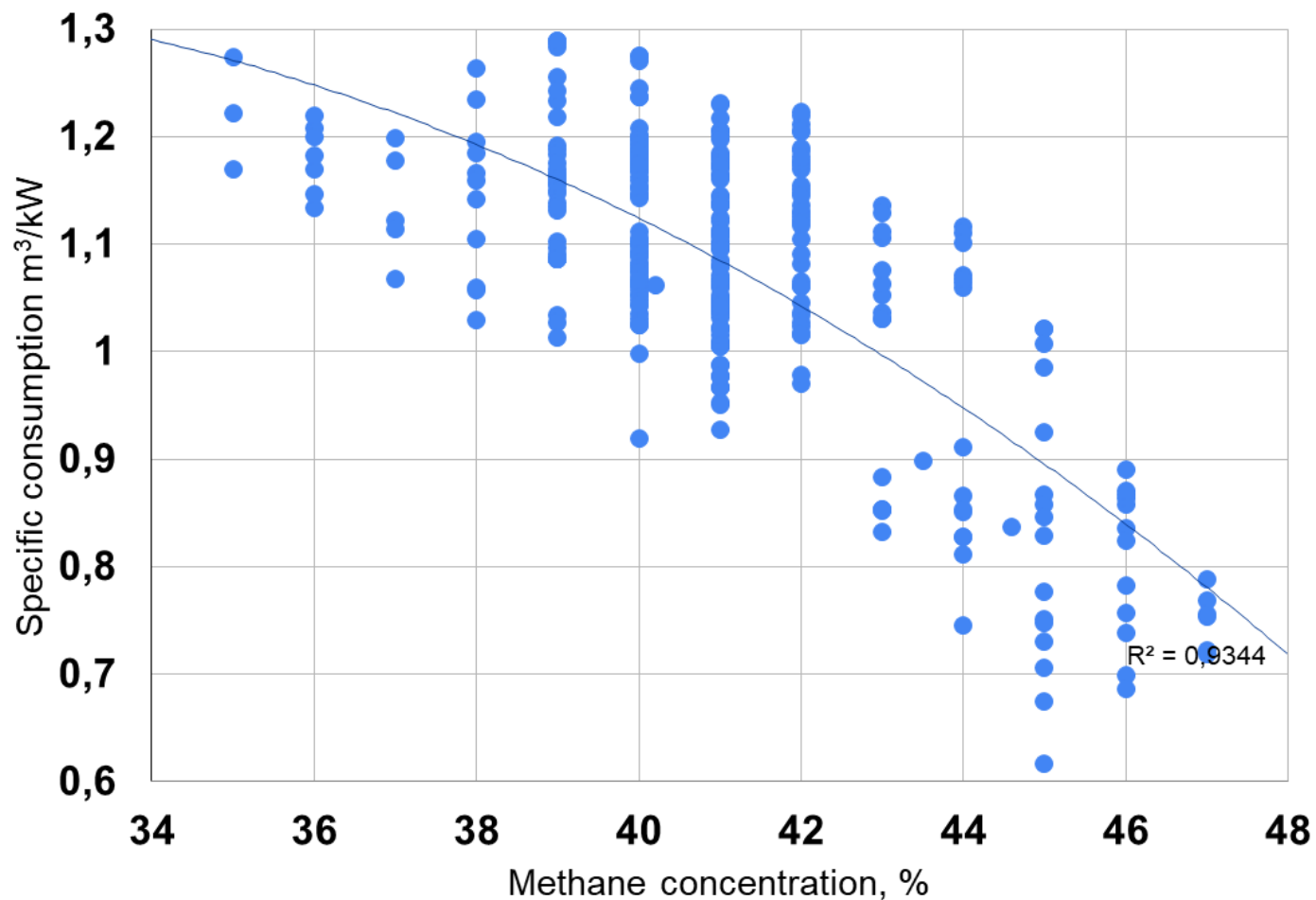
The variant of biogas enrichment (CO₂ extraction) with high air content (N₂ = 20-40 %) is considered. The concentration of methane increased by 1.2-1.4 times and the specific energy consumption amounted to 1.0 kWh/kg_CO₂ for all biogas compositions



	Biogas		
	G = 250 Nm ³ /h; t _{abs} = 40 ⁰ C; P _{abs} = 0.26		
	Composition, % (vol.)		
Absorbent - MDEAmod	CH ₄ -50	CH ₄ -45	CH ₄ -40
	CO ₂ -30	CO ₂ -25	CO ₂ -20
	N ₂ -20	N ₂ -30	N ₂ -40
Absorbent consumption, kg/h	2318	1733	1346
Content in methane gas, % (vol.):			
CH ₄	68,3	57,3	47,8
CO ₂	1,2	1,2	1,1
Output of gaseous CO ₂ , kg/h	143	118	92
Thermal load of reboiler desorber, kW	159	118	93
Specific consumption when obtaining gaseous CO₂, kW/kg_CO₂	1,1	1	1

