The recurring need for advantaged feedstocks as precursors to chemicals and fuels brings us once again to scientific and engineering matters pertaining to the conversion of molecules without any C-C bonds, such as methane, methanol, and dimethyl ether. Such C1 molecules, especially methane, present thermodynamic and kinetic challenges that bring significant complexity and costs into their chemical transformations. We gather here some unifying concepts and, in doing so, provide guidance about the most attractive C1 conversion strategies. These concepts include (i) thermodynamic constraints and the limitations of catalysis in circumventing them; (ii) the pre-eminence of process simplicity and inexpensive oxidants over the allure of direct conversions; (iii) the enduring and practical principles of kinetic and thermodynamic protection (iv) the coupling of separations with reactions and of multiple catalytic functions; (v) the prevalence of kinetic bottlenecks in forming the first C-C bond; and (vi) the emergence of a C2 conversion platform as we overcome (or accept) the limits of C1 chemistries. The conclusions are sobering, as the magnitude of the challenge so warrants.

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