POLLUTANT EMISSIONS FROM GAS TURBINE AND GAS ENGINE UNITS OPERATING ON NATURAL GAS

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Electricity-generating units employing modern gas turbine (GTU) and gas engine (GEU) technologies will soon form the foundation of Ukraine's distributed power generation system, enhancing its resilience, reliability, and efficiency during wartime and post-war periods (Khalatov & Fialko, 2025).

Gas turbine and gas engine systems possess several advantages, including high electrical efficiency, relatively low noise and vibration during operation, broad power range, low auxiliary power consumption, cost-effective operation under partial loads, serial production, well-established maintenance infrastructure, and the ability to use various fuels such as biogas, synthesis gases, and hydrogen (Bednarska et al., 2024).

In the European Union (EU), stringent environmental safety requirements apply to industrial combustion installations. Directive (EU) 2010/75/EU and Directive (EU) 2015/2193 set binding limits on pollutant emissions from medium (1-50 MWh) and large (>50 MWth) thermal combustion plants. The total thermal input of fuel across all units connected to a single exhaust stack is taken into account.

The purpose of this study is to compare the emission limits of nitrogen oxides (NO_x) and carbon monoxide (CO) from gas turbine and gas engine installations operating on natural gas, considering their categorization by total thermal input per stack-below and above 50 MWh

Analysis of Directives (EU) 2010/75/EU and (EU) 2015/2193 reveals that for units below 50 MWth, CO emission limits are not regulated, which may influence technology selection during design. For units exceeding 50 MWth, stricter NO_x and CO limits require advanced combustion control or flue gas treatment technologies. For installations fueled by biogas, sulfur dioxide emissions are also regulated.

Power category (MW)	Gas turbine units				Gas piston units			
	Polluting substance/concentration				Polluting substance/concentration			
	NO_x, mg/nm³		CO, mg/nm³		NO_x, mg/nm³		CO, mg/nm³	
Fuel	Natural gas	Biogas	Natural gas	Biogas	Natural gas	Biogas	Natural gas	Biogas
1–50 available	200	60	not regulated	not regulated	190	60	not regulated	not regulated
1–50 new	75	15	not regulated	not regulated	95	15	not regulated	not regulated
> 50	50	-	100	-	50	-	100	-

For GTUs above 50 MWth, actual average NO_x emissions reach approximately 150 mg/m³, which is about 30% higher than for GEUs, due to higher specific thermal loads during combustion (Gensets and the Medium Combustion Plant Directive, 2023). Categorization flexibility allows reclassification of GTUs and GEUs by grouping several smaller units under a single exhaust system.

The results can be applied in the modernization of Ukraine's energy infrastructure during post-war recovery to ensure compliance with EU environmental standards. Further research should focus on the effects of biogas, biomethane, and hydrogen-based fuels on pollutant emissions, as well as NO_x prevention and gas cleaning technologies for gas turbine and gas engine systems.

Conclusions. A comparative analysis of NO_x and CO emission limits for gas turbine and gas engine power plants using natural gas has been performed in line with Directives (EU) 2010/75/EU and 2015/2193. It was determined that installations under 50 MWth are not regulated for CO emissions, while larger systems are subject to stricter emission standards.

References:

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