Field research: Fuel consumption

Specific consumption methane concentration

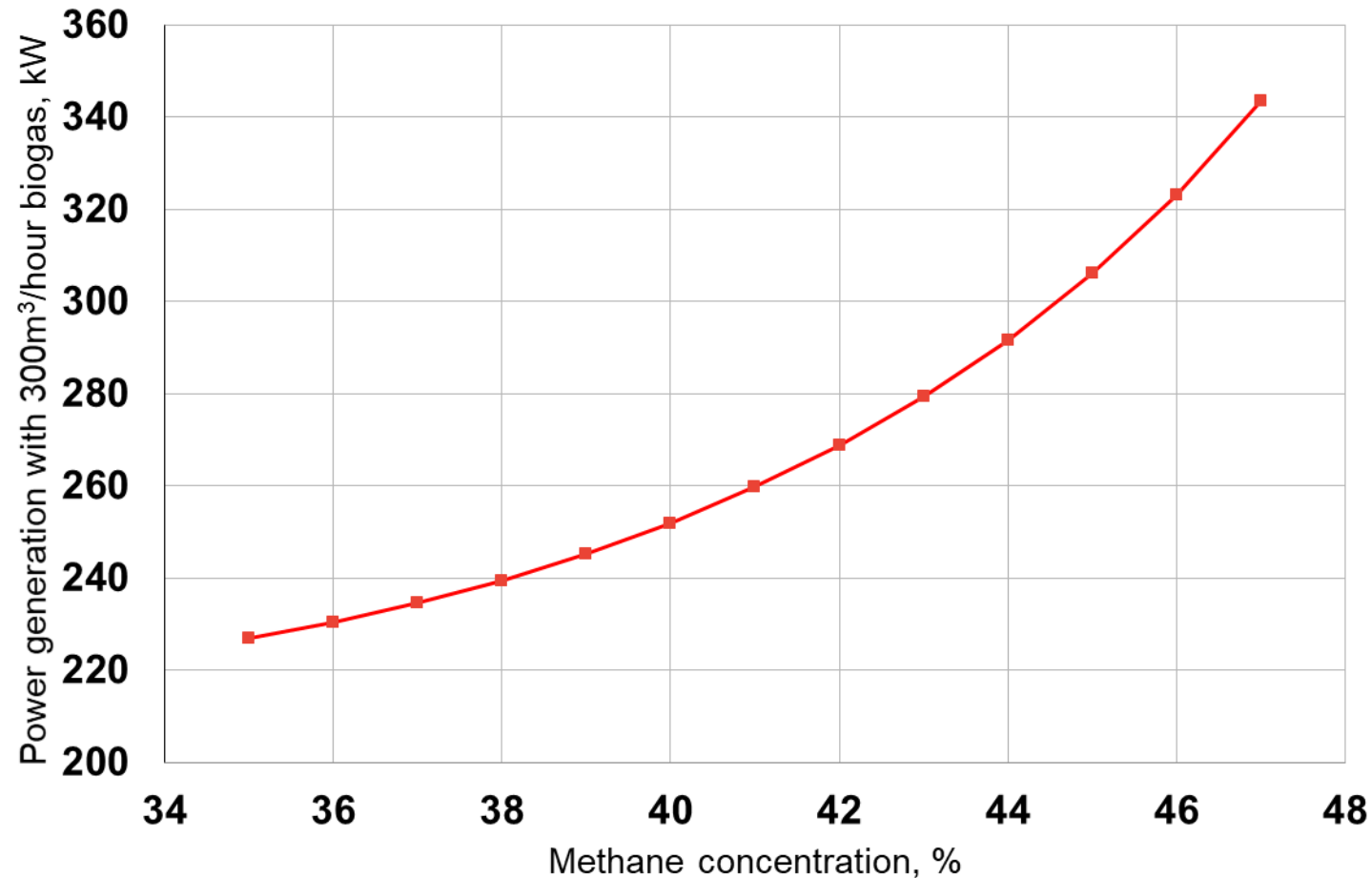


500 kW power station in Kamianets-Podilskyi town fuel consumption vs methane concentration was explored during last 2 years

