Steam gasification of carbonaceous materials is examined in a hybrid solar/autothermal process designed to continuously produce synthesis gas. The process operates in three modes: 1) steam gasification with the necessary process heat to drive the chemical reaction derived from concentrated solar irradiation, 2) autothermal steam gasification where pure oxygen is used to combust a portion of the carbonaceous feedstock for process heat, i.e., oxy-combustion, and 3) a combined mode during periods of low direct-normal solar irradiation where process heat is derived from a combination of solar irradiation and oxy-combustion. The resulting syngas can be continuously converted to liquid fuels via Fischer-Tropsch or other catalytic processes. Hybrid gasification affords a number of benefits over conventional autothermal gasification including reduced CO$_2$ emissions, pollutants, tars, dilution, and O$_2$ consumption. The process is investigated using thermogravimetry, computational modeling, and prototype testing in a high-flux solar simulator. Preliminary heat and mass transfer modeling using lignite coal as the feedstock demonstrates controllability and shows cold gas (upgrade) ratios of 1.2 when operating in a solar mode and 0.87 when operating autothermally. Thermogravimetric analyses of gasification and combustion using activated charcoal, bituminous coal, and miscanthus char are performed. Kinetic fits using Langmuir-Hinshelwood-type rate laws are developed. These kinetic rate laws will be used in prototype design and modeling. An indirectly-irradiated fluidized-bed reactor will be fabricated and tested in a high-flux solar simulator, monitoring temperatures and outlet gas concentrations under a set of lamp power and inlet gas conditions. This study will be the first experimental on-sun investigation of such a concept, demonstrating a process that can operate continuously while utilizing an intermittent, renewable resource.