

## EVALUATION OF POLLUTANT EMISSIONS FROM A HYBRID OVEN (WOOD-FIRED AND GAS-FIRED)

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### 1. Introduction

Non-industrial combustion is amongst the macrocategories of anthropogenic emissions, as classified by the EEA. Within non-industrial combustion, wood burning contributes to the emissions of the major air pollutants, such as particulate matter (PM), carbon monoxide (CO), organic gaseous carbon (OGC) and polycyclic aromatic hydrocarbons (PAHs) [1]. Emissions from this sector derive mainly from small-scale residential heating and cooking appliances. However, a non-negligible contribution has been estimated also for wood-burning ovens used in pizzerias [2]. This is especially the case in urban areas, where there is a higher concentration of establishments which make use of these devices, and population density is high, resulting in hot-spots of human exposure to wood burning. The interest of public administrations in pollutant emissions produced by pizzerias equipped with wood-fired ovens is therefore high, as these administrations are, on the one hand, driven to counteract a very relevant pollutant source, but on the other hand they are cautious about affecting a relevant economic sector and a product particularly appreciated by consumers and typical of Italian tradition.

### 2. Results and Discussion

Emission factors of the main air pollutants emitted by biomass burning (NO<sub>x</sub>, CO, PM, PAHs, OGC) were determined through the execution of experimental tests on an hybrid oven, which can operate both as a wood-fired oven and as a gas-fired one. Two different type of fuels were tested in the wood-fired operational mode: beechwood logs and beechwood briquettes. This essence was selected as it is currently the most widespread in Italian pizzerias, especially in the Northern part of the country. An ad-hoc sampling system was constructed by making reference to the UNI EN 16510-1:2019 technical standard and a new sampling protocol was designed to ensure reproducibility of the tests. All the main phases of oven operation were investigated (cold-ignition, hot re-ignition, stationary cooking) and standard reference combustion cycles were defined for each one. The stationary phase was tested both with and without pizza cooking in order to evaluate the possible impact of this activity on the emissions of the oven.

Based on the data obtained from the experimental tests, the pollutant emissions of the hybrid oven operated with the wood-burning mode fall within the wide range of values observed in literature for other wood-burning appliances, such as stoves and fireplaces [3]. Instead, tests on the oven used with the gas-firing mode show comparable emissions of NO<sub>x</sub> and a significant reduction in the concentrations of CO and PAHs. Moreover, the use of the gas-fired system enabled to shed light on the effect of pizza cooking on the emissions of OGC and PM. Indeed, by removing the contribution of wood-burning it was possible to highlight the significant impact of pizza cooking on the emissions of OGC during the stationary phase. Moreover, unlike the tests conducted in the wood-fired mode, a significant degree of condensation of semi-volatile organic compounds was observed in the dilution tunnel, as observed by the difference in concentration between particulate matter sampled on the hot and on the cold fumes.

In the absence of specific legislation and/or regulations regarding the emissions of wood-fired pizza ovens, the experimental emission factors determined in this study were compared to the current EU policy regarding emission reduction from domestic combustion. Specifically, the observed values were compared to the 2020



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emission requirements for open fronted solid fuel local space heaters. The emissions of both the wood-fired and gas-fired ovens are below the thresholds with regards to NO<sub>x</sub> and CO, whereas concentrations of OGC and PM often exceed the imposed limits. In both cases, the pizza cooking activity has an important contribution to the emissions for the considered parameters, clearly distinguishable from the emissions deriving from the combustion of the fuel.

### 3. Conclusions

The results of this study represent a significant step forward towards understanding the extent of the contribution of wood-fired pizza ovens to the emissions of the major air pollutants. Indeed, to the knowledge of the authors, this is the first-ever experimental determination of the emission factors of these devices. The data which is currently present in local emission inventories is based on estimates and modelling approaches and not on experimental testing. Hopefully, these results will help regulatory bodies to update the inventories and determine whether specific actions are necessary in order to limit the environmental impact of cooking ovens, whilst safeguarding a relevant economic sector and traditional product of the Italian culture.

### References

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