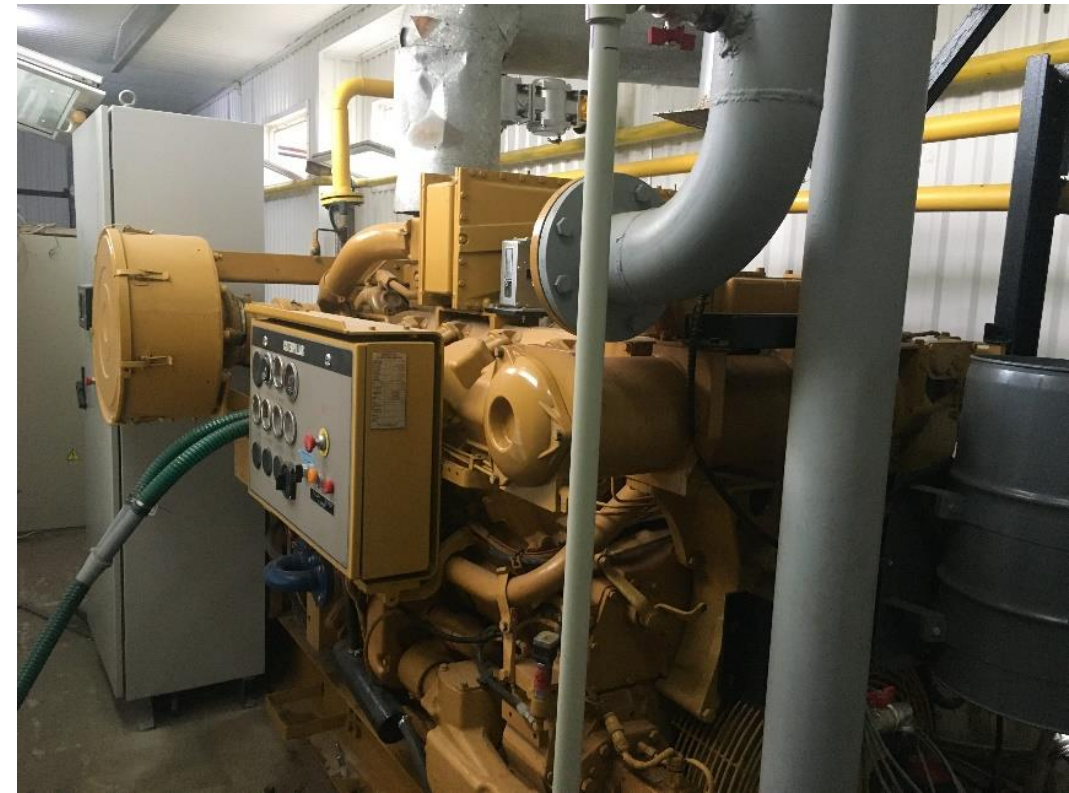


Field research: Power generation

Power generation vs methane concentration

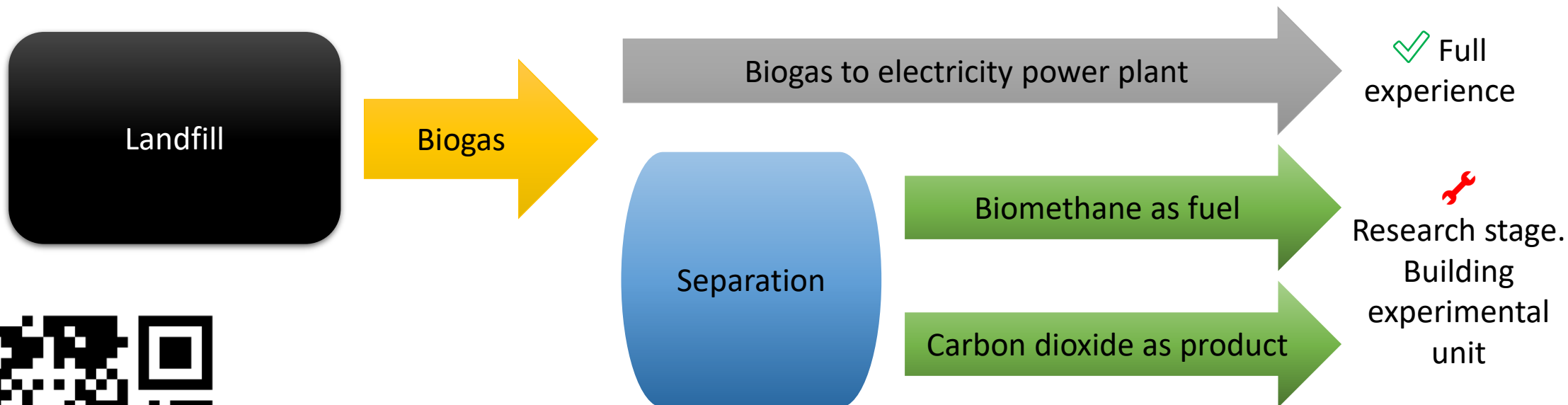


Caterpillar G3508: Rising of methane content in landfill gas causes specific gas consumption decrease and power generation increase.



STOP WAR
IN UKRAINE

Thank you for attention



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