The high solubility of gases in ionic liquids (ILs) has been the object of extensive research during the last few years. Aiming at enhancing the solubility and ultimately replace the hazard volatile organic compounds, many researchers have judiciously tailored ILs to accomplish such task. Nonetheless, and despite of the promising properties of ILs, further research is still required in order to make them feasible candidates for real applications. Being a key parameter in the design of equilibrium stage– and rate–based separations, reliable gas solubility data is of most interest and a fundamental step towards the development of industrial applications, either by the data itself or by developing predictive and simulation tools to aid in the development of such applications. Using a high pressure cell, previously used for extensive studies of CO$_2$ and CH$_4$ solubilities, VLE isotherms up to 363 K and pressures up to 100 MPa were measured for mixtures of CO$_2$, CH$_4$, N$_2$ or N$_2$O with several highly polar ionic liquids. Furthermore, the non-ideality is here investigated and shown that, with the exception of CO$_2$ that present negative deviations$^{[1]}$, the remaining systems present positive deviations to the ideality in the liquid phase. For last, the effect of the ionic liquid polarity, described through the Kamlet-Taft solvatochromic parameters, on the selectivities is investigated and shown to stand as a viable tool for the selection of ILs with enhanced selectivities.