Novel Electrified Chemical Plant based on Biogas Combustion for Syngas Generation by *in situ* CO_2 Chemical Transformation

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The aim of this work is to demonstrate the operational performance of a prototype of an innovative and sustainable chemical plant to produce syngas with possible co-generation of oxygen, hydrogen, electrical and thermal energy from combustion of biogas. The novelty consists in the innovative connection of existing technological equipment integrated into a single multi-generation plant with a high-temperature solid-oxide electrolytic cell (SOEC) and a solid-oxide fuel cell.

Part of the produced H_2 is fed to the Reverse Water-Gas Shift (RWGS) unit, which produces syngas at the desired composition. The remaining part of H_2 and the produced O_2 are fed to a SOFC, to recover part of the electrical energy used in a SOEC. The recovered electric power feeds a fixed-bed electric drying column for biomass pellets. The validity of the prototype was preliminary confirmed within the UniSim Design® software. The prototype is built on a laboratory scale in the premises of the research infrastructure of UNICAL, "S.I.L.A.", specifically dedicated to chemical plants.

The successful development of the aforementioned electrified plant would lay the foundations for developing an integrated syngas network between small/medium process industries and agricultural companies, which would work in synergy in a sustainable manner, promoting the industrial development of the territory. In addition, steam and hot water service lines could be installed to heat civilian homes and for sanitization in hospitals.

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